User Guide

Issue 1.49

SyncWatch-110

Versatile Synchronization Test
and Monitoring System

SyncWatch Version A

www.EXFO.com

Telecom Test and Measurement

EXFO

EXPERTISE REACHING OUT

Copyright statement

Trademarks

Units of measurement

Units of measurement in this publication conform to SI standards and practices.

Safety information

CAUTION

This unit is for indoor use only.

CAUTION

All electrical interfaces are SELV (Safety Extra Low Voltage) circuitry intended for intra-building use only.

To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cord.

CAUTION

No user serviceable parts are contained inside. Contact the manufacturer regarding service of this equipment.

IMPORTANT

All wiring and installation must be in accordance with local building and electrical codes acceptable to the authorities in the countries where the equipment is installed and used.

CAUTION

Electrostatic Discharge (ESD) Sensitive Equipment:

The unit can be damaged by static electrical discharge, particularly when performing fuse changes or adding a SIM card to the GSM/GPRS modem inside the unit. To minimize the risk of damage, dissipate static electricity by touching a grounded unpainted metal object;

- Before removing, inserting, or handling the unit.
- Before connecting or disconnecting cables to/from the unit.

Critical information

Caution: The SyncWatch probe should only be installed and maintained by a suitably qualified engineer after observing the precautions listed within this guide. If the SyncWatch product is used in a manner not specified in the instructions the safety afforded by the product may be impaired.

	Warning: To avoid serious personal injury or death, do not disregard warnings. All warnings use this symbol. Warnings are installation, operation, or maintenance procedures, practices, or statements that if not strictly observed, may result in serious personal injury or even death.
	Caution: To avoid personal injury, do not disregard cautions. All cautions use this symbol. Cautions are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in damage to, or destruction of, the equipment. Cautions are also used to indicate a long-term health hazard.
	ESD Caution: To avoid personal injury and electrostatic discharge (ESD) damage to equipment, do not disregard ESD cautions. All ESD cautions use this symbol. ESD cautions are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in possible personal injury, electrostatic discharge damage to, or destruction of, static-sensitive components of the equipment.
	Electrical Shock Caution: To avoid electrical shock and possible personal injury, do not disregard electrical shock cautions. All electrical shock cautions use this symbol. Electrical shock cautions are practices, procedures, or statements that if not strictly observed, may result in possible personal injury, electrical shock damage to, or destruction of components of the equipment.
	Recommendation: All recommendations use this symbol. Recommendations indicate manufacturer-tested methods or known functionality. Recommendations contain installation, operation, or maintenance procedures, practices, conditions, or statements, that provide important information for optimum performance results.
	Note: All notes use this symbol. Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information, which may make your task easier or increase your understanding.

Certification information

North America Regulatory Statement

This unit was certified by an agency approved in both Canada and the United States of America. It has been evaluated according to applicable North American approved standards for product safety for use in Canada and the United States.

Electronic test and measurement equipment is exempt from FCC part 15, subpart B compliance in the United States of America and from ICES-003 compliance in Canada. However, EXFO Inc. makes reasonable efforts to ensure compliance to the applicable standards.

The limits set by these standards are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the user guide, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment

European Community Declaration of Conformity

Warning: This is a class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

An electronic version of the declaration of conformity for your product is available on our website at www.exfo.com. Refer to the product's page on the Web site for details.

Note: If the equipment described herein bears the CE symbol, the said equipment complies with the applicable European Union Directive and Standards mentioned in the Declaration of Conformity.

For continued compliance to the requirements of the EMC Directive:

For the BNC/AUX port(s) use double-shielded coaxial cable, type 734A or equivalent.

For the REF OUT port use double-shielded cable, type LMR-240 ULTRAFLEX or equivalent, with a maximum length of 3m.

If the equipment described herein bears the CE symbol, the said equipment complies with the applicable European Union Directive and Standards mentioned in the Declaration of Conformity.

For BNC Input ports A & D use ferrites Wurth PN 742 711 42 to comply with Radiated emissions requirement.

Contents

1. About this guide

Purpose of this guide

The SyncWatch User Guide describes the procedures for unpacking, installing, operating and maintaining the SyncWatch probe. In addition, an overview of network synchronization principles is included.

Who should read this guide

The SyncWatch product overview found in section 4 is written for non-technical audiences who need general information about the product. Subsequent sections contain installation and configuration information as well as a technical reference.

This Installation and Operation Guide is designed for the following audiences:

- Systems Engineers
- Installation Engineers
- Operations Engineers
- Maintenance Engineers
- Network Design Engineers
- R&D Engineers

Structure of this guide

Each of the SyncWatch 'modes of operation' is dealt with independent sections within this guide. In some cases this will result in information being repeated. However, this approach simplifies access to the required information during the process of installation and configuration.

