NTP Testing

NTP and TE analysis with xGenius

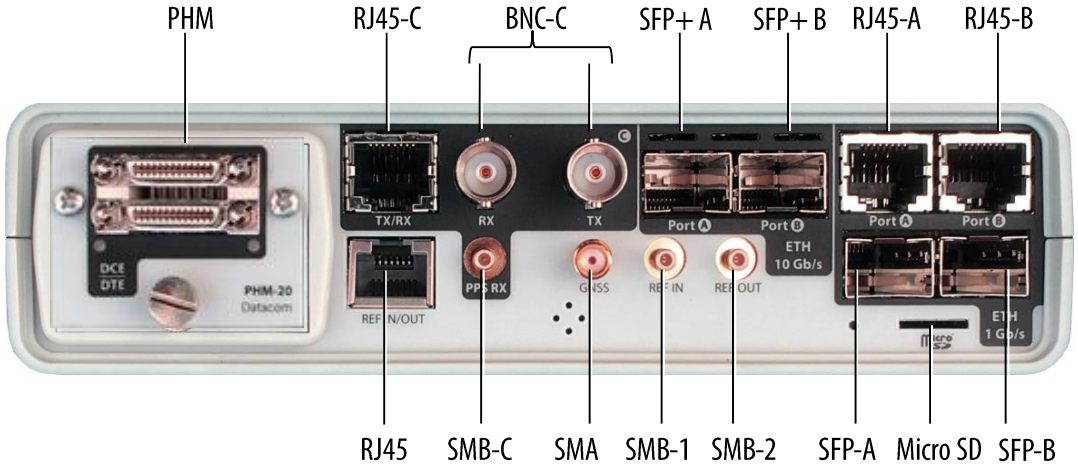
Guide & Slides corresponding to software ver. 2.3.13

ALBEDO

xGenius

xGenius provides deep insights to design, install, maintain, troubleshoot and engineer communications resources of Mobile Operators, Power Utilities, Finace, Labs and R+D centers. The unit is able to verify Ethernet/IP, SyncE, NTP, PTP, GbE, IRIG-B, 1PPS, T1/E1, G703, Serial Datacom, C37.94, GOOSE, SV, MMS, Round-trip & One-way Delay tests at all interfaces. It also has a set of programmable filters to capture live data traffic at wire-speed

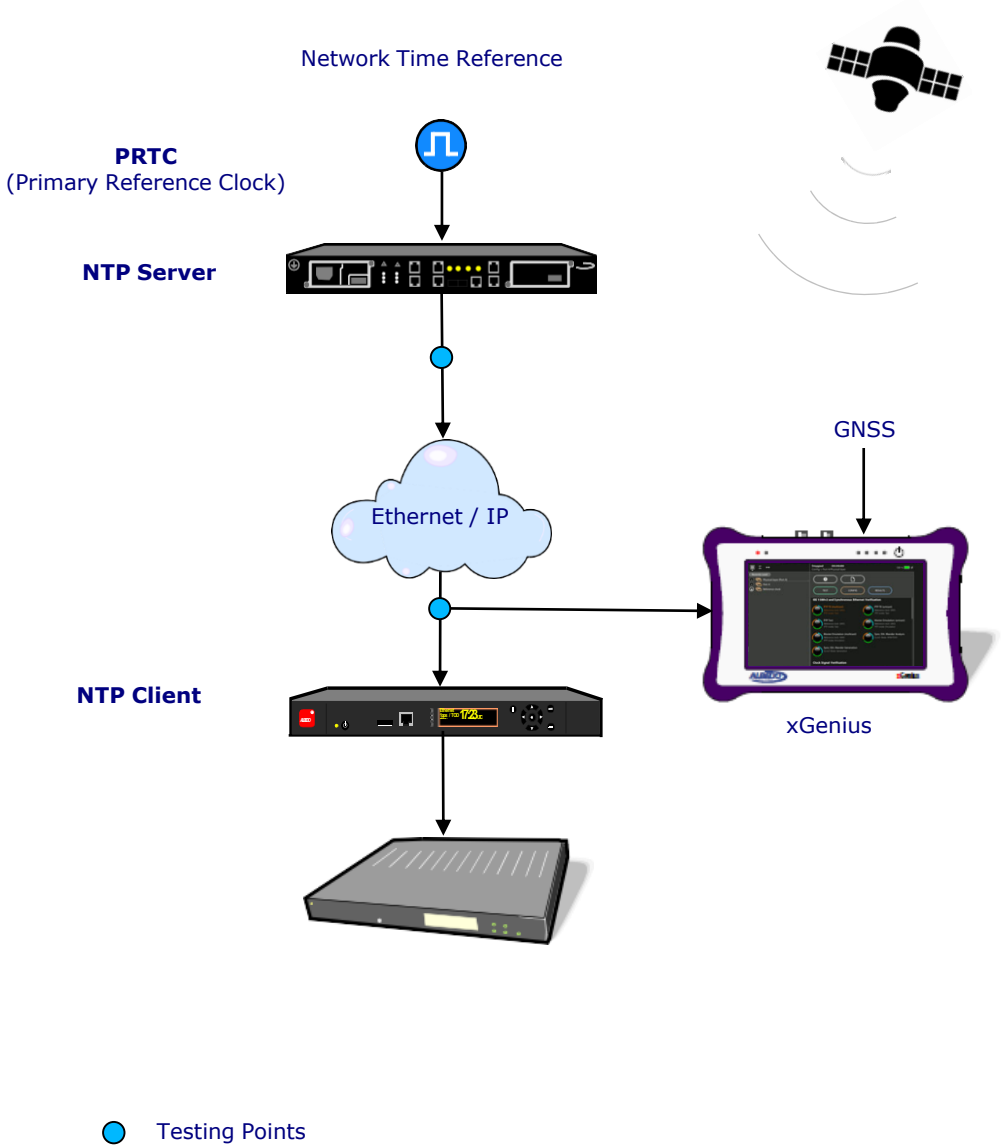
Interfaces & time **References**



The unit is equipped with GNSS receiver with SMA female connector for connecting an antenna typically supplied with a 5 m of coaxial cable plus a 10 m extension cable.

