GTR55

TIME & FREQUENCY TRANSFER GNSS RECEIVER

Version 1.1

OPERATING INSTRUCTIONS

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MESIT asd, s.r.o.
Sokolovská 573, Mařatice
686 01 Uherské Hradiště
Czech Republic

T +420 572 522 603
F +420 572 522 836
E-mail: defence@mesit.cz

Service support:
T +420 572 522 550
F +420 572 522 836

Technical support:
E-mail: defence@mesit.cz

For updated contacts see www.mesit.cz

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CONDITIONS OF GUARANTEE

The manufacturer guarantees the quality and completeness of the unit for the period stated in the purchase contract or order.

The warranty shall not apply:

a) to damages caused by extraordinary circumstances;

b) to damages caused by customer after delivery, by unauthorized intrusion, by unskilled servicing, by incorrect installation, by misuse for different purpose or operation than the purpose for which the unit was designed;

c) as a result of an accident occurring during transport;

d) if the seal is broken;

e) when the unit was not maintained according to the operating instructions.

The customer must not repair the unit in any manner without the supplier's approval during the guarantee period.

Warranty-covered repairs are carried out by the manufacturer or manufacturer certified service center.

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1. Introduction

The GTR55 is multisystem/multifrequency GNSS (Global Navigation Satellite System) receiver intended for time & frequency transfer. The receiver supports both code and carrier phase measurements. Thanks to large receiver bandwidth and advanced signal processing, even the code measurements provide sub-nanosecond accuracy. The built-in calibrator measures continuously the internal delays of all supported signals ensuring high long-term stability. The receiver can be directly connected to a local net/internet which allows remote control and output data download and upload.

Operation

The operation is fully automatic. After the very first configuration, the receiver continuously collects the measurement data. Output files in several standard and proprietary formats can be generated from the collected data. The data processing can be started manually or by a scheduler which enables routine processing at given times (weekly, daily, hourly). The resulting data files can be downloaded from the receiver, automatically uploaded to a server or automatically saved to an external disk. A brief message is sent to an e-mail address after the processing is finished. The output measurement data can be referenced to the input 1PPS and/or to the output 1PPS time reference.

Remote control

The receiver can be controlled from any computer on the net. The User Interface has the form of a web page which can be accessed using a web browser. It enables control of the receiver, monitoring of the receiver operation, and download of the measurement data. Authorization is required to access the receiver.

Diagnostic system

The diagnostic system indicates several dozens of operational events and states. The diagnostic messages can be recorded in the log, displayed in the User Interface, and sent to an e-mail address.

Monitoring with graphical representation

History of operational parameters (time difference, temperature, satellite elevation/azimuth, etc.) is displayed in graphs in the User Interface.

2. Technical Specifications

Time Reference Input

Input signal:	1PPS (leading edge)
Connector type:	BNC-f
Input impedance:	50 Ω
Trigger level:	0 - 2.5 V adjustable
Max level:	5.5 V / 50 Ω
Min level:	-0.1 V / 50 Ω

The 1PPS time mark must be coherent with the frequency reference at the 10 MHz input and it must be in the range UTC ± 2 ms.

Time Reference Output

Output signal:	1PPS (leading edge)
Connector type:	BNC-f
Low level:	0 - 0.05 V / 50 Ω
High level:	1.8 - 2.5 V / 50 Ω

Frequency Reference Input

Input signal:	10 MHz
Connector type:	TNC-f
Input impedance:	50 Ω
Max level:	3 Vpp / 50 Ω
Min level:	0.5 Vpp / 50 Ω

Precision

Code measurement:	< 0.3 ns RMS (CGGTTS data, short-baseline common view)
Phase measurement:	< 15 ps RMS (short-baseline common view)
Ionospheric delay:	< 2 ns RMS (CGGTTS data)

Output Data Formats:

CGGTTS (all tracks / all satellites in view, MSIO iono-delay), versions 01, 02, 2E
RINEX (observation / navigation files)
versions 2.10 (GPS only), 2.11, 3.01
L3P_30s (standard P3 data, 30 s sampling period), versions 02, 2E
L3P_1s (P3 data, 1 s sampling period) , versions 02, 2E
ESA (format similar to L3P with 5-minute tracks)
RAW (proprietary format, all signals, both code and carrier phase data)
EL_MASK (CNR analysis and search for obstacles)
STAT (statistics of collected measurement data)
1PPS_DIF (proprietary format, REF_IN - REF_OUT difference)

GNSS Receiver

Supported signals:	GPS: L1 C/A , L1P, L2C, L2P, L5 GLONASS: L1OF, L1SF, L2OF, L2SF, L3OC GALILEO: E1, E5a, E5b, E5 AltBOC, E6 NAVIC: L5 ready SBAS: L1, L5
Type of measurement:	code / carrier phase, referenced to input / output time reference
Connector type:	TNC-f
Receiver bandwidth:	up to 60 MHz
Number of satellites:	all in view
Number of HW channels:	864

Built-in calibrator measures continuously the internal delays of all supported signals including GLONASS inter-channel biases ensuring low temperature dependence and high long-term stability.

Time Interval Counter

Precision:	< 10 ps RMS

Dimensions:	19"/2U standard chassis
Power Supply:	100 - 240 V AC / 50 - 60 Hz
Operating Temperature:	0 to 50°C

Antenna

Antenna supply:	5 V / up to 90 mA (plus on inner contact)
Recommended antennas:	Novatel GPS-704-WB Novatel GNSS-850
Optional amplifier supply:	12 V / up to 90 mA

3. Standards and Recommendations

Receiver operation, parameters, and output data formats comply with the following recommendations:

CGGTTS guidelines for manufacturers of GNSS receivers used for timing, Consultative Committee for Time and Frequency - Group on GNSS Time Transfer Standards (CGGTTS), June 2001.

D.W. Allan, C. Thomas, "Technical Directives for Standardization of GPS Time Receiver Software," Metrologia, vol. 31 (1994), p.69-79.

P. Defraigne, G. Petit, "CGGTTS - Version 2E: an extended standard for GNSS Time Transfer," Metrologia, vol. 52 (2015) G1, no. 6, p. 1-22.

J. Azoubib, W. Lewandowski, "CGGTTS GPS/GLONASS data format Version 02," Document of the 7th CGGTTS Meeting, 1998.

W. Gurtner, "RINEX The Receiver Independent Exchange Format, version 2.10," Astronomical Institute of the University of Berne 2000.

W. Gurtner, "RINEX The Receiver Independent Exchange Format, version 2.11,". Astronomical Institute of the University of Berne 2007.

W. Gurtner, "RINEX The Receiver Independent Exchange Format, version 3.01," Astronomical Institute of the University of Berne 2009.

RINEX The Receiver Independent Exchange Format, version 3.03, International GNSS Service, July 2015.

IGS Site Guidelines, International GNSS Service, April 2012.

4. Getting Started

4.1 Installation

1. Connect power supply 100 – 240 V AC to the connector on the rear panel.
2. Connect GPS antenna cable to the ANT (TNC-f) connector on the front panel. The device provides the antenna supply +5 V (up to 90 mA) on the inner contact of the connector. In case that an antenna cable is longer than 50 m, we recommend to use an optional external cable amplifier supplied from the 12 V connector on the front panel.
3. Connect 10 MHz frequency reference to the 10 MHz (TNC-f) connector on the front panel. The signal level must be between 0.5 Vpp and 3.0 Vpp.
4. Connect 1PPS time reference signal to the 1PPS (BNC-f) connector on the front panel. The input impedance is 50 Ω. The mark is supposed to be referenced to the leading edge. The trigger level can be set from 0.0 to 2.5 V. The high level of the mark should not be higher than 5.5 V / 50 Ω. The input 1PPS time mark must be coherent with the frequency reference at the 10 MHz input. When only measurements related to the output 1PPS time reference are required, the input 1PPS reference signal does not need to be connected.
5. Connect the ethernet cable to the connector on the rear panel.

4.2 Net administration

Contact your net administrator and ask him or her to perform following configurations:

1. DHCP server configuration. The device expects automatic configuration of IP address and related settings from DHCP server. The IP address should be from the static pool.
2. DNS server configuration. Name of the device must be associated to the IP address.
3. Firewall configuration. If the device should be accessible through a firewall, it must be transparent for following protocols: HTTP, SMTP, FTP, SSH.

The Ethernet HW address and a name of the device are necessary for the configurations. The Ethernet HW address is written on a label on the rear panel. Choice of the device name is up to the user.

4.3 Switching on

Press the power button on the front panel.

4.4 LEDs

Two LEDs provide the very basic information about the GTR55 operation.

Receiver LED

When the receiver is on and no satellites are tracked, the LED is red. Otherwise this LED blinks as follows:

- a green blink for each GPS, GALILEO, BeiDou and SBAS satellite being tracked,

- an orange blink for each GLONASS satellite being tracked,

- a pause if at least one satellite has CNR> 48 dBHz or red blink if no satellite has CNR> 48 dBHz.

Trigger LED

When measurement is running and 1PPS_IN is connected, the LED blinks after every 1PPS mark trigger. Otherwise, it does not blink.

4.5 User Interface

The GTR55 can be controlled and its operation monitored using a User Interface which has form of a web page and can be accessed using a web browser. The User Interface is described in detail in the chapter 5.

4.6 Startup

1. Turn on the GTR55.
2. Enter URL of your GTR55 to the web browser (URL = http://<host name>).
3. After the login field of the User Interface appears, enter your user name and password. Factory default: User = user, Password = user. It is strongly recommended to change these default values (see 6.3).
4. Wait till the measurement starts.