Useful definitions

GPS	Global Positioning System is a US government owned system using a number of Satellites orbiting the earth, these satellites are primarily intended to give positioning information for navigation but can also be used to derive a highly accurate timing source.
MTIE	Maximum Time Interval Error is a measurement based on TIE data designed to provide the maximum deviation of the peak-to-peak value of the TIE within, by widening the observation window.
NTP	Network Time Protocol is a protocol that is used to synchronize computer clock times in a network of computers.
PDV	Packet Delay Variation is the difference in end-to-end delay between selected packets in a flow with any lost packets being ignored.
PTP	Precision Time Protocol is an IEEE1588 defined protocol for distribution of timing over packet networks e.g. Ethernet.
Rb	Rubidium is an atomic frequency standard and can be used as an accurate frequency reference source for telecoms applications.
SYNC-E	Synchronous Ethernet is the ability to provide PHY-level frequency distribution through an Ethernet port. It can be considered one of the critical building blocks of the next generation packet networks.
TIE	Time Interval Error is the difference between the measure of a time interval as provided by a clock and the measure of that same time interval as provided by a reference clock.
UTC	Coordinated Universal Time is the time standard by which the world regulates clocks and time. Coordinated Universal Time is a time standard based on International Atomic Time with leap seconds added at irregular intervals to compensate for the Earth's slowing rotation.

Abbreviations

ANSI	American National Standards Institute
ATM	Asynchronous Transfer Mode
B8ZS	Bipolar 8 Zero Substitution
BITS	Building Integrated Timing Supply
DAB	Digital Audio Broadcasting
DC	Direct Current
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DVB	Digital Video Broadcast

ESD	Electrostatic Discharge
ETSI	European Telecom Standard Institute
FTP	File Transfer Protocol
GNSS	Global Navigation Satellite System
GPIB	General Purpose Interface Bus
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Group Special Mobile
HDB3	High Density Bipolar 3 Code
IEEE	Institute of Electrical & Electronics Engineers
IP	Internet Protocol
ITU	International Telecommunications Union
LAN	Local Area Network
LED	Light Emitting Diode
LOS	Loss of Signal
LTE	Long Term Evolution
MCU	Micro-Controller Unit
MTIE	Maximum Time Interval Error
NTP	Network Time Protocol
OXCO	Oven Compensated Crystal Oscillator
PDV	Packet Delay Variation
PIN	Personal Identification Number
PPM	Parts per million
PPS	Pulses Per Second
PRC	Primary Reference Clock
PRS	Primary Reference Source
PSTN	Public Switched Telephone Network
PTP	Precision Time Protocol
QoE	Quality of Experience
RAS	Remote Access Server
Rb	Rubidium
RF	Radio Frequency
SDH	Synchronous Digital Hierarchy
SIM	Subscriber Identity Module
SMART	Synchronization Monitoring and Reporting Tool
SMS	Short Message Service
SNMP	Simple Network Management Protocol

SONET	Synchronous Optical Networking
SSH	Secure Shell
SSU	Synchronization Supply Unit
SYNC E	Synchronous Ethernet
TCP	Transmission Control Protocol
TIE	Time Interval Error
TTL	Transistor-Transistor Logic
USB	Universal Serial Bus
UTC	Universal Time Coordinated

2. Synchronization introduction

What is network synchronization?

Synchronization is the means by which digital equipment in a communications network operates in unison. For the transmission of digital data, information is coded into discrete bits, data frames or packets. When this data is transmitted through a network of digital communication links and nodes, all parts of the system must be synchronized in order to avoid data loss or the retransmitting of data.

Synchronization is critical for maintaining the correct operation of telecom networks and services including SDH/SONET, ATM, 2G/3G mobile backhaul and PSTN voice services.

With communication service providers now rolling out high-speed packet networks based on IP/MPLS and Ethernet technology, synchronization remains equally as critical for supporting both legacy and next generation time sensitive services e.g. IPTV, online gaming, music streaming.

As wireless operators rollout 4G LTE/WIMAX networks, synchronization is still required at the base station to maintain the air interface frequency and any legacy voice infrastructure.

Network clocks

A network clock located at the originating site controls the rate at which the bits or frames/packets are transmitted from the sending node. A second network clock is located at the receiving node, controlling the rate at which the information is being read. The objective of network timing is to keep the source and receiver clocks in step so that the receiving node can properly interpret the digital signal. Poor synchronization at nodes within a network will cause the receiving node to either drop data or have to re-read information sent to it.