	GNSS	PTP	NTP	ToD	IRIG-B	PPS	PP2S	SyncE	T1/E1	MHz	Data
RJ45-A		in/out	in/out					in/out			
RJ45-B								in/out			
SFP-A		in/out	in/out					in/out			
SFP-B								in/out			
SFP+A		in/out	in/out					in/out			
SFP+B								in/out			
BNC-C									in/out	in/out	
RJ45-C				in		in	in		in/out	in/out	
SMB-C											
SMA	in										
SMB-1					in	in	in				
SMB-2					out	out	out				
RJ-45				in/out	in/out	in/out	in/out		in/out	in/out	
PHM											in/out

NTP in xGenius & Zeus



This presentation describes how to verify the accuracy and quality of one NTP server.

xGenius and **Zeus** support NTP server / client emulation using external time references such as GNSS, ToD or IRIG-B (avoid 1.5/2.0 MHz, 2048 kHz, 1 PPS and SyncE, because are frequency-only references and this test require also phase)

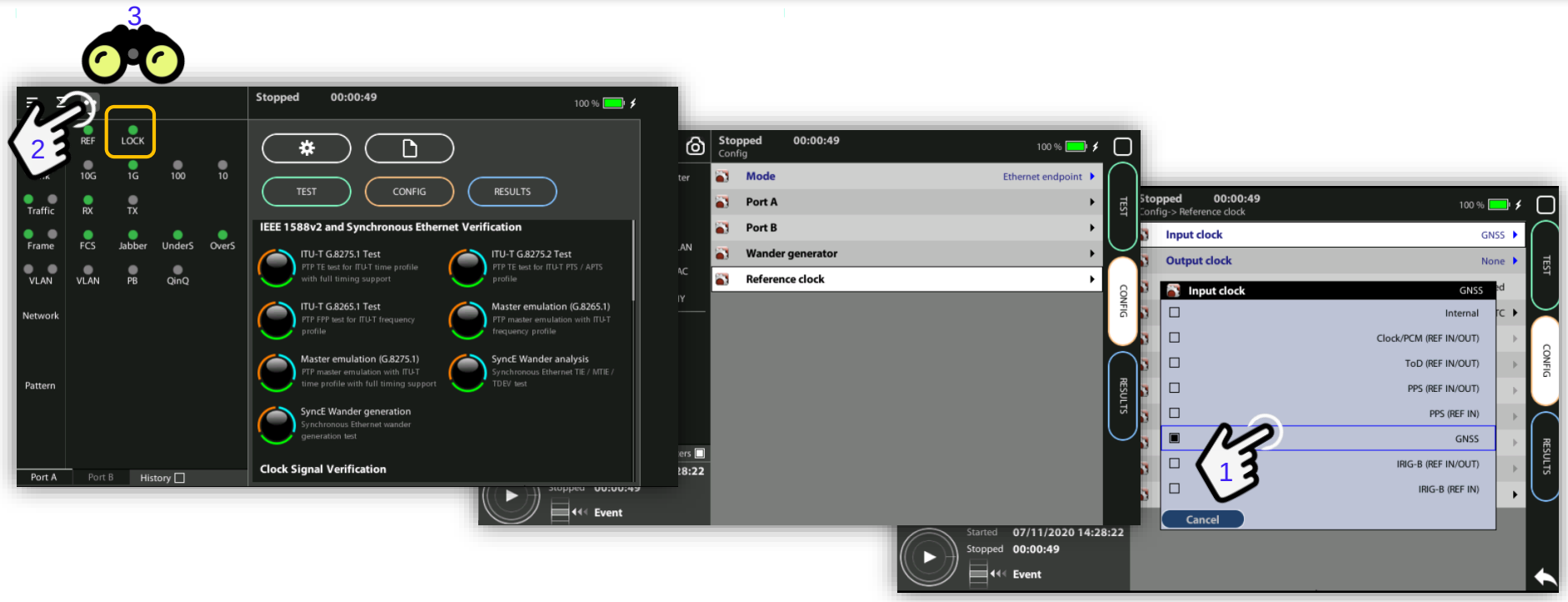
NTPv4 maintain 1-20ms time using software-interrupt based solutions over Internet achieving accuracies of 1us or better in ideal conditions.

Connecting the **antenna** & the **network**

xGenius is equipped with a built-in GNSS receiver. It has a SMA female connector suitable for connecting an antenna. A compact antenna with 5 m of coaxial cable plus a 10 m extension cable. Using a different antenna is possible whenever is compliant with xGenius specifications.

1. Connect the NTP network to Port A of the xGenius by means of one cable or one optical fiber.
2. Connect the antenna to the unit oriented to open sky. Some tests may loss accuracy if the number of satellites in sight is limited.

Steps to connect the **built-in GNSS**



1. Home > Config > Reference clock > Input clock := *GNSS* (*)
2. Press LEDS to check the status
3. Wait for the REF and LOCK LEDs to become green

(*) Go to Home panel, go to Config, the port setup will be displayed then Go to Reference clock and configure Input clock to GNSS.

OCXO or Rubidium

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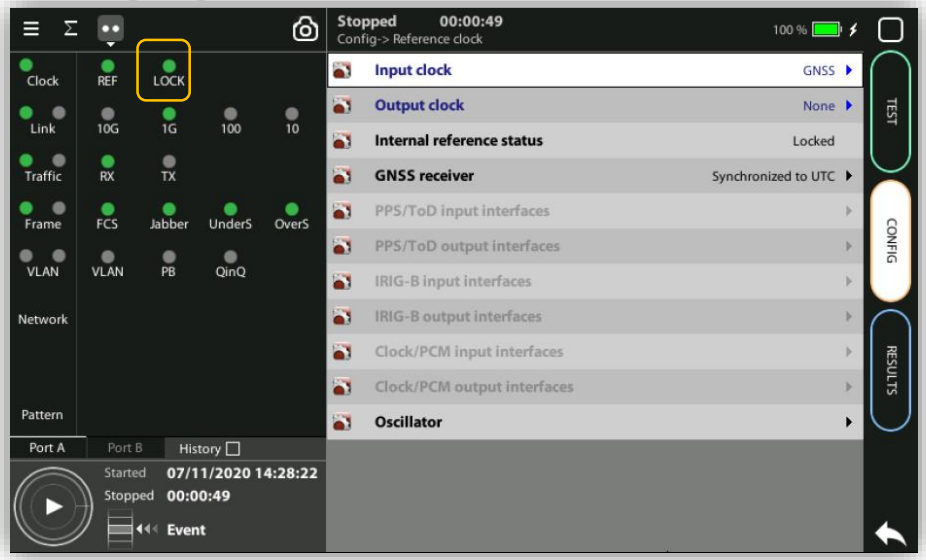
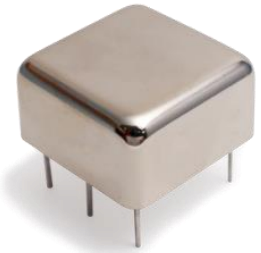