Now the measurement is running and the measurement data being collected on the HDD in hourly files. Do not do any Device or Site & Time Reference settings after the measurement starts. The measurement must be stopped before these settings are done.

4.7 Monitoring of operation

The device operation can be monitored using the **Display** functions: **Time Difference, CGGTTS Data, Diagnostics, Satellites, Temperature, Position, Log,** and **Receiver Information**. The functions are selectable from the menu.

4.8 Measurement data processing

1. Select the **Control / Processing** in the menu.
2. Select the desired type of processing:

   RINEX_O generates a RINEX observation file only.

   RINEX_ON generates RINEX observation and navigation files.

   CGGTTS generates a CGGTTS file (all tracks / all satellites in view).

   RAW generates a proprietary format file which includes both code and carrier phase measurements (see Attachment V).

   EL_MASK analyzes the dependence of the signal-to-noise ratio on azimuth and elevation and searches for obstacles around the antenna.

   STAT provides statistics of available measurement data.

   L3P_1s generates nonstandard P3 data based on measurements taken with 1 s sampling period. The fit algorithm is identical to the algorithm used in the classical CGGTTS protocol.

   L3P_30s generates standard P3 data based on measurements taken with 30 s sampling period.

   ESA generates a data file similar to CGGTTS / L3P, but with the track length of 5 minutes (GPS, GLONASS, GALILEO, BeiDou, Attachment IX).

   1PPS_DIF generates a proprietary format file which includes time differences between REF_IN and REF_OUT 1PPS marks (see Attachment VI).
3. Select the desired version of the data format for RINEX and CGGTTS:

   RINEX V2.10 (only GPS), V2.11, V3.01,

   CGGTTS V01, V02, V2E.
4. Select date and time of the first observation to be processed (MJD or date in ISO format, UTC or GPS time).
5. Select length of the observation to be processed (days, hours and minutes).
6. Select period of observation (only for RINEX, RAW, EL_MASK, and 1PPS_DIF).

7. Select time reference (external / internal). In default the measurement results are referenced to external 1PPS time marks connected to the 1PPS_IN connector.
8. Select satellites to be processed. All satellites are processed in default.
9. Select whether an e-mail message at the end of the processing should be sent.
10. Press the **Start Processing** button.

List of running processes is shown at the top of the page. A sequence number (0..99) which serves for identification of the resulting data, is assigned to every process. All the running processes can be stopped by the **Kill All** button.

Resulting files can be downloaded at the **Control / Get File** page. Only files from last five processes are kept. Older files are automatically deleted. In the case of RINEX, CGGTTS, RAW, L3P, ESA, and EL_MASK processes, a copy of the resulting data file with a generic name is also generated. These files are automatically deleted after 30 days.

4.9 Shutdown

1. Press the **Maintenance** button in the menu.
2. Press the **GTR55 shutdown** button.

Wait until the device switches off.

5. GTR55 User Interface

The User Interface enables remote control and monitoring of the device operation. It has the form of a web page which can be accessed using a web browser.

5.1 Access to User Interface

1. Enter URL of your GTR55 to the web browser (URL = http://<host name>).
2. After the login field appears, enter your user name and password. Factory default: User = user, Password = user. It is strongly recommended to change these default values (see 6.3).

Caution: Do not leave the computer logged in for more than a day to prevent the operating system hangs!

5.2 Appearance of User Interface page

Each page of the User Interface consists of four areas. The device type and its name (see **Settings / Site & Time Reference**) are on the top of the page, the main menu is on the left and the firmware revision number is on the bottom. The main content is in the large area on the right. Some pages are refreshed automatically.

5.3 Homepage

The home page provides the basic information on the device operation. It is being refreshed every 5 seconds. The following data are displayed:

Last Status Update - UTC date and time of last update. Before UTC parameters are received, GPS time is displayed.

State - Receiver state according to the state diagram in the attachment I.

Satellites - Numbers of GPS, SBAS, GALILEO, GLONASS and BeiDou satellites being received.

Ext. Ref. - Indication of 1PPS and 10 MHz external reference connection.

Diagnostics - Indication of diagnostic alerts/warnings. Detailed diagnostic information is available at **Display / Diagnostics** and **Display / Log** pages.

5.4 Control functions

Measurement

The measurement can be stopped and started from this page in order to setup Device or Site & Time Reference parameters. Please note that the measurement starts automatically after the receiver is turned on. The measurement must be stopped first to change instrument configuration.

Scheduler

The scheduler starts a processing task at a given time. Repeated data processing (weekly, daily, hourly) is also possible. An asterisk (*) in Day of Months, Month and Day of Week means "every".

These types of processing can be started from the scheduler:

CGGTTS V01/V02/V2E generates a CGGTTS file from all observations from the last week/day.

L3P V02/V2E generates a standard P3 data file from all observations from the last week/day.

RINEX_ON V2.10/V2.11/V3.01 generates an observation RINEX file with 30 s / 5 s observation period from the last day/hour and corresponding navigation RINEX files.

ESA generates an ESA data file from all observations from the last day/hour.

RAW generates a RAW data file from all observations from the last day/hour.

The resulting data files can be downloaded at page **Control / Get File** or automatically uploaded to a server. A brief message can be sent to an e-mail address after the processing is finished. The e-mail and ftp addresses can be set at the **Settings / Communication** page.

Processing

A processing task can be started from this page. The following types of processing can be selected:

RINEX_O generates a RINEX V2.10, V2.11 or V3.01 observation file (for observation types see Appendix VII). The observation data can be related to the input or output time reference. Receiver delay corrections are applied on the code measurement data to keep them consistent with other processing results.

RINEX_ON generates RINEX observation and navigation files.

CGGTTS generates a CGGTTS file V01, V02 or V2E (all tracks / all satellites in view).

RAW generates a proprietary format file which includes both the code and carrier phase measurements (see Attachment V).

EL_MASK analyzes the dependence of the signal-to-noise ratio on azimuth and elevation and searches for obstacles around the antenna.

STAT provides statistics of available measurement data.

L3P_30s generates standard P3 data V02 or V2E based on measurements taken with 30 s sampling period.

L3P_1s generates nonstandard P3 data V02 or V2E based on measurements taken with 1 s sampling period. The fit algorithm is identical to the algorithm used in the classical CGGTTS protocol.

ESA generates a proprietary format similar to CGGTTS / L3P, but with the track length of 5 minutes (GPS, GLONASS, GALILEO, BeiDou, see Attachment IX).

1PPS_DIF generates a proprietary format file which includes time differences between REF_IN and REF_OUT 1PPS (see Attachment VI).

Prior to the start of the processing select:

- desired type of processing,
- desired version of the data format for RINEX, CGGTTS and L3P,
- date and time of the first observation to be processed (MJD or date in ISO format, UTC or GPS time),
- length of observation to be processed,
- period of observation (only for RINEX, RAW, EL_MASK, and 1PPS_DIF),
- satellites to be processed.

An e-mail announcement can be sent after the processing finishes. The e-mail address is to be set at the **Settings / Communication** page.

List of running processes is shown at the top of the page. A sequence number (0..99), which serves for identification of the resulting data, is assigned to every process. All the processes can be stopped by the **Kill All** button. Resulting files can be downloaded at the **Control / Get File** page.

Get File

Resulting data files can be downloaded from this page. Every process generates a data file and a log file which includes a brief description of the process. Both files are identified by the process sequence number. Only files from last five processes are kept. Older files are automatically deleted.

In the case of RINEX, CGGTTS, RAW, L3P, ESA, and EL_MASK processes, a copy of the resulting data file with a generic name is also generated. These files are automatically deleted after 30 days.

All files in the folder can be deleted using **Maintenance / Delete output data** button.

Maintenance

Field of buttons at this page enables one to start and stop the measurement program, set all the device settings to default values, delete all measurement data, delete all output data, delete the log file, enter calibration delays, and shut down the device. Once the device has been shut down, it can be turned on again only by the HW button on the front panel.

5.5 Display functions

Time Difference

This page displays online results of one-way measurement of the (Input/Output Reference Time - GPS Time) difference.

The following data are displayed:

Time Difference - Graphs of the last 24 hours history of the time differences.

Current Time Difference - Last measured time difference.

Mean Time Difference - Average of time difference over history shown in the graph.

Linear Fit / Slope - Slope of the time difference estimated from linear fit over the last 24 hours.

Linear Fit / Current Time Difference - Current time difference estimated from linear fit over the last 24 hours.

Scale of the graph can be set at **Settings / Graphs**. It is not necessary to stop measurement prior this graph settings.

CGGTTS Data

This page displays the CGGTTS and L3P data from the last generated files.

For GPS, GLONASS, GALILEO and BeiDou the following data are displayed in tabs:

- Graph of the REFSYS data.

- Latest observed time difference.

- Average of time difference over history shown in the graph.

- Slope of the time difference estimated from linear fit over the history shown in the graph.

Scale of the graphs can be set at **Settings / Graphs**. It is not necessary to stop measurement prior this graph settings.

Diagnostics

This page displays the current diagnostic states and last five reported diagnostic events. Only the states and events tagged at **Settings / Device / Diagnostics / UI Ind.** are displayed. Each message consists of its importance category (I: information, W: warning, A: alert), time of the occurrence and a brief description.