Effects of poor synchronization

Poor synchronization is caused by differences in timing accuracy among clocks at different network levels or by phase movements called jitter and wander. Jitter and wander distort network timing references as they are distributed from one node to another. As the frequency of the clock drifts, quality of service problems can increase. These problems can include dropped sessions and the need for retransmission in wire line systems, or dropped calls and delayed handoffs in wireless systems

A telecom sync system

Most telecommunications administrations use a hierarchical master-slave method to synchronize their networks. The master or source clock for a network is a PRC (Primary Reference Clock) comprising one or more Primary Reference Sources (PRS). This clock reference is distributed through a network of receiver clocks.

A node with the most stable, robust clock is designated as a source node. The source node transmits a timing reference to one or more slave nodes. The slave nodes, having equal or worse timing performance than the source node, lock onto the timing reference of the source node and then pass the reference to other slave nodes. This way timing is distributed down a hierarchy of nodes.

These slave nodes are usually designed to accept two or more timing references. At any time, one reference is active while all other alternate references are standby. In the case where the active reference is lost, the receiver node can switch references and lock to an alternate reference. Each receiver node therefore, has access to timing from two, or more, source nodes providing redundant operation.

Source clocks

Traditional networks

Modern telecommunications networks use highly accurate primary reference clocks (PRC) that must meet the international standards requirement for long term frequency accuracy better than 1 part in 10^{11}. To get this performance, atomic clocks or GPS are normally used. PRC clocks are also known to as stratum 1 clocks. A PRC/stratum 1 clock is defined by the International and Regional standards bodies ITU, ETSI and ANSI.

Packet networks

A Grandmaster is a term used for a master clock for a packet network. Grandmaster clocks typically use rubidium or quartz oscillators that are steered by timing information obtained from GPS. Grandmaster clocks transmit PTP timing packet information, as defined by IEEE 1588v2, to PTP slave clocks residing on its network segment.

Receiver clocks

The role of a receiver clock is to recover the clock from a reference signal and maintain timing as close to the source node's timing as possible. To accomplish this, the receiver clock must perform two basic tasks:

- It must reproduce the source clock's timing from a reference signal, even though the reference signal may have errors imposed upon it by the transmission media
- It must maintain adequate timing for a defined period in the absence of a timing reference

Traditional networks

The normal mode of operation for a receiver clock is to extract timing from the source clock's reference. Should any short-term reference errors occur the receiver clock must be able to handle them. These errors may be timing instabilities (jitter) or short-term reference interruptions (error bursts). Errors of these kinds are usually caused by the facility transporting the reference from the source clock to the receiver clock.

A receiver clock uses low-pass filters to handle short-term timing instabilities. During short interruptions of the timing reference, a receiver clock is designed to have two, or more, references so that it can switch references during short-term impairments.

The second mode of operation is a receiver clock running with a loss of all its timing references. This mode is called ‘Holdover’ and refers to the capability of the receiver clock to operate when it is not locked to an external reference. It uses data acquired during previous tracking of the timing reference to help maintain its accuracy.

Packet networks

Slave or Receiver clocks in packet networks are also known as clients. They have to perform all the same functions as slave or receiver clocks in traditional networks, but have to deal with noise levels on the reference timing signal that are many orders of magnitude greater than the noise experienced in traditional networks. Due to the nature of packet networks, a slave clock may experience holdover more frequently, and have to deal with the noise created by packet delay variation.

Management

All modern telecommunication networks need management systems and tools in order to operate effectively.

Monitoring

Monitoring of synchronization is possible by using the in-built capabilities of network elements or synchronization elements or from independent monitoring devices and tools.

The built-in capabilities of network elements or the synchronization sources, receiver clocks or clients varies significantly by manufacturer and of course does not provide a truly independent view of synchronization performance.

Devices that continuously monitor synchronization performance that use their own reference that is independent of the synchronization delivery infrastructure provide an absolute measure of performance and reliability.

Decisions to monitor can be either strategic or tactical and are not typically dependent on the network infrastructure. Implementation of packet networks and the requirement to maintain synchronization at mobile base stations and other synchronization sensitive applications has increased the need for monitoring.

Monitoring is undertaken by operators as part of:

- Revenue assurance programs
- Quality improvement activities
- Service level agreement definition and policing

Testing

Testing the quality of synchronization has always been required; be it as part of equipment acceptance, installation/commissioning or as part of on-going maintenance and support activities.

Synchronization test equipment must be portable/transportable and easy to use by engineering teams that have to support an ever-increasing number of equipment and services that operators provide.

3. Making synchronization and timing measurements

Synchronization and timing measurement fundamentals

The purpose of a synchronization or timing measurement is to determine the quality of a clocking source. This may also include the effects introduced by the delivery mechanism or network path of the signal from the clock itself to the test point. The results from a measurement are used to qualify, calibrate or troubleshoot clock sources and delivery methods.

Synchronization measurements are performed by comparing the quality of the clock at the measurement point against a reference, clock of known quality, the instantaneous difference between the two clocks are recorded at a determined sample time, and consecutive samples show the performance of the measured clock over the total measurement period.