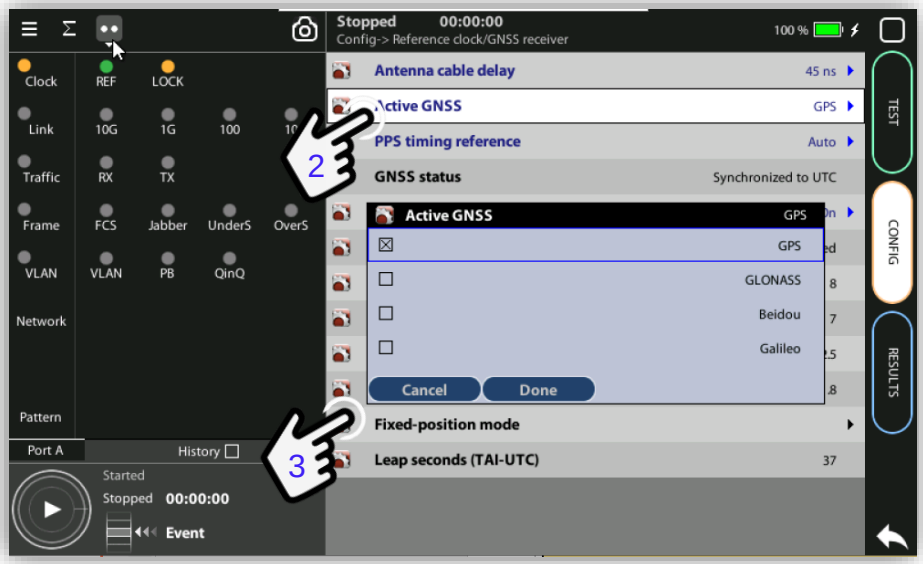


1. The unit will be ready for testing LOCK LED is green
2. Mind that time is different depending which oscillator xGenius is equipped

Metric	OCXO	Rubidium
Locking time	< 5 minutes	< 4 hours

Note: Current locking status (Locking, Fine locking, Locked, Holdover, etc.) can be checked in the Reference clock menu.

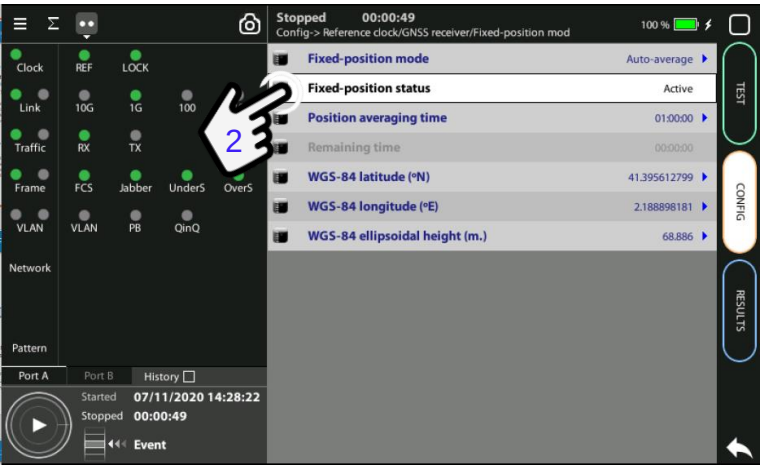
Configuring the **GNSS Properties**



Configure the GNSS to increase the accuracy:

1. Config > Reference clock > GNSS receiver > Antenna cable delay to configure a compensation at the correction field
2. Enable/Disable constellation Active GNSS setting := [*GPS* | *GLONASS* | *GALILEO* | *BEIDOU*]
3. Go to Fixed-position mode := *Auto-average*

Position **Averaging** time



GPS has a statistical distribution and averaging for a time filters errors to improve accuracy.

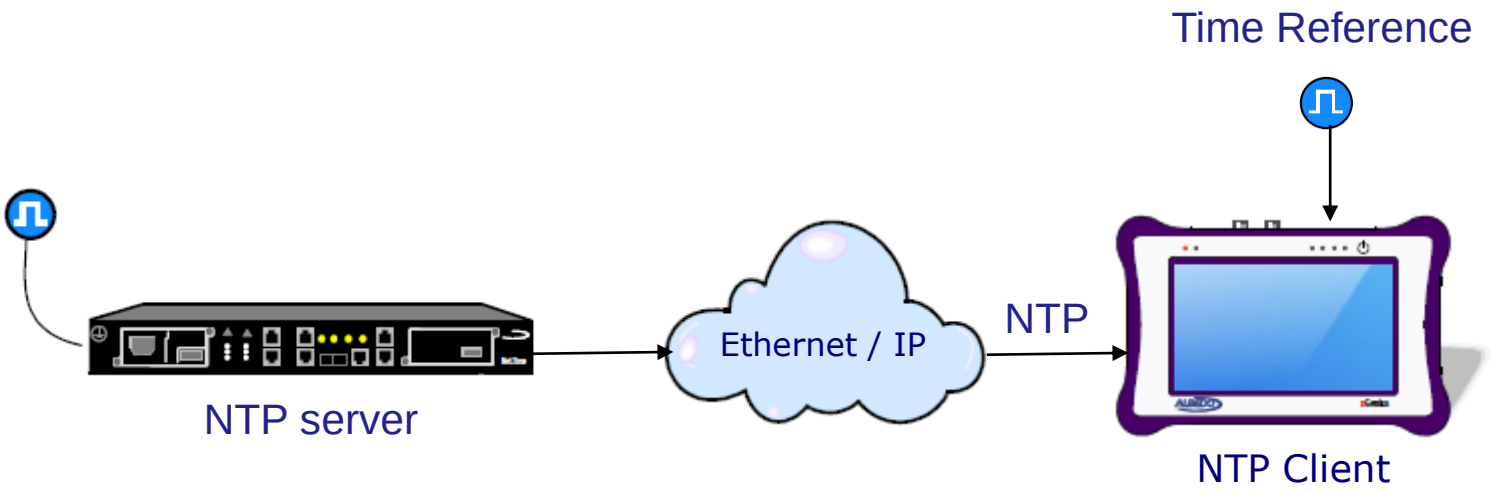
1. Adjust the Position averaging time and by configuring Auto-average in the that now displays *Averaging*

Notes: (a) At least 1h of averaging is required for reasonable accuracy. (b) The procedure should be run only once as long as the location does not change. If any change is detected (longitude, latitude, altitude) an error will be displayed.