Satellites

Information about every GNSS satellite is displayed in the table. There is a tab for every GNSS. Clicking on a table item opens a new window with graphs of the 1-day history of the parameters.

The following data are displayed:

PRN - Satellite number.

EL - Satellite elevation.

AZ - Satellite azimuth.

CNR - Signal-to-noise ratio for every signal of the given GNSS.

Scale of the CNR graphs can be set at **Settings / Graphs**. It is not necessary to stop measurement prior this graph settings.

Temperature

This page displays temperature in the receiver box and the receiver board temperature including graphs of their 1-day history:

Temperature - Temperature in the receiver box.

Receiver board temperature - Temperature of the receiver board.

Scale of graphs can be set at **Settings / Graphs**. It is not necessary to stop measurement prior these graph settings.

Position

The page displays the currently measured X, Y, Z antenna position referenced to WGS-84 frame, as a result of autonomous (not differential) measurement, or the position entered in **Settings / Site & Time Reference**.

Log

This page enables access to the log of diagnostic records. Only the states and events tagged at **Settings / Device** are recorded. Every diagnostic record consists of date/time of the event, category of importance (I – information, W – warning, A - alert) and a brief description. A message indicating the start or end of a state contains the letter S or E in addition. All records can be sorted by date/time, type, or description. Search in all categories is available.

Receiver information

This page displays information on the receiver (serial number, SW version, IGS name) and the receiver board (model, ID, FW version), list of available receiver features, and the summary of the calibration delays.

5.6 Settings functions

Site & Time Reference

This page allows all settings associated to the site and the time reference. Changes in settings are possible while the measurement is not running (IDLE or WARMUP state).

Site:

Site - Identification of Site & Time Reference settings.

Lab - Laboratory name for CGGTTS file header (LAB) and RINEX file header (RUN BY, AGENCY).

Observer - Observer name for RINEX file header (OBSERVER).

Marker - Marker name for RINEX file header (MARKER NAME).

Marker No. - Marker number for RINEX file header (MARKER NUMBER).

Antenna:

Antenna Type - Type of the antenna for RINEX file header (TYPE)

Antenna No. - Antenna serial number for RINEX file header (ANT #).

Antenna Delta H/E/N: Height and horizontal eccentricity (east/north) of the antenna reference point with respect to the marker in meters. If not known, use zeros.

Antenna Position:

X, Y, Z - Antenna position XYZ [m]. If not known, enter 0, 0, 0 and use the measured RINEX data for the position computation.

Frame - Reference frame for CGGTTS file header (FRAME).

Elevation Mask: Elevation mask in dependence on azimuth. Only measurements with elevation higher than this elevation mask are processed. EL_MASK processing function can be used to determine the appropriate elevation mask.

Input time reference:

Reference Name - Input time reference name for CGGTTS file header (REF).

Reference Delay - Input time reference cable delay. It is added to all measurement data related to the input time reference.

Trigger Level - Trigger level at the 1PPS input [V]. It can be any value from 0.0 to 2.5 V.

Output time reference:

Reference Name - Output time reference name for CGGTTS file header (REF).

Reference Delay - Output time reference cable delay. It is added to all measurement data related to the output time reference.

Antenna Cable:

Antenna Cable Delay – Antenna cable delay. It is subtracted from all measurement data.

CGGTTS and L3P files:

File Name - The laboratory code and the receiver identification (4 characters). The full CGGTTS file name consists of the letters GM/RM/EM/CM followed by these 4 characters, the first 2 digits of MJD of the start of the observation, dot, and the last 3 digits of the MJD. The full L3P file name consists of the letters GZ/RZ/EZ/CZ followed by these 4 characters, the first 2 digits of MJD of the start of the observation, dot, and the last 3 digits of the MJD. Similar generic names are also used for proprietary ESA and RAW files (see Attachment X).

Comment - Comment for the file header (COMMENTS). The maximum length is 60 characters.

RINEX files:

File Name - First four letters of RINEX file name. The full RINEX file name consists of these 4 letters, day of the year of the start of the observation, a file sequence number within the day, dot, year (last 2 digits), and the letter O for the observation file or N, G, L, H, P for the navigation file. If the file contains all existing observations of the day, the file sequence number is 0. Hourly RINEX files have a letter A..X for hours 0..23 instead of the sequence number.

Comment - Comment for the file header (COMMENT). The maximum length is 60 characters.

Device

This page allows settings of the device operational parameters. Changes in settings are possible while the measurement is not running (states IDLE or WARM UP).

Device Settings:

Device Name - Name of the device for identification in e-mail messages.

Diagnostic Settings:

Events - List of diagnostic events is in the attachment II. Each event is processed depending on the following settings.

Cat - Category of importance (I - information, W - warning, A - alert) to be displayed in the event message.

UI Ind. - If allowed, the event message is displayed in the User Interface.

Log Entry - If allowed, the event is recorded in the diagnostic log.

E-mail - If allowed, the event message is sent to the e-mail address.

States - List of diagnostic states is in the attachment III. Each state is determined by two events - the start and the end of the state. These two events are processed in dependence on the settings. The following must be set in addition to the above:

Start Delay - Minimum duration to start the state indication.

Stop Delay - Minimum duration to stop the state indication.

Parameters - List of diagnostic parameters is in the attachment IV. All these parameters are continuously monitored. When value of a parameter is out of the range, it is indicated like a state. The following must be set in addition to the above:

Lower Trsh - Lower bound of the parameter range.

Upper Trsh - Upper bound of the parameter range.

Graphs

This page allows setting range of temperature, time differences, CNR, and last CGGTTS graphs. The graphs settings can be changed anytime (in any state).

Communication

This page allows the settings of the e-mail address where messages will be sent to and the connection parameters for the connection to the servers where the files resulting from scheduler-started processing will be uploaded.

E-mail – An address or a comma separated list of addresses where all e-mail messages will be sent.

CGGTTS Data Storages:

Host 1..3 – The locations to which the CGGTTS files resulting from a scheduler-started processing are uploaded.

RINEX Data Storages:

Host 1..3 - The locations to which the RINEX files resulting from a scheduler-started processing are uploaded.

L3P Data Storages:

Host 1..3 - The locations to which the L3P files resulting from a scheduler-started processing are uploaded.

ESA Data Storages:

Host 1..3 - The locations to which the ESA files resulting from a scheduler-started processing are uploaded.

RAW Data Storages:

Host 1..3 - The locations to which the RAW files resulting from a scheduler-started processing are uploaded.

An example: `ftp://labotai:PASSWORD@tai.bipm.org/data/LAB/links/gnss/MC` to upload to BIPM ftp server or `file:///media/usbdisk` to store to an USB disk.

Satellites

This page allows configuration of satellites that are displayed in the Display / Satellites page and can be selected in the Control / Processing page. The satellite unselecting does not stop the reception of the satellite signals. These settings can be changed anytime (in any state).

Calibration Delays

This page allows settings of the calibration delays for all supported GNSS signals including the GLONASS interchannel delays. The entered Calibration Identification is used in the CGGTTS V2E header.

6. Administration and access to data

The GTR55 application SW runs under Debian Linux operating system. The system can be administrated from a local console (when a keyboard and a display are connected) or remotely via SSH. If required, the output data can be accessed from a local console or remotely via SCP or FTP instead of the web based User Interface.
A card with the factory default user name and password is attached to the device. We recommend using the PuTTY SSH client (www.putty.org) and WinSCP client (www.winscp.com).

6.1 Output data

All the output data can be found in the folder: `/var/lib/gtr/user`.

Every measurement data processing generates a data file and a log file which includes a brief description of the processing. Both files are identified by the process sequence number. Only files from last five processes are kept. Older files are automatically deleted. If you want to keep any of them, it must be copied outside the GTR55 or its name must be changed.

In the case of RINEX, CGGTTS, L3P, and EL_MASK processes, a copy of the resulting data files with standard names is also generated. These files are automatically deleted after 30 days.

6.2 Measurement data

All measurement data can be found in the folder: `/var/lib/gtr`.

The measurement data are collected in hourly binary files with names GM*yymmddhh* where *yy* is year, *mm* is month, *dd* is day, and *hh* is hour of start of the measurement.

The collected GM files are kept for 180 days and then automatically deleted. If required, the measurement data can be archived outside of the GTR55 for later processing.

6.3 User Interface access administration

The factory default username and password are as follows: User = user, Password = user

New user or change of password: htpasswd /etc/gtrpasswd <user_name>

Delete of a user: Delete <user_name> line in /etc/gtrpasswd.

6.4 PZ90 to WGS84 transformation parameters

PZ90 to WGS84 transformation parameters are saved in `/var/lib/gtr/data/pz2wgs_par` ASCII file (see Attachment VIII).

6.5 Remote diagnostics and maintenance

Possible problems can be optimally diagnosed and solved when the receiver can be accessed remotely via internet. Please, contact the technical support for more information.

7. Basic receiver operation

The receiver continuously measures delays of all the received GNSS signals with respect to the internal time scale locked to the input 10 MHz frequency reference. Output files in several formats can be generated from these collected measurement data. The output data can be referenced to the input time reference or to the output time reference.

Input time reference

The input time reference is represented by 1PPS time marks. It can be connected to the 1PPS_IN connector. The reference point lies at the end of the time reference cable with delay entered in **Settings / Site & Time Reference**. If the entered input time reference delay is zero, the reference point is at the 1PPS_IN connector.