The required quality of a clock source depends on the application, for some applications being accurate to the nearest second is acceptable, for others accuracy is required to within trillionths of a second.

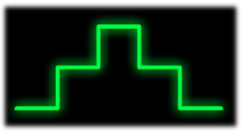
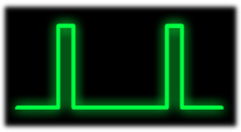
Synchronization in telecom networks

The quality requirements for clocks in telecom networks is typically between a few billionths (nanoseconds) to around 30 millionths (microseconds) of a second depending on which aspect of the network the clock signal is being used for. This level of accuracy, and subsequently the required measurement accuracy, is far finer than other ‘data’ or ‘packet jitter’ tests of telecom signals which typically have requirements the thousandths of a second (millisecond) range.

Determining the signal type

There are three major types of external signals that can be input into SyncWatch, it is important to connect to ports of the correct impedance and configure the correct signal type.

If the signal shape is not known prior to measurement, it should be determined using an oscilloscope.

Sine / square wave	E1/T1/SyncE digital signal	1 Pulse Per Second
		
Analogue signal, or frequency, usually a positive-negative or positive-zero cycle. It is described in cycles per second, Hertz, e.g. 10 MHz. Connect to SyncWatch ports: A,B,C,D,E	Digital signal, it may have data 'bits' encoded on it. Differing framing formats exist but this does not affect measurement. Described in Bits per second, bps, e.g. 2.048 Mbps. Digital signals also have names defined in the relevant standards, such as E1, T1 or Ethernet. Connect to SyncWatch ports: A, C, G	Pulse signal, a short pulse to mark the edges of seconds passing. Described in pulses per second, e.g. 1 PPS. Typically the 1 second 'rollover' is marked by the rising edge of the pulse. Connect to SyncWatch port: F

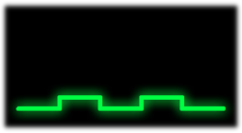
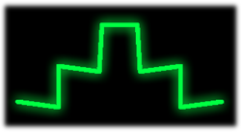
Controlling signal levels and integrity

If the voltage levels of any input signal are out of the allowable range, incorrect or no sampling (triggering) will occur and the measurement will be invalid, the allowable range varies depending on the SyncWatch port, the levels are details in the user documentation.

The signal level and integrity can be determined using an oscilloscope and, if required, subsequently modified by using 3rd party amplification or attenuation hardware to bring the signal into the measurable range.

The measurement tolerances are tighter when measuring digital (E1/T1) signals due to the complex signal shape. This means there is an increased chance that signal modification will be required to enable correct measurement.

A U-Link-Tap may be used to passively access a terminated data link. It presents a very low level copy of original signal. If a U-Link-Tap is employed SyncWatch must be configured for '30dB Down' to increase the port gain and allow visibility of the low level signal, however the signal may require further amplification after the U-Link-Tap to enable correct measurement.

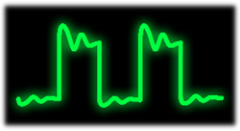
Input levels too high	Input levels too low	Bad digital signal integrity
		
The signal voltage is too high, SyncWatch will 'clamp' the excess voltage back to zero leading to false negative triggers. Attenuation is required to bring the signal level down before it reaches the SyncWatch input port.	The signal voltage is too low, SyncWatch will be unable to detect a trigger voltage and may report loss of signal. Amplification is required to bring the signal into measurable range.	As E1/T1 signals are measured with two trigger voltages, multiple triggering can occur if the input signal is not framed within set tolerances. Either amplification or attenuation may be used to bring the signal into the range where it can be measured.

Matching end-to-end signal impedance

A device or port generating a signal for measurement by SyncWatch has ‘output impedance’ — the impedance value of its internal circuitry as 'seen' from the outside. Each SyncWatch input port has ‘input impedance’ – the impedance value of that port as ‘seen’ from the outside.

The possible SyncWatch port impedance values are 50 Ω/75 Ω/100 Ω/120 Ω/Hi-Z depending on the port. Cabling, connectors and other hardware such as amplifiers and attenuators used in the chain also have impedance values.

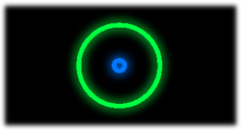
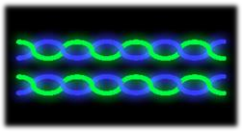
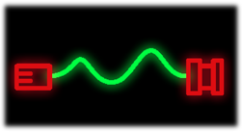
The impedances of the equipment output port, SyncWatch input port, all cabling and any other equipment in the signal chain must match to ensure an optimal measurement environment. If impedance is not fully matched, not all of the signal power will be transferred to the SyncWatch input port and some may travel back up the coaxial line affecting the shape of subsequent signals or pulses and may cause the measurement results to be invalid.