2. Wait to the Fixed position status to become *Active*. The unit is now ready for testing.

Note: Theoretically, testing could start before the end of the position averaging process. The improved time estimation due to this function would be automatically applied starting from the end of the auto-averaging process.

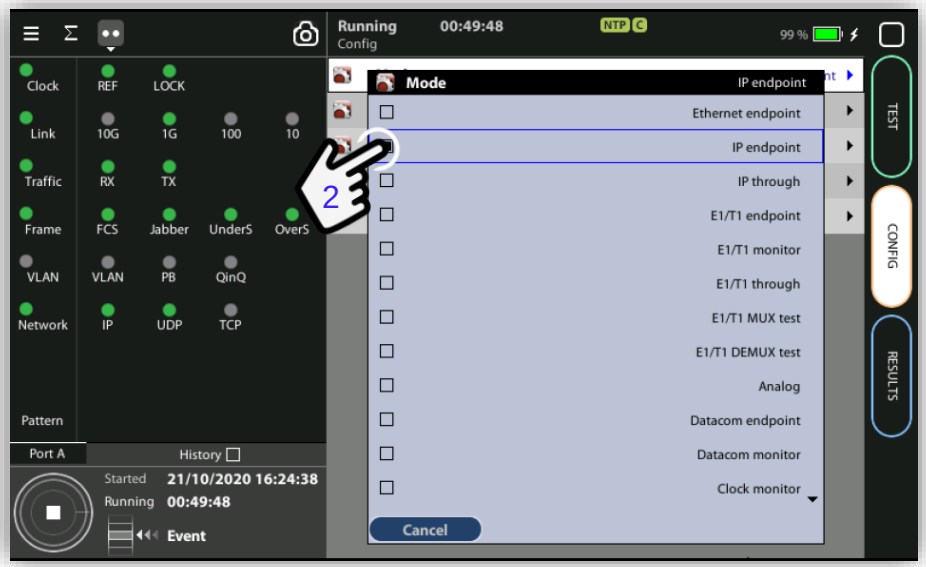
Hands-on to NTP test



xGenius can be configured as a genuine NTP client, **no differences** at all excepting that xGenius can also qualify the quality of a NTP timing source.

In the pseudo-slave emulation mode xGenius behaves as a NTP client but keeping an independent synchronization source that enables the unit to calculate parameters such as Time Error (TE) by comparing both timing signals.

Connecting the tester



In order to connect the xGenius use the RJ-45 or the SFP to link the network and configure it :

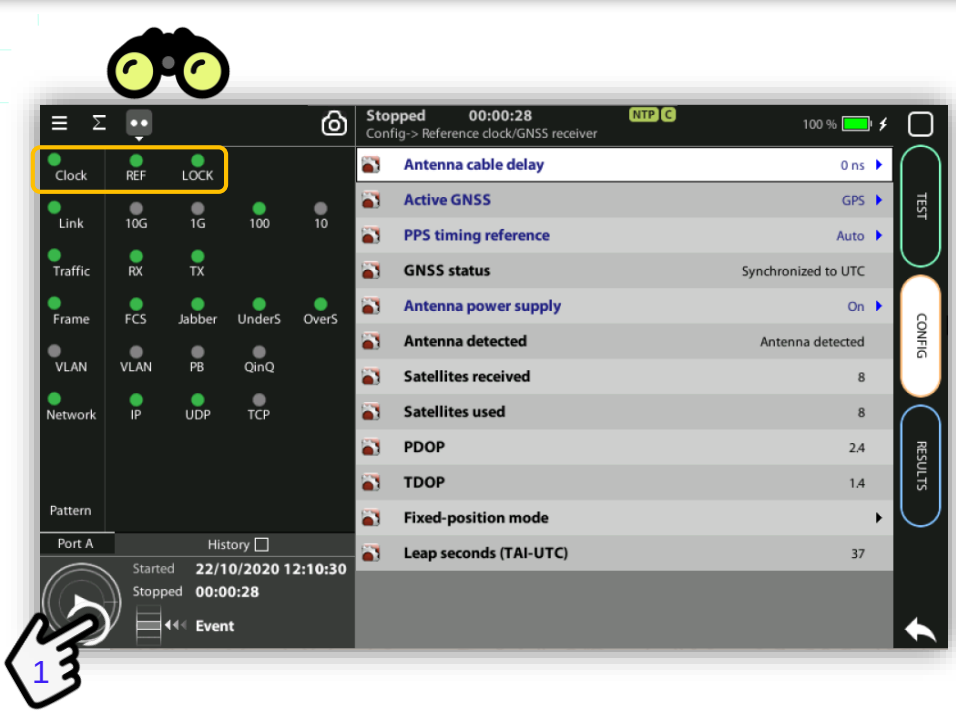
1. Go to the Home panel
2. Home > Config > Mode := IP endpoint

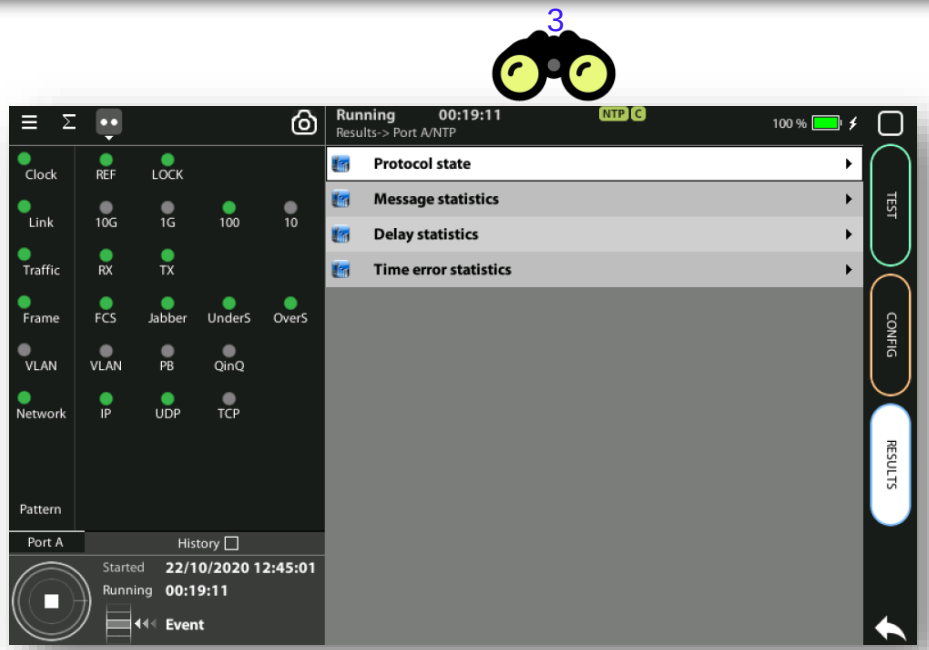
Configuring NTP in test Port A

You can configure as NTP Client, Server or Test (also known as pseudo-client):