Output time reference

The output time reference is represented by 1PPS time marks outcoming from the 1PPS_OUT connector. The reference point lies at the end of the time reference cable with delay entered in **Settings / Site & Time Reference**. If the entered output time reference delay is zero, the reference point is at the 1PPS_OUT connector.

The output time reference is generated in the receiver coherently with the input 10 MHz frequency reference. When the measurement starts, this time scale is set near UTC. From that time it follows the 10 MHz frequency reference. The initial REF_OUT - UTC time difference is usually better than 30 ns.

REF_IN - REF_OUT difference

The difference between the input and output time references is continuously measured, processed by a Kalman filter in order to suppress influence of 1PPS jitter, and applied when the processing results are referenced to the input 1PPS time reference. This time difference can be also viewed as a result of the 1PPS_DIF processing (see Attachment VI). The residual jitter of the measured REF_IN - REF_OUT difference is usually better than 10 ps RMS.

Built-in calibrator

The built-in calibrator continuously measures and corrects receiver internal delays of all supported signals including GLONASS inter-channel biases ensuring good long-term stability of the receiver. Note that the calibrator does not cover the antenna and antenna cable delays. In order to ensure the best possible calibrator function, it is advisable to avoid rapid changes of the receiver temperature.

8. Calibration of receiver

There is up to 24 internal delays to be calibrated:

GPS: Int_dly_GPL1CA, Int_dly_GPL1P, Int_dly_GPL2C, Int_dly_GPL2P, Int_dly_GPL5, Int_dly_GPL1C,

GLONASS: Int_dly_GLL1OF, Int_dly_GLL1SF, Int_dly_GLL2OF, Int_dly_GLL2SF, Int_dly_GLL3,

GALILEO: Int_dly_GAE1, Int_dly_GAE5a, Int_dly_GAE5b, Int_dly_GAE5, Int_dly_GAE6,

BeiDou: Int_dly_BDB1, Int_dly_BDB2, Int_dly_BDB3, Int_dly_BDB1-2, Int_dly_BDB2a, Int_dly_BDB1C,

SBAS: Int_dly_SBL1, Int_dly_SBL5.

These delays include the delays of the complete receiver chain including the antenna.

Concerning GLONASS, additional differential delays can be calibrated for every signal L1OF, L1SF, L2OF, L2SF in all frequency channels -7..6:

Dif_int_dly_GLL1OF(-7..6),

Dif_int_dly_GLL1SF(-7..6),

Dif_int_dly_GLL2OF(-7..6),

Dif_int_dly_GLL2SF(-7..6).

The total calibration delay is equal to the sum of the internal delay and the differential delay, e.g. Int_dly_GLL1OF + Dif_int_dly_GLL1OF(-7) for signal L1OF in the channel -7. If the delay calibration in individual frequency channels is not required, the differential delays must be zeroed.

The calibration delays are saved in the internal memory of the receiver board and can be viewed in the User Interface in **Display / Receiver information**. The antenna cable delay is set separately in **Settings / Site & Time Reference**.

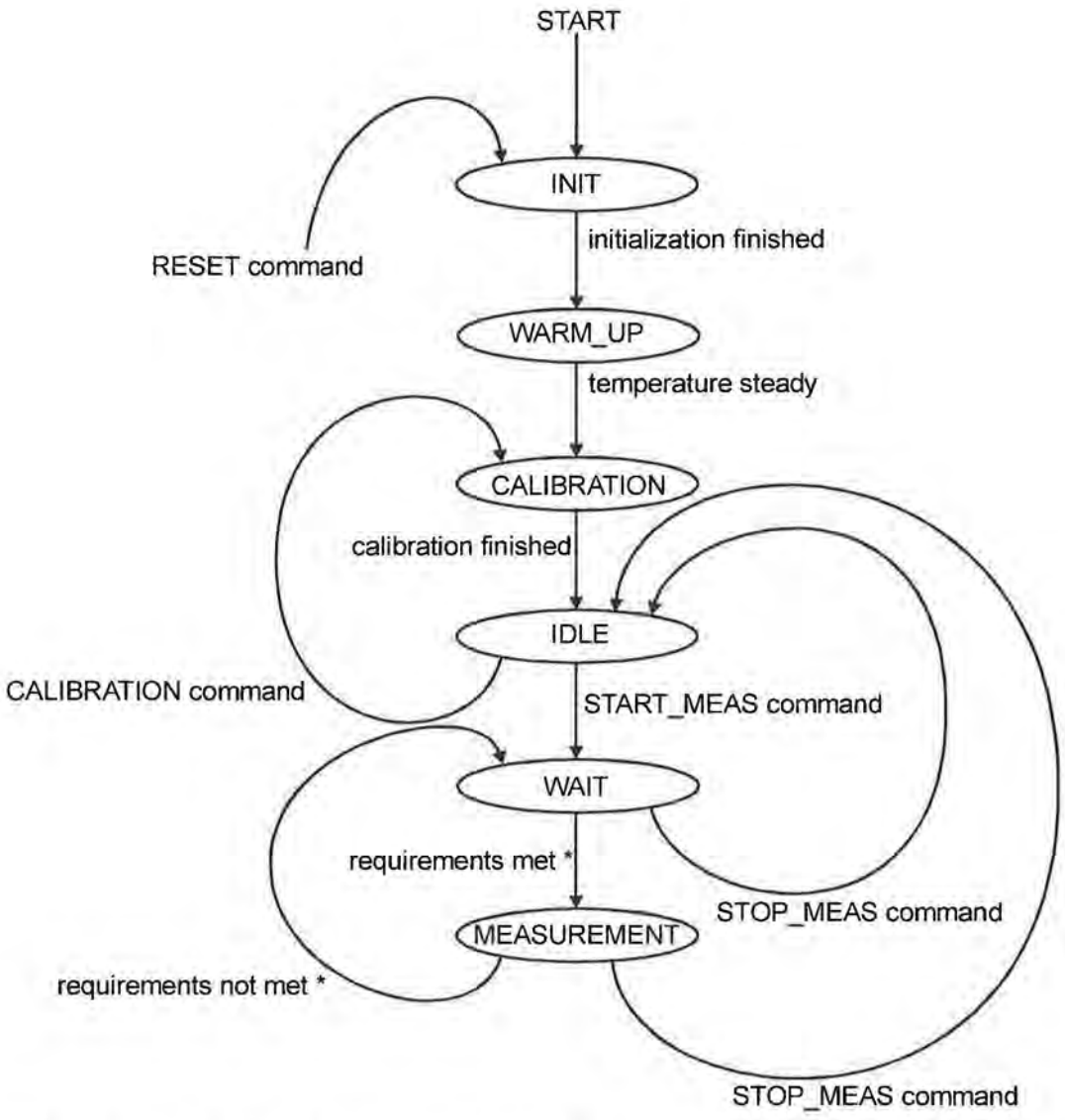
To change the calibration delays:

1) Stop the measurement with **Measurement / Stop** button.

2) Enter the new calibration delays in **Settings / Calibration delays**.

3) Start the measurement again with **Measurement / Start** button.

Attachment I: State diagram of the GTR55 operation



* Requirements to start / continue measurement:
1. Appropriate input signals are connected.
2. The GPS receiver is in positioning mode for last 30 seconds.

Attachment II: List of diagnostic events

Event 1

Associated message: Initialization finished.

Description: The transition from the INIT state to the WARM_UP state.

Event 2

Associated message: Warm-up finished.

Description: The transition from the WARM_UP state to the CALIBRATION state.

Event 3

Associated message: Calibration finished: OK.

Description: The transition from the CALIBRATION state to the WAIT state after the Interval Measurement Unit passed the test. Results of the IMU test are added to the log entry:

Offset = DC offset at ADC input,
ADC_s = Standard deviation of noise at ADC input,
ADC_min = Minimum of noise at ADC input,
ADC_max = Maximum of noise at ADC input,
R_min = Minimum of the response at ADC input,
R_max = Maximum of the response at ADC input,
R_r = Standard deviation of noise in response at ADC input.

Event 4

Associated message: Calibration finished: fault.

Description: The transition from the CALIBRATION state to the WAIT state after the Interval Measurement Unit has failed the test. The above results of the IMU test are added to the log entry.

Event 5

Associated message: Measurement request.

Description: The transition from the IDLE state to the WAIT state.

Event 6

Reserved

Event 7

Associated message: Start of measurement.

Description: The transition from the WAIT state to the MEASUREMENT state.

Event 8

Associated message: Waiting for measurement stopped.

Description: The transition from the WAIT state to the IDLE state.

Event 9

Associated message: Measurement interrupted.

Description: The transition from the MEASUREMENT state to the WAIT state. The measurement cannot continue any more.

Possible reason: The 10 MHz input signal is not connected.

Event 10

Associated message: Measurement stopped.

Description: The transition from the MEASUREMENT state to the IDLE state.

Event 11

Associated message: Site parameters setting.

Description: Update of parameters from Settings / Site & Time Reference.

Event 12

Associated message: Device parameters setting.

Description: Update of parameters from Settings / Device.

Event 13

Associated message: Calibration delay settings

Description: Update of calibration delays from Settings / Calibration Delays.

Event 14

Reserved

Event 15

Reserved

Event 16

Associated message: No response from IMU/0, forced init.

Description: The transition to the INIT state caused by watchdog.

Event 17

Associated message: No response from IMU/1, forced init from calibration.

Description: The transition from the CALIBRATION state to the INIT state caused by watchdog.

Event 18

Associated message: No response from IMU/1, forced init from measurement.