Signal reflections	Signal ringing / overshoot
	
If impedance matching is not employed correctly, remnants of the original signal may ‘bounce’ back up the line to the source and adversely affect the shape of the signal being transmitted to SyncWatch, causing incorrect triggering.	If impedance matching is not employed correctly, the voltage may oscillate at the upper or lower values. Depending on the original power of the signal, this can cause incorrect triggering.

Using correct cable infrastructure

The characteristics and configuration of the cables and connectors used will affect measurements. As well as ensuring the correct impedance, the type of cable used must also be suitable for the type of signal being measured.

Telecoms grade cabling and connectors must be used to ensure the signal is transferred within the correct tolerances.

50 Ω / 75 Ω / Hi-Z- coaxial	10 0Ω / 120 Ω - twisted pair	Connector quality
		
For 50 Ω or 75 Ω or Hi-Z signals, coaxial cable and connectors of the correct impedance must be used and correctly terminated. As a general rule, thicker cable is better, so for instance RG58 or RG59 are better than thinner cable types, particularly over distances greater than 5 meters.	For 10 0Ω or 120 Ω signals, twisted pair cabling and connectors of the correct impedance must be used and correctly terminated. If the measurement environment contains RF signals, ‘shielded’ cabling must be used to maintain the integrity of the transmitted signal.	The terminating connectors affect the end-to-end signal transfer as they have impedance characteristics. Additionally the quality of the bond with the cable elements affects performance.

Compensating for propagation delay

A signal takes a certain amount of time to traverse a cable. The longer the cable the more time it will take the signal to travel from the source equipment to the destination equipment. The speed that the signal travels depends on the cable type, so manufacturer documentation must be referenced to correctly calculate this. However, an average value is 4 nanoseconds per metre.

The SyncWatch system is capable of making accurate time interval measurements between 1 pulse-per-second (1 PPS) signals. The most common scenario of which is using the SyncWatch internal GPS receiver as a reference 1 PPS which is traceable to UTC and measuring the offset of another 1 PPS signal, e.g. derived over some network distribution system. Using the SyncWatch internal GPS reference in this way will give accurate absolute offsets. This assumes that the antenna cable delay had been configured using the methods described in section 7, as the antenna and associated cabling contributes to the delay of the GPS signal, and hence the UTC alignment of the 1 PPS signal generated in the receiver.

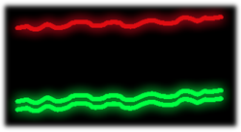
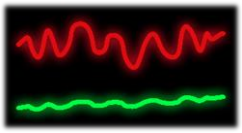
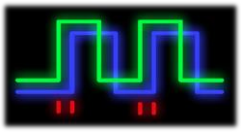
If cable delay is not compensated for when required it is not possible to know if a measured offset is a function of the reference clock, the measured clock, or the cable infrastructure.

In some circumstances, when GPS reception is not available, e.g. due to unavailability of a suitable antenna location or access restrictions, it may still be useful to make some 1 PPS measurements without GPS and therefore without UTC traceability. In this case the GPS receiver inside the SyncWatch probe would either be in holdover or free-run. If the unit is manually put into free-run, then a ‘pseudo 1 PPS’ signal is generated by the TIE measurement function inside SyncWatch so as to be close to the 1 PPS signal under test, to start the measurement with values close to zero. Without UTC traceability, absolute offsets from UTC cannot be calculated, but it may still be meaningful to observe how the 1 PPS under test changes over time with reference to the ‘pseudo 1 PPS.’

If a measurement is started with a GPS reference and the GPS signal subsequently lost, disconnected or removed part way through the test, the UTC traceability will also be lost. The GPS/Rb module's 1 PPS signal will then drift away from UTC at the rate of the rubidium drift. As the drift rate of the rubidium is linear, it can be removed during post-processing of the measurement result data.

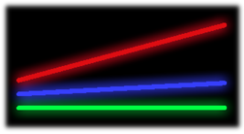
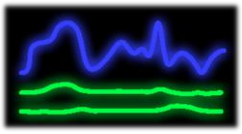
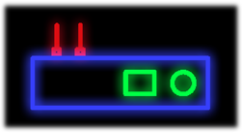
Understanding what is being measured

The quality of a timing signal is correctly measured by comparing it to a reference clock that has the same or better timing qualities than those being measured in the measured clock. The relative timing differences between the two clocks as expressed by the output signals that are being measured are recorded as the absolute performance of the measured clock.

Accuracy	Stability	Time Interval Error
		
Accuracy is a measure of the deviation at any point in time between the measured clock and the reference clock. This can be expressed in terms either of the signal cycle frequency or the offset of a single pulse or a digitally encoded timestamp.	Stability is a measure of the amount and magnitude of timing variations present in a clock over a given timeframe.	Time Interval Error (TIE) is the basis for all synchronization and timing measurements it is the raw offset, or difference between the reference signal or timestamp and the measured signal or timestamp at any point in time. Once TIE has been recorded, it can be analyzed using algorithms and metrics to enable comparison with other timing signals or published standards.