1. From the Home > Test > NTP > NTP mode := [*None* | *Server* | *Client* | *Test*]
2. Select *Client* or *Test*. A NTP label will appear in top area
3. Configure the NTP protocol parameters including [Version] and [IP address]
4. Configure Destination host name that could a name or an IP address
5. Configure Max/Min polling intervals of the NTP client

Running the Test

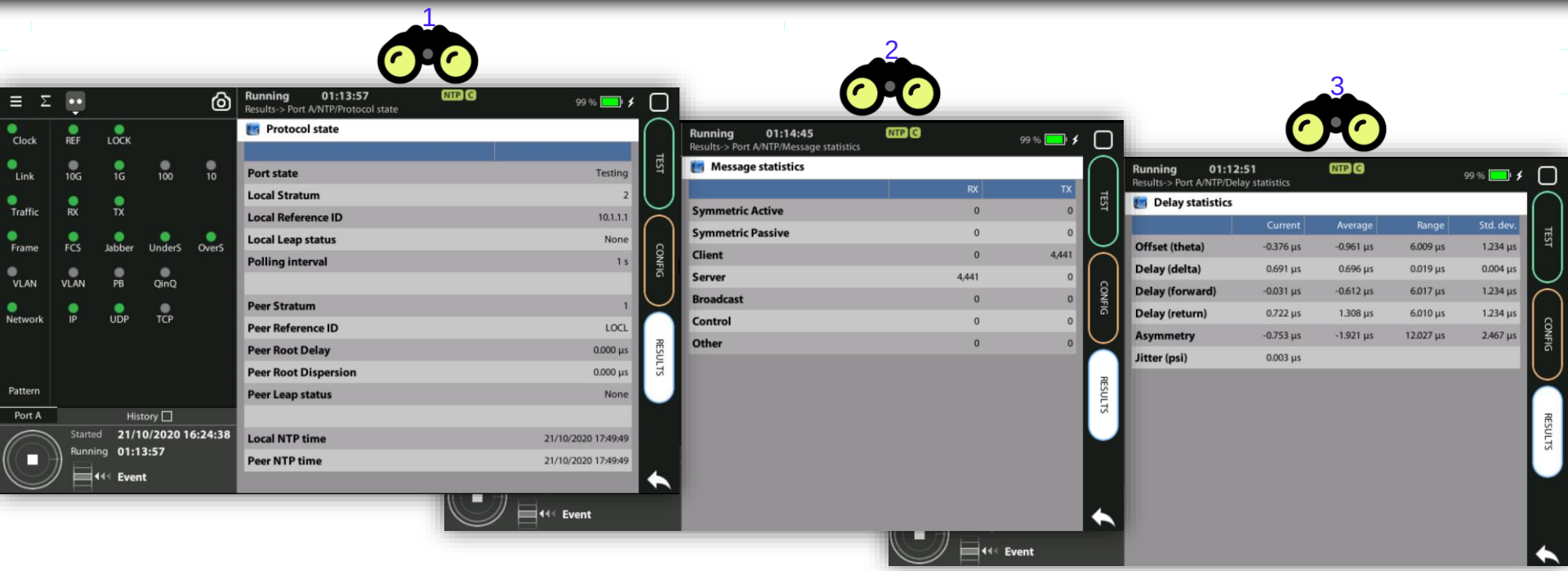




Once you have configured the test and the oscillator is locked to the time reference is the moment to execute the test:

1. Press **RUN** and test results will began to be computed in real-time
2. To display NTP results: Home > Results > Port A > NTP
3. Select the results you want to analyze

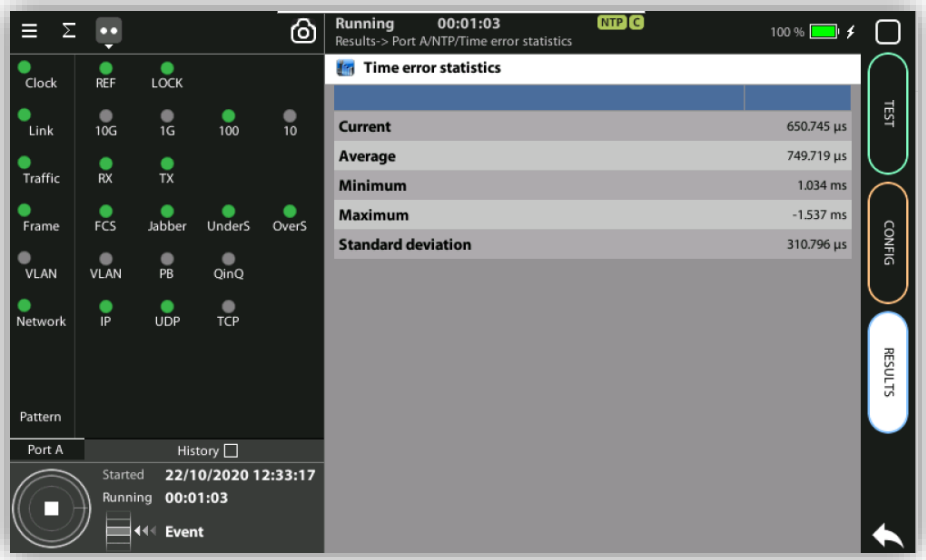
3 x type of **Results** (Server & Client mode)



Go to Home > Results > Port A > NTP then, if the tester was configured as Client or Server three different results will be available:

1. **Protocol state**: results depend on the server/client configuration
2. **Message statistics**: displayed in a table of Rx/Tx message counts
3. **Delay statistics**: include Current/Avrg/ Range/St.dev of offset (theta), round-trip delay (delta), forward delay, return delay, asymmetry and jitter (psi)