Description: The transition from the MEASUREMENT state to the INIT state caused by watchdog.

Event 19

Associated message: IMU measured wrong data.

Description: The transition from the MEASUREMENT state to the INIT state caused by reception of wrong data from the Interval Measurement Unit.

Event 20

Associated message: Frequency deviation, measurement interrupted.

Description: The transition from the MEASUREMENT state to the WAIT state caused by large frequency deviation of the Interval Measurement Unit internal reference oscillator.

Event 21

Associated message: Frequency jump, measurement interrupted.

Description: The transition from the MEASUREMENT state to the WAIT state caused by jump in frequency of the Interval Measurement Unit internal reference oscillator.

Attachment III: List of diagnostic states

State 1

Associated message: Antenna not connected.

Description: The DC supply current into the antenna is too low.

Possible reason: The antenna is not connected or the antenna cable is broken.

State 2

Associated message: Antenna overcurrent.

Description: The DC supply current into the antenna is too high.

Possible reason: Short on the antenna cable.

State 3

Reserved

State 4

Associated message: 1PPS not connected.

Description: The 1PPS input signal is not present.

Possible reason: The external 1PPS signal is not connected.

State 5

Associated message: 10 MHz not connected.

Description: The device is waiting for measurement (WAIT state) and the 10 MHz input signal is not present.

Possible reason: The 10 MHz signal is not connected.

State 6

Associated message: Temperature out of range.

Description: Temperature is out of the range from 10 to 50°C.

State 7

Associated message: Cable amplifier not connected to power supply.

Description: The DC supply current into the cable amplifier is lower than 5 mA.

State 8

Associated message: Cable amplifier overcurrent.

Description: The DC supply current into the cable amplifier is higher than 90 mA.

Attachment IV: List of diagnostic parameters

Parameter 1

Associated message: Temperature deviation out of range.

Description: Temperature of the receiver.

Unit: degree of Celsius.

Parameter 2

Associated message: Time deviation out of allowed range.

Description: Measured time difference referenced to GPS time.

Unit: nanosecond

Parameter 3

Associated message: Frequency deviation of local oscillator out of range.

Description: Difference between quiescent and nominal frequencies (normalized to nominal frequency).

Unit: 10^{-6} s/s

Parameter 4

Associated message: Low number of GPS satellites.

Description: Number of received GPS satellites.

Parameter 5

Associated message: Low CNR of GPS L1C/A signal.

Description: CNR of the strongest GPS L1C/A signal.

Unit: dBHz

Parameter 6

Associated message: Low CNR of GPS L1P signal.

Description: CNR of the strongest GPS L1P signal.

Unit: dBHz

Parameter 7

Associated message: Low CNR of GPS L2C signal.

Description: CNR of the strongest GPS L2C signal.

Unit: dBHz

Parameter 8

Associated message: Low CNR of GPS L2P signal.

Description: CNR of the strongest GPS L2P signal.

Unit: dBHz

Parameter 9

Associated message: Low CNR of GPS L5 signal.

Description: CNR of the strongest GPS L5 signal.

Unit: dBHz

Parameter 10

Associated message: Low CNR of GPS L1C signal.

Description: CNR of the strongest GPS L1C signal.

Unit: dBHz

Parameter 11

Associated message: Low number of GLONASS satellites.

Description: Number of received GLONASS satellites.

Parameter 12

Associated message: Low CNR of GLONASS L1OF signal.

Description: CNR of the strongest GLONASS L1OF signal.

Unit: dBHz

Parameter 13

Associated message: Low CNR of GLONASS L1SF signal.

Description: CNR of the strongest GLONASS L1SF signal.

Unit: dBHz

Parameter 14

Associated message: Low CNR of GLONASS L2OF signal.

Description: CNR of the strongest GLONASS L2OF signal.

Unit: dBHz

Parameter 15

Associated message: Low CNR of GLONASS L2SF signal.

Description: CNR of the strongest GLONASS L2SF signal.

Unit: dBHz

Parameter 16

Associated message: Low CNR of GLONASS L3OC signal.

Description: CNR of the strongest GLONASS L3OC signal.

Unit: dBHz

Parameter 17

Associated message: Low number of GALILEO satellites.

Description: Number of received GALILEO satellites.

Parameter 18

Associated message: Low CNR of GALILEO E1 signal.

Description: CNR of the strongest GALILEO E1 signal.

Unit: dBHz

Parameter 19

Associated message: Low CNR of GALILEO E5a signal.

Description: CNR of the strongest GALILEO E5a signal.

Unit: dBHz

Parameter 20

Associated message: Low CNR of GALILEO E5b signal.

Description: CNR of the strongest GALILEO E5b signal.

Unit: dBHz

Parameter 21

Associated message: Low CNR of GALILEO E5 signal.

Description: CNR of the strongest GALILEO E5 signal.

Unit: dBHz

Parameter 22

Associated message: Low CNR of GALILEO E6 signal.

Description: CNR of the strongest GALILEO E6 signal.

Unit: dBHz

Parameter 23

Associated message: Low number of SBAS satellites.

Description: Number of received SBAS satellites.

Parameter 24

Associated message: Low CNR of SBAS L1 signal.

Description: CNR of the strongest SBAS L1 signal.

Unit: dBHz

Parameter 25

Associated message: Low CNR of SBAS L5 signal.

Description: CNR of the strongest SBAS L5 signal.

Unit: dBHz

Parameter 26

Associated message: Low number of BEIDOU satellites.

Description: Number of received BEIDOU satellites.

Parameter 27

Associated message: Low CNR of BEIDOU B1 signal.

Description: CNR of the strongest BEIDOU B1 signal.

Unit: dBHz

Parameter 28

Associated message: Low CNR of BEIDOU B2 signal.

Description: CNR of the strongest BEIDOU B2 signal.

Unit: dBHz

Parameter 29

Associated message: Low CNR of BEIDOU B3 signal.

Description: CNR of the strongest BEIDOU B3 signal.

Unit: dBHz

Parameter 30

Associated message: Low CNR of BEIDOU B1-2 signal.

Description: CNR of the strongest BEIDOU B1-2 signal.

Unit: dBHz

Parameter 31

Associated message: Low CNR of BEIDOU B2a signal.

Description: CNR of the strongest BEIDOU B2a signal.

Unit: dBHz

Parameter 32

Associated message: Low CNR of BEIDOU B1C signal.

Description: CNR of the strongest BEIDOU B1C signal.

Unit: dBHz

Parameter 33

Associated message: Low number of NAVIC satellites.

Description: Number of received NAVIC satellites.

Parameter 34

Associated message: Low CNR of NAVIC L5 signal.

Description: CNR of the strongest NAVIC L5 signal.

Unit: dBHz

Attachment V: RAW data format

Name	Description	Unit	Columns	Format	Comment
SYS	GNSS identifier		1	%1c	1)
PRN	Satellite number	-	2 - 3	%2u	2)
MJD	MJD of measurement	day	4 - 16	%13.6f	
UTC	UTC of measurement	hhmmss	18 - 23	4%2u	
EL	Satellite elevation	deg	26 - 27	%2u	
AZ	Satellite azimuth	deg	29 - 31	%3u	
IOE	Issue of Ephemeris data	-	33 - 35	%3u	
C1code	REF-SYS time difference from L1C code measurement	ns	36 - 47	%12.3f	3)
C1carrier	REF-SYS time difference from L1C carrier phase measurement	ns	48 - 59	%12.3f	3), 4)
C1CNR	L1C Signal-to-noise ratio	dBHz	61 - 65	%5u	
P1code	REF-SYS time difference from L1P code measurement	ns	66 - 77	%12.3f	3)
P1carrier	REF-SYS time difference from L1P carrier phase measurement	ns	78 - 89	%12.3f	3), 4)
P1CNR	L1P Signal-to-noise ratio	dBHz	91 - 95	%5u	
L1IONO	L1 standard ionospheric correction	ns	96 - 103	%8.2f	
C2code	REF-SYS time difference from L2C code measurement	ns	104 - 115	%12.3f	3)
C2carrier	REF-SYS time difference from L2C carrier phase measurement	ns	116 - 127	%12.3f	3), 4)
C2CNR	L2C Signal-to-noise ratio	dBHz	129 - 133	%5u	
P2code	REF-SYS time difference from L2P code measurement	ns	134 - 145	%12.3f	3)
P2carrier	REF-SYS time difference from L2P carrier phase measurement	ns	146 - 157	%12.3f	3), 4)
P2CNR	L2P Signal-to-noise ratio	dBHz	159 - 163	%5u	
L2IONO	L2 standard ionospheric correction	ns	164 - 171	%8.2f	
L5code	REF-SYS time difference from L5 code measurement	ns	172 - 183	%12.3f	3)
L5carrier	REF-SYS time difference from L5 carrier phase measurement	ns	184 - 195	%12.3f	3), 4)
L5CNR	L5 Signal-to-noise ratio	dBHz	197 - 201	%5u	
L5IONO	L5 standard ionospheric correction	ns	202 - 209	%8.2f	
TROPO	Standard tropospheric correction	ns	210 - 217	%8.2f	
FR	GLONASS frequency channel	-	218 - 220	%3i	

Comments:

1) G - GPS, R - GLONASS, E - GALILEO, S - SBAS.
2) In case of SBAS the satellite number is PRN - 100.
3) (REF time – SYS time) difference measured through specific satellite. Satellite clock correction and standard tropo/iono delay corrections are included.
4) Phase measurement ambiguity is not solved.