Choosing a valid measurement reference

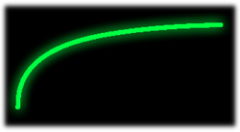
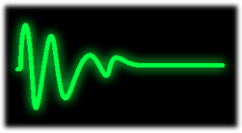
Making a measurement with SyncWatch requires at least one reference clock with which to compare the measured clock, correct reference selection is a critical aspect of ensuring a valid measurement.

High quality reference signal	Use 2 references where possible	Internal or external references
		
The accuracy and stability (quality) of the reference signal(s) must be known before they are used and must be of the same or, ideally, orders of magnitude better quality that the measured signal(s), otherwise it is the reference signal that will be measured, rendering the measurement results invalid. The expected quality of a clock will be detailed in the manufacturer documentation or in published standards for clock or network interface types or location. These should be referenced to ensure the reference clock is of a suitable quality compared to the measured clock.	When making a synchronization measurement, it is important to be sure that any significant events seen in the results are a function of the measured signal only and not the reference signal(s). If available, using two reference signals from diverse sources will give visibility of this.	SyncWatch, depending on model, features Internal GPS and/or Rubidium modules to provide a reference signals. If external references are not available or their quality is unknown, the internal references must be used.

Validating the internal reference

SyncWatch has two methods of generating a reference signal for a measurement, GPS or Rubidium. For these references to be of suitable quality to use, care should be taken to ensure that the reference is allowed to properly stabilize before being used as a reference.

If the reference is not allowed to stabilize, artifacts such as drift, wander, and phase jumps will render the measured data invalid.

Rubidium warm-up	GPS locking
	
Rubidium has a large drift when initially powered, over time the drift slowly stabilises until it is suitable for use as a measurement reference. Setup validation or other non-important short-term tests can be performed 10 minutes after power-on. Critical or long-term tests should be performed no sooner than 45 minutes after power on.	Immediately after power-on or antenna connection, the GPS module will begin to stabilise. This period is characterised by the oscillator making large corrections, then subsequently smaller ones until it is locked to the GPS reference. Due to the nature of the locking process, no testing should be performed until the SyncWatch GPS is reporting '3D Fix'.

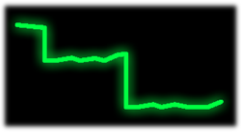
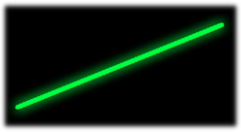
Identifying invalid measurements

It is important to be able recognize an invalid measurement within the shortest possible period of time after starting it, as this will limit wasted time and eliminate the need to redo long-term tests.

Before starting a measurement it is important to have an idea of what the results are expected to look like after certain periods of time, and if they don't look as expected, to verify all elements of the test setup.

It is unlikely that the exact characteristics of a measured signal are known prior to measurement. However some basic assumptions can be made based on information such as alarm state of the measured equipment, oscillator type, master reference, synchronization trail length and delivery method and free-run drift rate. These assumptions can be used place the expected results within a certain timing quality bracket and any deviations within an 'order of magnitude'. If test results are significantly different to those expected then there may be an issue with the measurement setup.

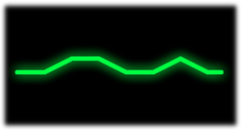
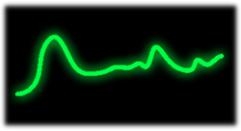
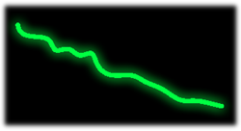
As the measurement is simply plotting the TIE between the measured signal(s) and the reference signal(s) invalid measurements can be caused as much by an issue with the reference signal as the measured signal, particularly if an external reference signal is being used.

Large unexpected phase steps	Excessive noise	Large fixed offset
		
Large phase steps occur when a measured Time Interval Error is much larger than the ones immediately preceding it. It may be a valid measurement but it can also be caused by 'missed' pulse(s) due to the trigger voltage not being met. In the latter case the magnitude of the phase steps will be close to a single or multiples of the Unit Interval of the measured signal e.g. 488 ns for a 2.048 MHz signal.	Excessive noise occurs when each measured Time Interval Error is massively positive or negative compared to the preceding one, the values appear random. It is highly unlikely that the measurement is valid as all timing signals have a certain stability, even if it is just a fixed drift in one direction. This type of invalid measurement is usually caused by incorrect input configuration, e.g. measuring an E1 signal when the port is configured for 2.048 MHz.	A large fixed offset may indicate that the measured signal is generated by equipment in free-run. However it may also be caused by incorrect configuration of the input frequency, meaning that pulses will be measured at a rate that is different from the actual signal rate by a fixed offset – the fixed offset is what is plotted.