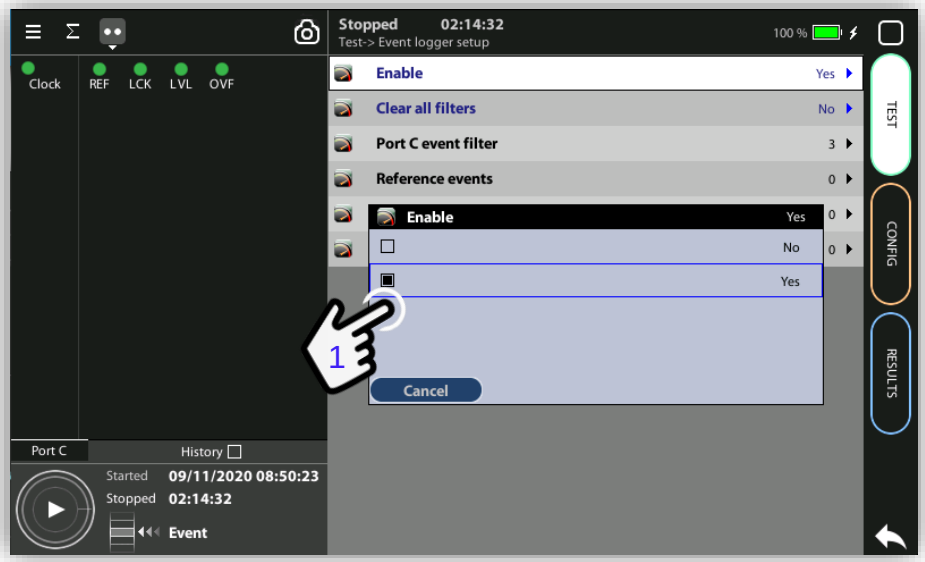
Time Error results



If you have selected the Test mode (also known as pseudo-client) then Time Error results will be also available otherwise this information will not be available.
TE that is computed as the difference between the time provided by NTP server and a reference:

1. Go to Results > Port A > NTP > Timer error statistics
2. Check [*Current*, *Average*, *Min.*, *Max.*, *Std dev*] results

Event logger enable



Global counts, statistics and LEDs provide information about which events and how many of them have been registered but they do not say too much about how they are distributed in time. These information is supplied at the Event Logger a graphical representation tool that permits to trace the evolution of key parameters.

The first thing to to is to enable it:

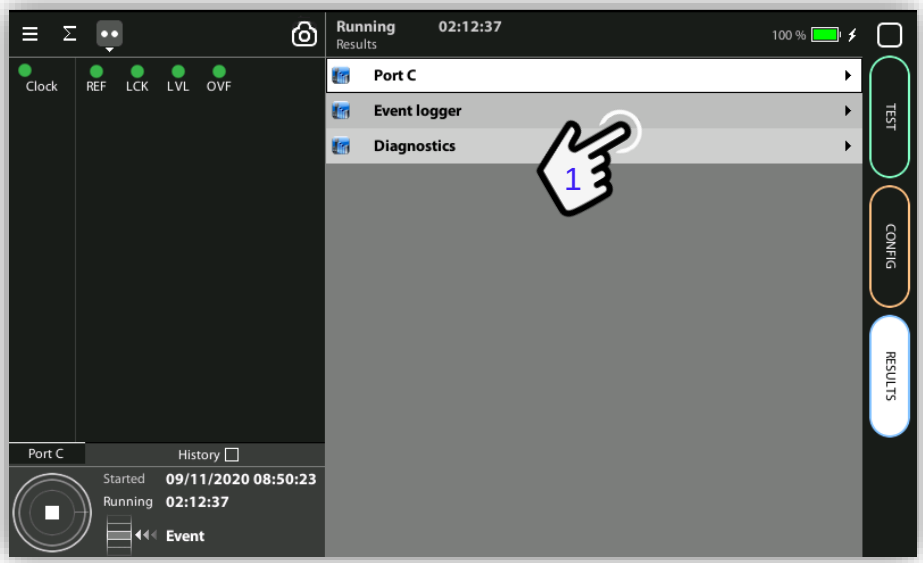
1. Go to Home > Test > Event logger setup
2. Set Enable := *Yes*

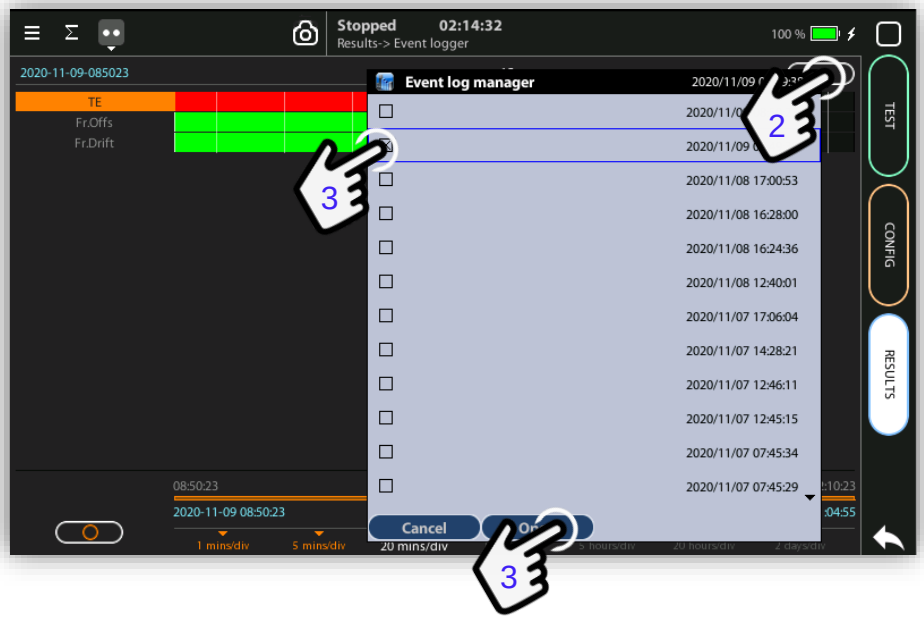
Configuring the Event Logger

Traceable Events are categorized in different classes. Moreover, each test port has its own traceable events. These events may be different for each test port.