Attachment VI: 1PPS_DIF format

The 1PPS_DIF data files include time difference between input and output 1PPS time references. Format of one line of this ASCII file is described in the table.

Name	Description	Unit	Columns	Format
MJD	MJD of measurement	day	1 - 12	%12.6f
UTC	UTC of measurement	hhmmss	14 - 19	4%2u
DIF	Time difference REF_IN - REF_OUT	ns	20 - 33	%12.3f

Attachment VII: RINEX Observation Types

RINEX V2.10 (GPS only)

```
     5    C1    P1    L1    P2    L2                        # / TYPES OF OBSERV
```

RINEX V2.11

```
     8    C1    P1    L1    C2    P2    L2    C5    L5      # / TYPES OF OBSERV
```

RINEX V3.01

```
G   10 C1C L1C C1P L1P C2X L2X C2P L2P C5X L5X              SYS / # / OBS TYPES
R    8 C1C L1C C1P L1P C2C L2C C2P L2P                      SYS / # / OBS TYPES
E    4 C1X L1X C5X L5X                                      SYS / # / OBS TYPES
S    4 C1C L1C C5X L5X                                      SYS / # / OBS TYPES
```

Attachment VIII: PZ90 to WGS84 transformation parameters

The ASCII file /var/lib/gtr/data/pz2wgs_par includes one line with seven transformation parameters in order according to the table. In addition it can include any number of comment lines starting with % character.

Column	Parameter	Unit
1	X translation	m
2	X translation	m
3	X translation	m
4	Scale	-
5	X rotation	rad
6	Y rotation	rad
7	Z rotation	rad

Example:

```
% PZ-90.02
-0.36 0.08 0.18 0 0 0 0
```

Attachment IX: ESA data format

The proprietary ESA data format comes from the CGGTTS V02 / L3P. It supports GPS, GLONASS and GALILEO data. To distinguish different systems, following letters before the satellite number are used:

G - GPS
R - GLONASS
E – GALILEO.

Example:

```
GPS/GLONASS/GALILEO 5 MIN DATA FORMAT VERSION = 01
REV DATE = 2015-02-25
RCVR = GTR55 1300022 1.1.2
CH = 20
IMS = GTR55 1300022 1.1.2
LAB = TP
X = +3967283.27 m
Y = +1022538.11 m
Z = +4872414.48 m
FRAME = FRAME
COMMENTS = NO COMMENTS
INT DLY = -23.6 ns (GPS C1), -29.4 ns (GPS P1),   0.0 ns (GPS C2), -35.0 ns (GPS P2),   0.0 ns (GPS L5)
CAB DLY = 149.0 ns
REF DLY =  10.0 ns
REF = UTC(TP)
CKSUM = EC

SAT CL  MJD  STTIME TRKL ELV AZTH   REFSV      SRSV     REFSYS    SRSYS  DSG IOE MDTR SMDT MDIO SMDI MSIO SMSI ISG FR HC FRC CK
            hhmmss  s  .1dg .1dg    .1ns     .1ps/s     .1ns    .1ps/s .1ns      .1ns.1ps/s.1ns.1ps/s.1ns.1ps/s.1ns
G05 FF 57049 010000  300 219  571   +2874443   +518       +281   +570   78 026  208   +5   42 -414   42 +414   86  0  0 L3P 52
G16 FF 57049 010000  300 224 3056   +1616459   +168       +331   +200   88 085  203  -58   16  -49  +16  -49   69  0  0 L3P 79
G21 FF 57049 010000  300 545 1873   +4099924    +32       +307    -11   34 069   96   -9   56   +5   56   +5   27  0  0 L3P F0
G25 FF 57049 010000  300 285 1349      -5553     62       +311    -89   68 039  163  +17   67  +34   67  +34   46  0  0 L3P 09
G29 FF 57049 010000  300 549  702   -5883598   -139       +276   -117   20 103   96   +8   23 +115   23 +115   15  0  0 L3P 42
G31 FF 57049 010000  300 398 2279   -3246186   +128       +288   +120   39 022  128  +18   86  -64   86  -64   30  0  0 L3P 5F
G05 FF 57049 010500  300 217  549   +2874477   -293       +330   -241   67 026  210   +9   -1 +236   -1 +236   49  0  0 L3P 48
G16 FF 57049 010500  300 245 3060   +1616406   -614       +307   -582   85 085  187  -49   25 +172   25 +172   71  0  0 L3P 83
G21 FF 57049 010500  300 569 1866   +4099953    +56       +324    +13   33 069   93   -8   38  +18   38  +18   24  0  0 L3P 25
G25 FF 57049 010500  300 264 1359      -5562   +377       +294   +351   73 039  176  +44   84 -301   84 -301   55  0  0 L3P 40
G29 FF 57049 010500  300 528  717   -5883605    +99       +276   +122   22 103   98   +9   18 -133   18 -133   17  0  0 L3P 43
G31 FF 57049 010500  300 359 2262   -3246160    -76       +311    -84   43 022  131  +21   77  +50   77  +50   33  0  0 L3P 1D
G05 FF 57049 011000  300 214  527   +2874457   -507       +326   -454   69 026  213  +13    2 +365    2 +365   41  0  0 L3P 3A
G16 FF 57049 011000  300 266 3063   +1616418   +149       +329   +181   91 085  174  -42   -5 -114   -5 -114   68  0  0 L3P 6C
G21 FF 57049 011000  300 592 1858   +4099976    +74       +334    +32   31 069   91   -7   29  -62   29  -62   24  0  0 L3P 22
G25 FF 57049 011000  300 243 1369      -5576   +304       +273   +278   57 039  190  +52   98 -208   98 -208   44  0  0 L3P 58
G29 FF 57049 011000  300 507  731   -5883609   -167       +279   -145   18 103  101  +10   10  +90   10  +90   12  0  0 L3P 2D
G31 FF 57049 011000  300 339 2246   -3246166    +53       +303    +45   42 022  140  +24   89  -57   89  -57   25  0  0 L3P 2D
```

Attachment X: Measurement data file names

CGGTTS / L3P / ESA / RAW

The file name consists of a code identifying type of the data (see table), a laboratory and receiver identification (4 characters), 2 digits of the hour of the start of the observation (RAW only), the first 2 digits of MJD of the start of the observation, dot, and the last 3 digits of the MJD.

	GPS	GLONASS	GALILEO	BeiDou	SBAS
CGGTTS	GM	RM	EM	CM	-
L3P	GZ	RZ	EZ	CZ	-
ESA	GX	RX	EX	CX	-
RAW	RAW	RAW	RAW	RAW	RAW

Examples:
GMTPAA57.087, RZTPAA57.087, EBTPAA57.087, EXTPAA57.087, RAWTPAA0057.087
(lab/receiver TPAA, MJD 57087)

RINEX

The RINEX file name consists of a station (laboratory/receiver) designator (4 characters), day of the year of the start of the observation (3 characters), a file sequence number within the day (1 character), dot, year (last 2 digits), and the letter O for the observation file or N, G, L, H, P (see table) for the navigation file. If the file contains all existing observations of the day, the file sequence number is 0. Hourly RINEX files have a letter A..X for hours 0..23 instead of the sequence number.

O	Observation file
N	GPS navigation file
G	GLONASS navigation file
L	GALILEO navigation file
H	SBAS navigation file
P	Mixed navigation file

Examples:
TPAA0010.15O - all observations of the day
TPAA001C.15O - hourly observation file beginning at 02:00
TPAA0013.15O - 3rd file generated in the day
TPAA0010.15N - GPS navigation file
(lab/receiver TPAA, day of year 001, year 2015)