Identifying valid measurements

It is important to be able recognize a valid measurement within the shortest possible period of time after starting it, as this will limit wasted time and eliminate the need to redo long-term tests.

Each synchronization measurement situation is different and the characteristics of the measured data will vary but there are some common features that can be strong indicators of a valid measurement.

Low short term variations	Positive / negative wander	Long term drift – with variations
		
In general, the measured signals will have low variations (0-20 ns) from one sample to the next. High variations indicate high signal jitter, if this is not expected then there may be an issue with the measurement. Another indicator of a good measurement is a balance between positive, zero, and negative TIE jumps over short time frames (10 s).	Segments of both positive and negative wander over longer timeframes are an indicator of a valid measurement of a signal coming from equipment that is locked to its own reference or to upstream equipment in a network. Regardless of the longer term tendency, the presence of this wander shows that a range of events are being recorded.	A measurement may feature long term drift, this could be due to the measured signal or as a function of using a free-running Rubidium reference. However, even with a pronounced drift, there should still be segments of noticeable variations that indicate a valid measurement.

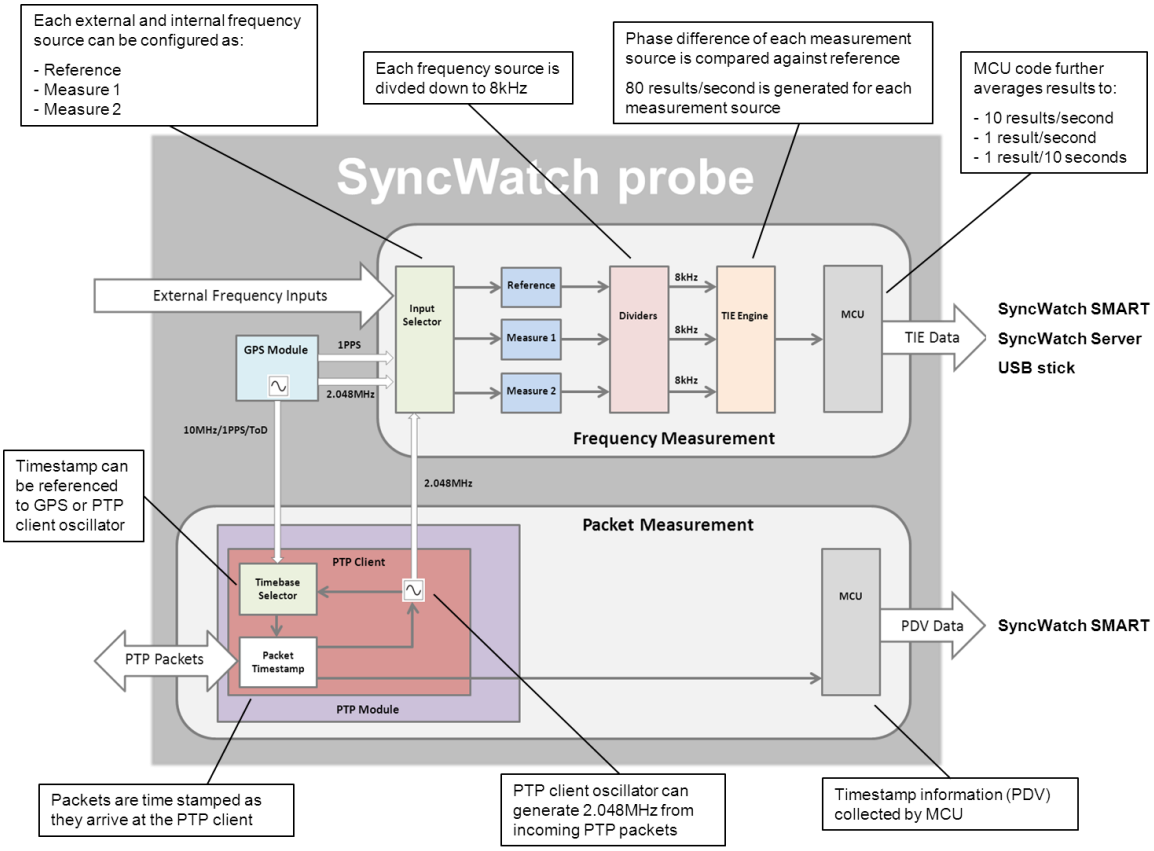
4. Product overview

SyncWatch provides a highly versatile telecoms sync testing and monitoring system. This is ideal for network operators, service providers, broadcasters (DVB/DAB) and suppliers involved in specifying and implementing both new generation networks as well as managing and maintaining traditional networks as they reach end of life.