1. Clear the currently selected filters: Clear all filters := *Yes*
2. Select the Port A or Port B
3. Choose the events to trace: Anomalies/defects | Bandwidth statistics | Frame layer statistics | SLA statistics | BERT | PTP | NTP | Synchronization
4. Press Run to begin the generation of a trace file

Display the logs

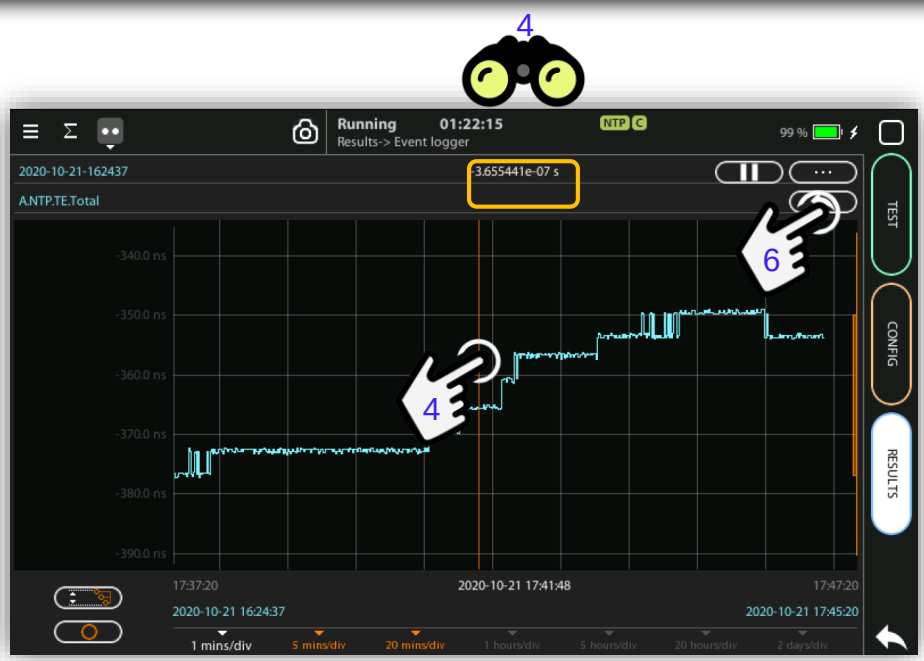




With the Event Logger you can select one or various events and trace them so that all changes along with the time and date these changes are registered are recorded with a 1 second resolution. The event logger provides representations and zoom levels to enable event analysis at different time scales:

1. Go to Results > Event logger
2. To select a saved trace double click at (…) to display the folder of traces
3. Select and Open one of the files

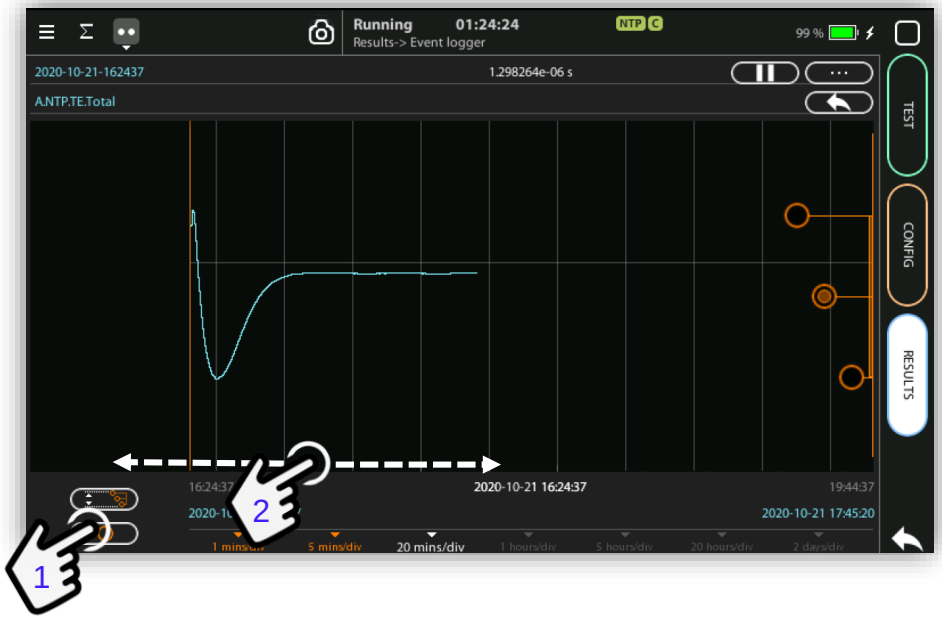
Event logger results



You can display the trace of the evolution of the previously selected parameters:

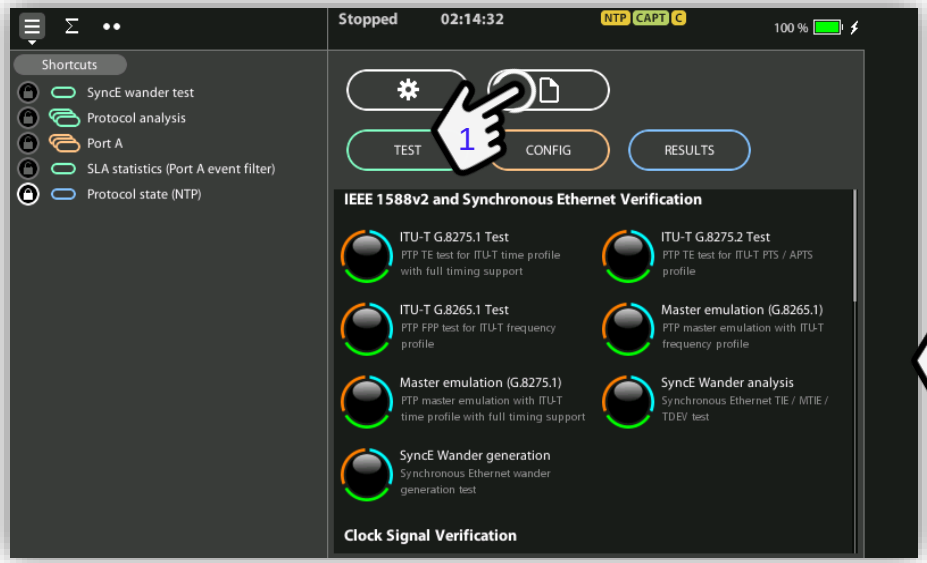
1. View and analyze the details of the histogram
2. Set the scale at your preferred zoom level
3. Selected one event to display a more detailed diagram
4. Click on the screen to know the exact value at one specific time