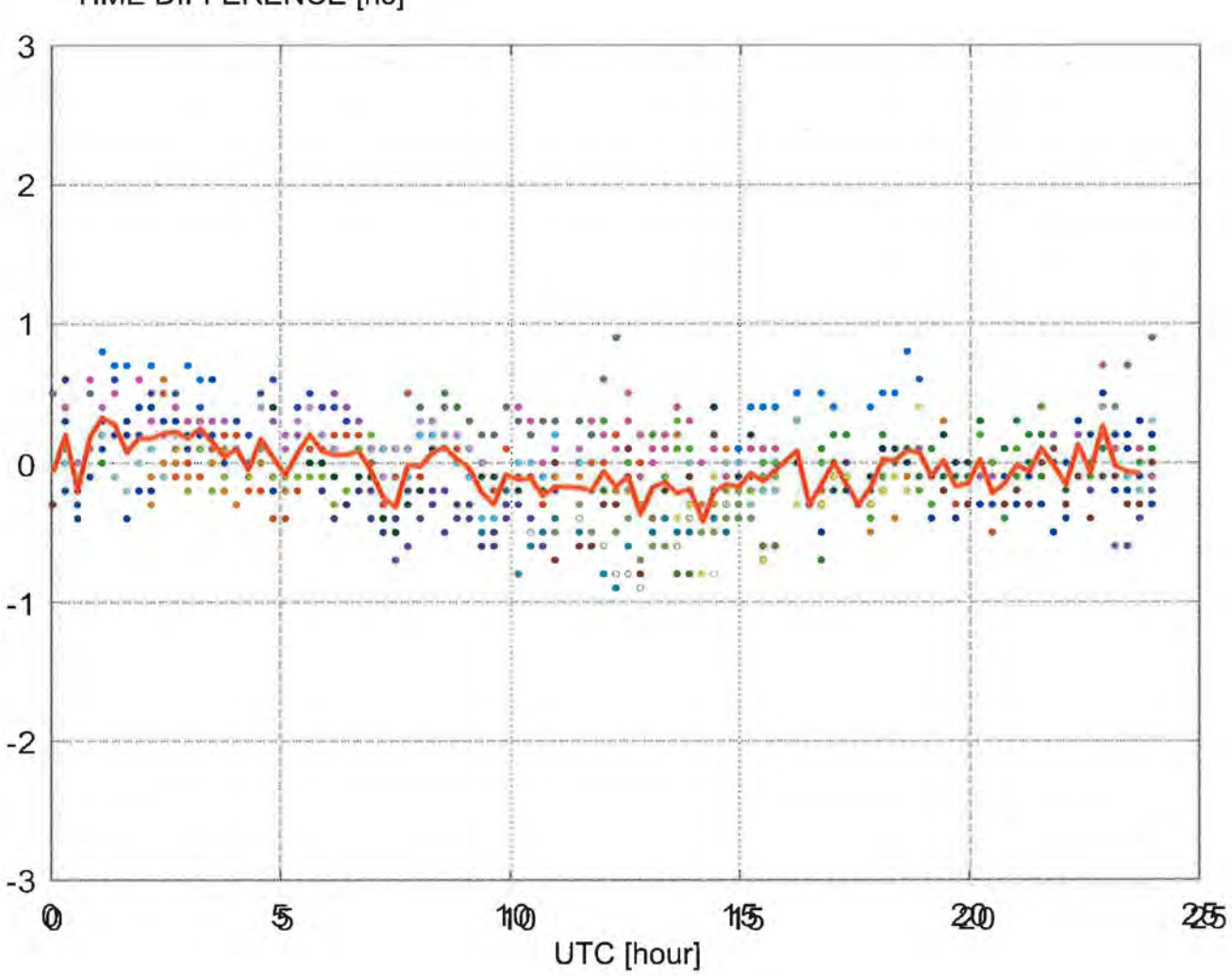
TEST MEASUREMENT

TESTED RECEIVER: GTR55 S/N 1808001
ANTENNA: NOV-850 S/N NMLK18070096N
REFERENCE RECEIVER: GTR55 S/N: 1541941

DATE: 2018-09-16
SITE: PRAGUE
BASELINE: 8 m

OUTPUT DATA: **CGGTTS**
SATELLITES: ALL IN VIEW
SIGNAL: GPS L1C/A

SIGMA = 150 ps

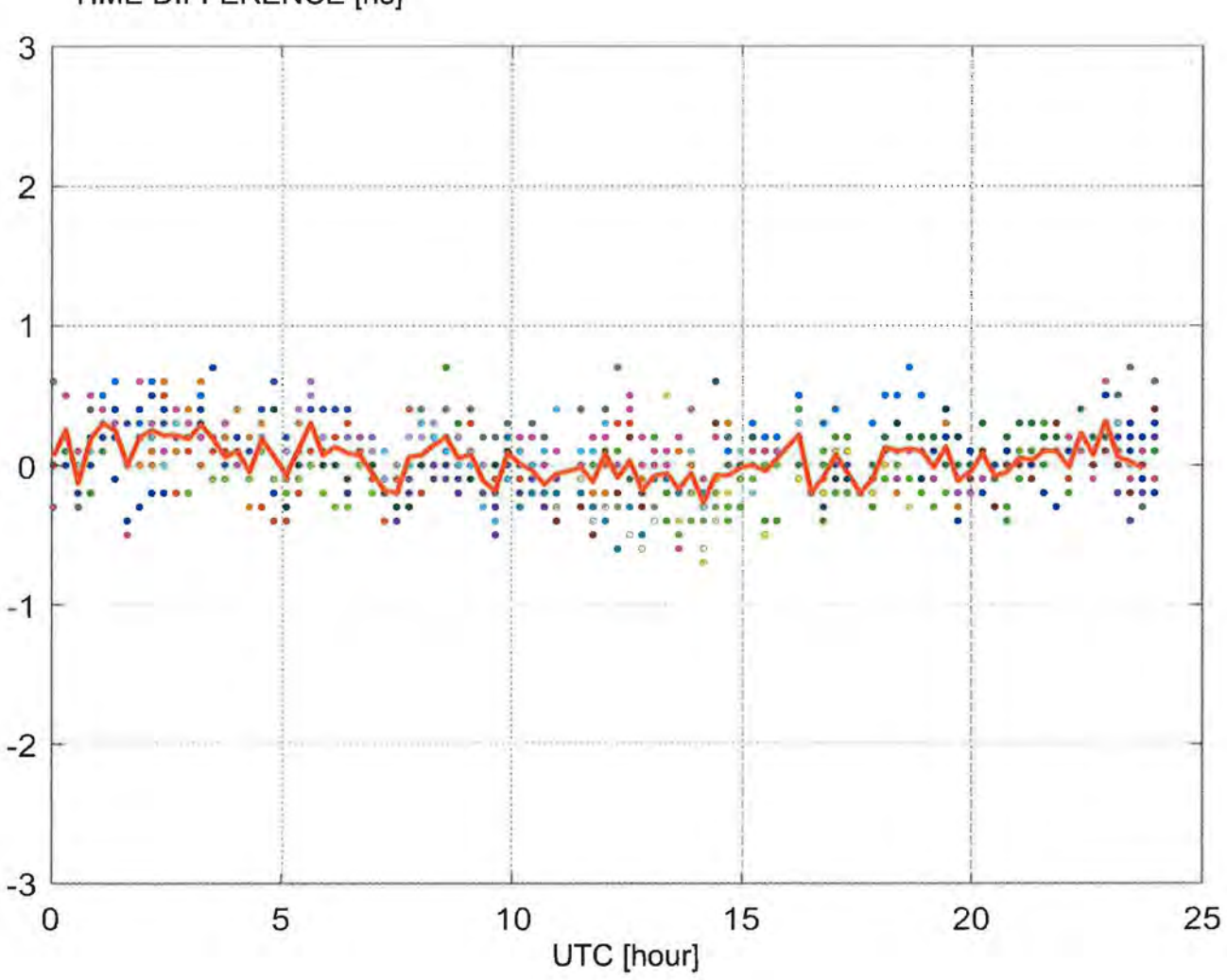


POINTS = TRACKS
COLOR = SATELLITE

RED LINE = AVERAGE OVER ALL SATELLITES IN VIEW

OUTPUT DATA: **CGGTTS**
SATELLITES: ALL IN VIEW
SIGNAL: GPS L1P

SIGMA = 140 ps

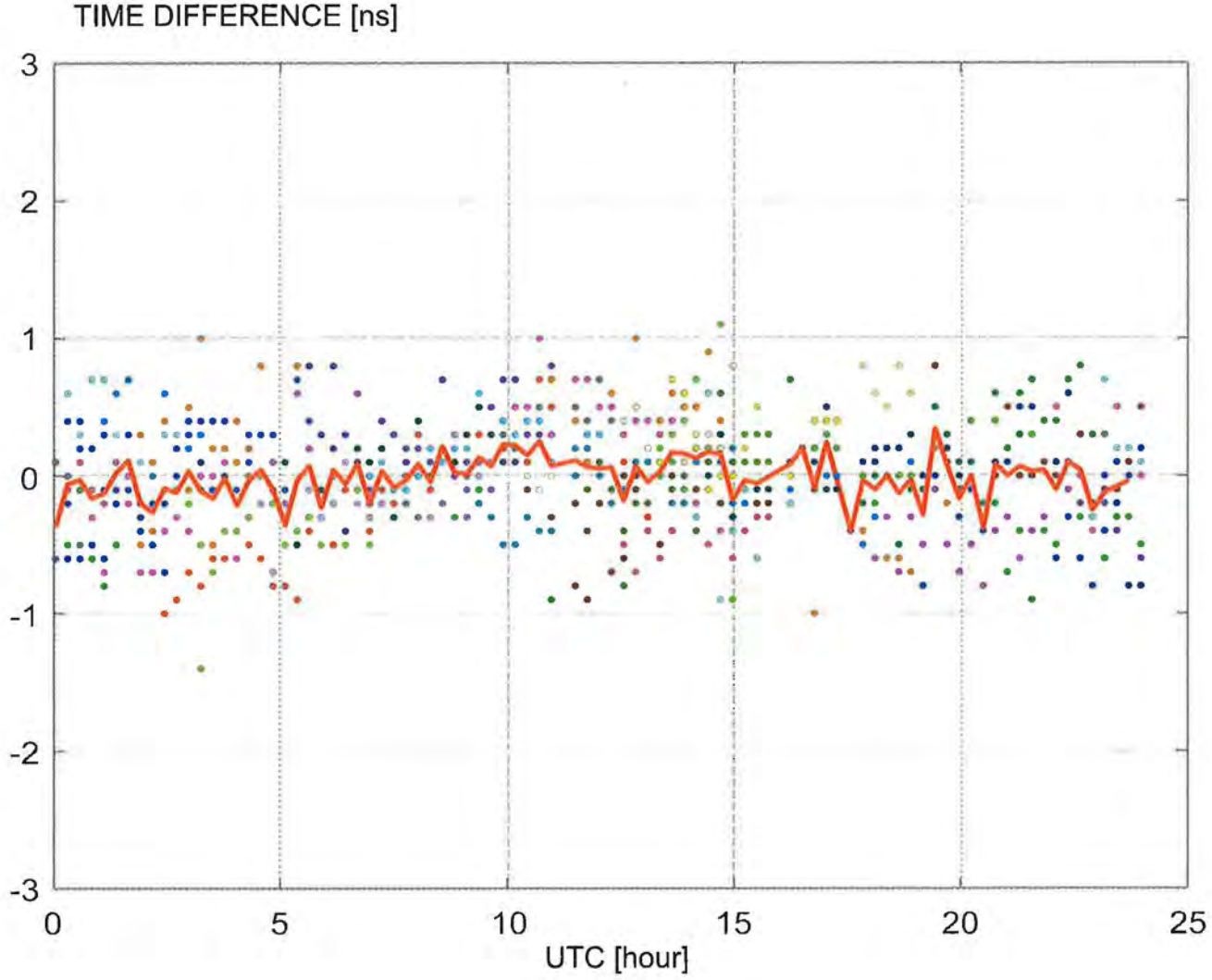


POINTS = TRACKS
COLOR = SATELLITE

RED LINE = AVERAGE OVER ALL SATELLITES IN VIEW

OUTPUT DATA: **CGGTTS**
SATELLITES: ALL IN VIEW
SIGNAL: GPS L2P

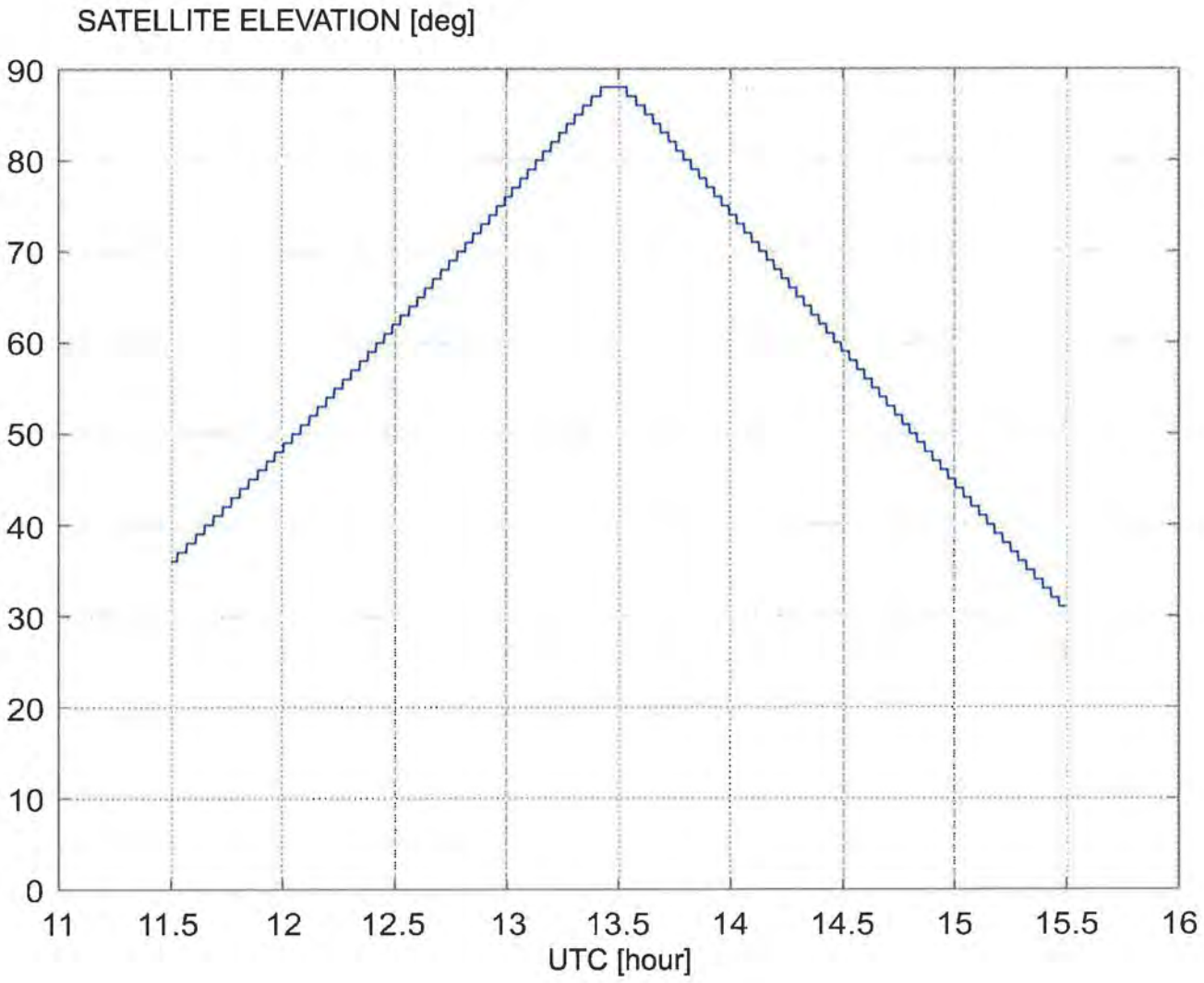
SIGMA = 150 ps



POINTS = TRACKS
COLOR = SATELLITE

RED LINE = AVERAGE OVER ALL SATELLITES IN VIEW

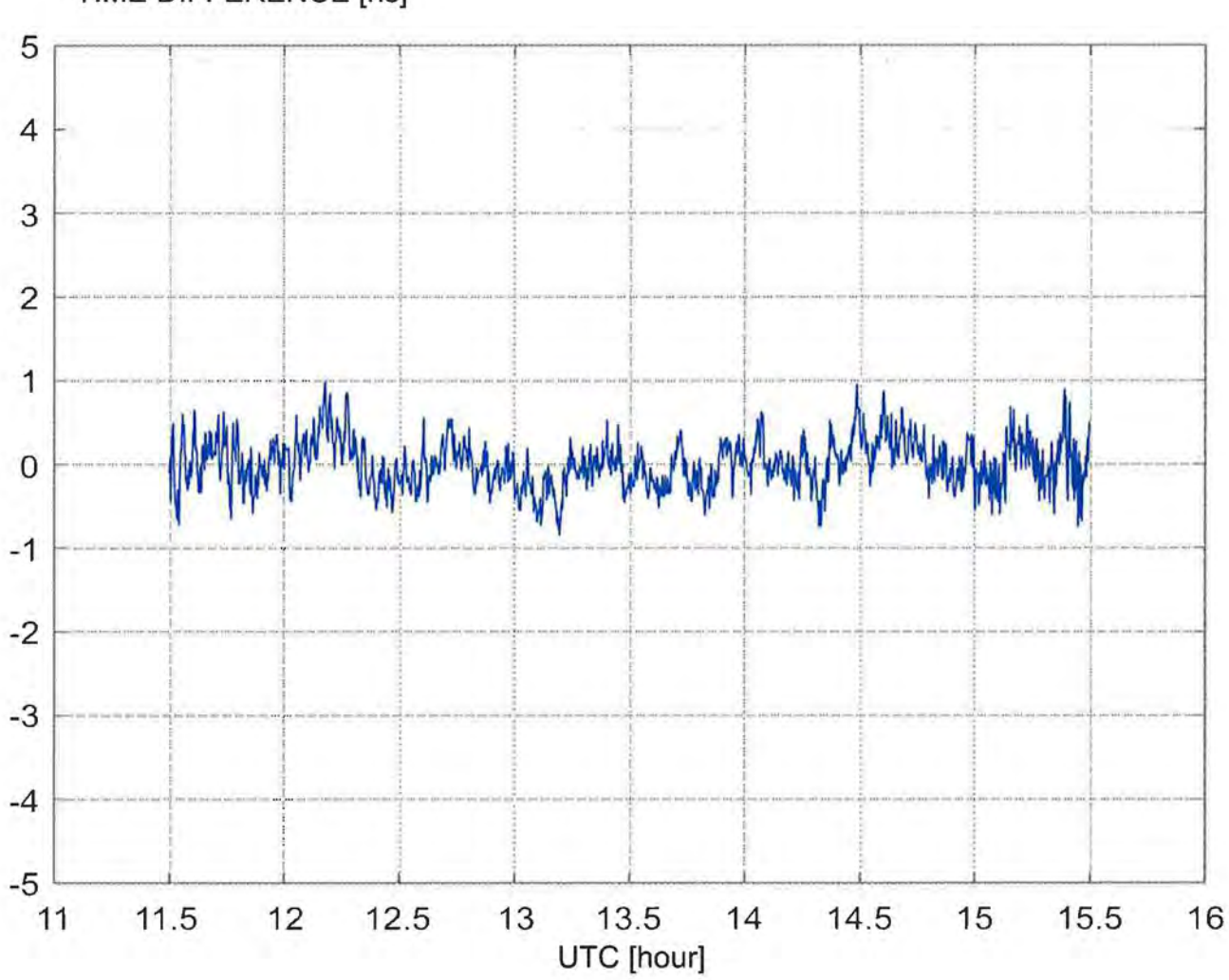
OUTPUT DATA: **RAW**
SATELLITE: PRN 1
SIGNAL: GPS L1C/A



OUTPUT DATA: **RAW**
SATELLITE: PRN 1
SIGNAL: GPS L1C/A

CODE MEASUREMENT

SIGMA = 0.3 ns



OUTPUT DATA: **RAW**
SATELLITE: PRN 1
SIGNAL: GPS L1C/A

CARRIER PHASE MEASUREMENT

SIGMA = 10 ps