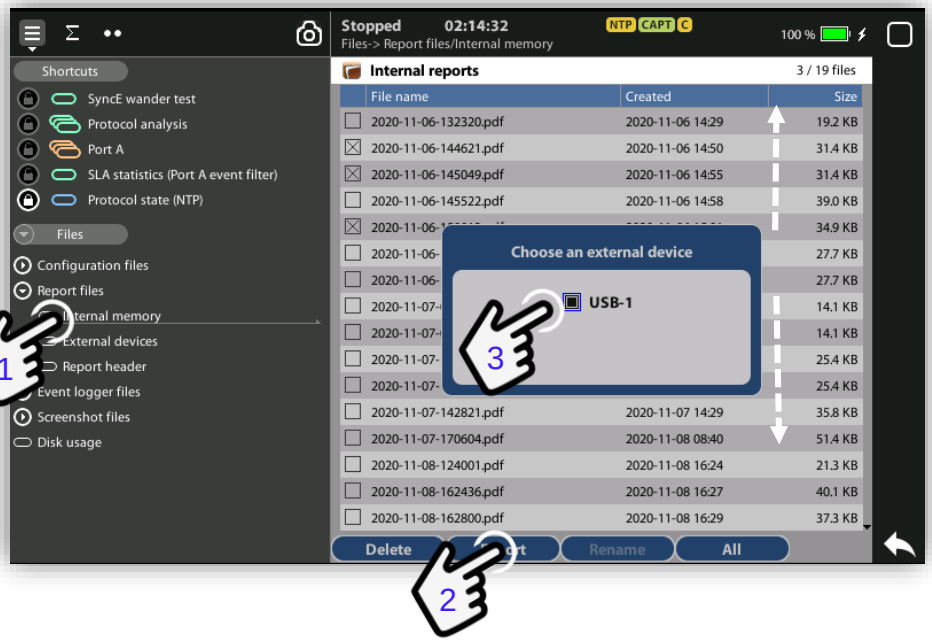
Scaling the trace



1. To change the scale horizontally click one time, for vertical two times
2. Click in the red buttom and draw to the left or to the right
3. To change the scale vertically click two times
4. To move the trace across the time click one of the three the red buttoms and draw the finger up and down
5. Click in the auto-scale symbol to return to the initial conditions

Exporting Logs





To export log files in CSV format:

1. Go Home > [File icon] > Configuration files | Report files > Internal memory to list the files currently stored in the unit
2. Select the files you want to export: File name > Export
3. Choose an external device: micro SD | USB
4. If no external device a popup will appear: ‘No devices present’

Glossary

AAA: Authentication, Authorization, and Accounting
ACL: Access Control List
AP: Access Point
Busbar: Metallic strip or bar, typically housed inside switchgear, panel boards, and busway enclosures for local high current power distribution **C37.94**: TDM interface devoted for teleprotection
CB: Circuit Breaker designed to close or open electrical circuit under normal or abnormal conditions. It operates on relays command.
CBWFQ: Class-Based Weighted Fair Queuing
CG: Connected Grid
CID: Individual configuration of each IED **CIP**: Critical Infrastructure Protection **CLI**: Command-Line Interface
CorpSS: Corporate Substation
CT: Current Transformer, used for measurement of current, if too high to apply directly to measuring instruments, a CT produces a proportional current which can be measured and recorded, CT are used in metering and protective relays
DAN: Doubly Attached Nodes implementing HSR or PRP
DAU: Data Acquisition Unit
Disconnector: isolates physically and visually the lines
DMZ: Demilitarized Zone
DCB: Directional Comparison Blocking
DCS: distributed control systems
DSC: Differentiated Services Code Point
ESP: Electronic Security Perimeter
Feeder: Transmits power to the distribution points
GM: Grandmaster
GNSS: Global Navigation Satellite System
GOOSE: Generic Object-Oriented Substation Events is a control model defined as per IEC 61850 which provides a fast and reliable mechanism of transferring event data over entire electrical substation networks. When implemented, this model ensures the same event message is received by multiple physical devices using multicast or broadcast services
HMI: Human Machine Interface
PTP: Precision Time Protocol
RedBox: Redundancy Box
Relay: is automatic device which senses an abnormal condition of electrical circuit and closes its contacts and complete the circuit breaker trip.
REP: Resilient Ethernet Protocol
RCT: Redundancy Control Trailer
RTU: Remote Terminal Unit
SA: Substation Automation
SAN: Singly-Attached Node
Secondary Lines: lower voltage side at the substation
SCADA: Supervisory Control And Data Acquisition, transmits and receives data from events of controls, measuring, safety and monitoring. Power system elements can be controlled remotely over. Remote switching, telemetering of grids showing voltage, current, power, direction, consumption in kWh, synchronization.
SCD: Substation Configuration Description **SCL**: Substation Configuration Language **SNTP:** Simple Network Time Protocol
Station Bus: Connects the entire substation and helps provide connectivity between central management and individual bays
STP: Spanning Tree Protocol
SV: Sampled Values, is a method to read instantaneous values such as currents, voltages, impedances, etc. from CTs, VTs or digital I/O and then transmitted to make them are available for those IED subscribed.
Switchgear: combination of switches, fuses or CB to control, protect and isolate electrical equipment
SyncE: Synchronous Ethernet
TLV: Type, Length, Value
VT: Voltage Transformer (see CT)Potential Transformer, gives the reference voltage to the Relay for Over-voltage or Under-voltage Protection
UCA IuG: Utility Communications Architecture International Users Group
VDAN: Virtual D
HQoS: Hierarchical Quality of Service
HSR: High-Availability Seamless Redundancy
IA: Industrial Automation
ICS: Industrial control systems
ICU: Intelligent Control Unit
IEC: International Electrotechnical Commission
IEC 61850: Standard defining communication protocols for intelligent electronic devices at electrical substations
IED: Intelligent End Device, microprocessor-based controllers of power system equipment, such as circuit breakers, transformers and capacitor banks to enable advanced power automation.
IRIG: Inter-Range Instrumentation Group
ISE: Identity Services Engine
L3VPN: Layer 3 Virtual Private Network
LA: Lightning Arrester protects the power grid from electric storms
MQC: Modular QoS Command-Line Interface
MMS: Manufacturing Message Specification, messaging system for exchanging real-time data and supervisory control information. Allows client such as SCADA, an OPC server or a gateway to access all IED objects **MPLS**: Multi-protocol Label Switching
MU: Merging Unit connected to the process bus converts analog data(ie. volts, currect...) into digital information
NERC: North American Electric Reliability Corporation
NIST: National Institute of Standards and Technology
NMS: Network Management System
OAM: Operations and Maintenance
PCP: Priority Code Point
PIOC: Instantaneous overcorrent Protection
PLC: Programmable Logic Controller
PMU: Phasor Measurement Unit
POTT: Permissive Overreaching Transfer Trip
PP: Primary Power
Process Bus: Connects primary units and control equipment to the IEDs
PRP: Parallel Redundancy Protocol
PRTC: Primary Reference Clock
PT: see VT
T-GM: Grand Master PTP
T-BC: Boundary Clock
T-TSC: Slave Clock

That's all

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