This section provides a foundation understanding of the basic features and functions of the SyncWatch probe.

The system

For frequency measurements the SyncWatch probe has a TIE engine that can measure up to two sources simultaneously against a single reference source. The measurement and reference sources can be selected from any external or internal frequency source. The internal GPS receiver module can generate a PRC compliant 2.048 MHz clock, 1 PPS and ToD traceable to UTC. The internal PTP monitoring module can generate a 2.048 MHz clock from incoming PTP packets. The probe can generate results at the following sampling rates: 10 Hz, 1 Hz or 0.1 Hz (i.e. 1 result every 10 seconds).



For packet measurements the probe uses the internal PTP monitoring module to timestamps each incoming PTP packet. This timestamp information is then used to calculate the packet delay variation of the PTP flow. The PTP monitoring module can either use its own oscillator or the internal GPS receiver module as a reference source for the timestamps. The benefits of using GPS as a reference are listed below:

1. GPS is UTC traceable. This ensures more accurate timestamps
2. Same time base as the Grandmaster source that is also referenced to GPS
3. The time base of the oscillator is derived from the Grandmaster but it is also subject to small errors caused by the packet delays in the network - the very thing the SyncWatch probe is trying to measure
4. The PTP algorithm assumes the delay in both directions of the packet flow is the same. This means that the oscillator cannot be used to independently measure the delay variation of each direction whereas it can with a GPS reference source

Modes of operation

The SyncWatch probe can be configured to run in one of three modes of operation:

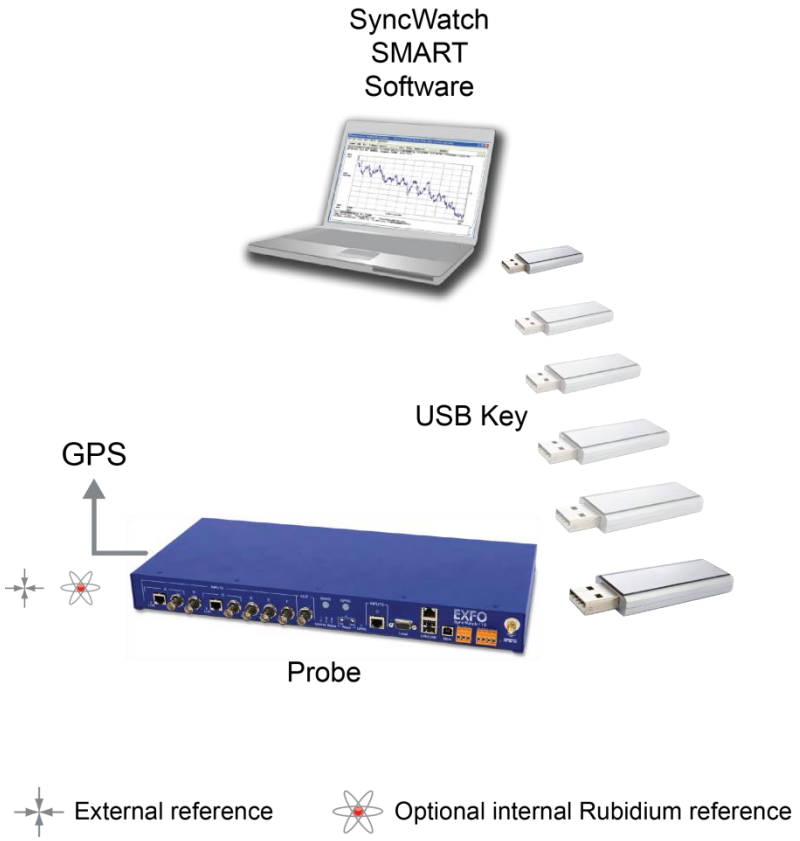
1. USB mode
2. Standalone mode
3. Managed mode

Analysis and reporting on the collected information is carried out using software specific to each mode. When ordering a SyncWatch probe, the supported mode of operation will determine what hardware and software components are delivered.

The following sections provide description of each operation modes. Full details of how to install and configure each mode of operation can be found in the following sections.

USB mode

In USB mode the probe is configured by, and writes measurement data to a USB storage device. This mode is ideal for lab or remote testing where data can be collected quickly and easily for subsequent offline analysis.



The current version of the SyncWatch probe does not support PTP packet monitoring in USB mode.

SyncWatch probe hardware

- Small form-factor
- Low power consumption
- Flexible input types
- Common telecom traffic/clock signals
- Common test and measurement signals
- Powerful on-board processing capability
- Internal GPS receiver module with Rubidium oscillator (optional)
- Internal GPS receiver module with oscillator (optional)
- USB stick

SyncWatch SMART software

- Graphical User Interface
- TIE and MTIE plots
- Industry standard MTIE masks

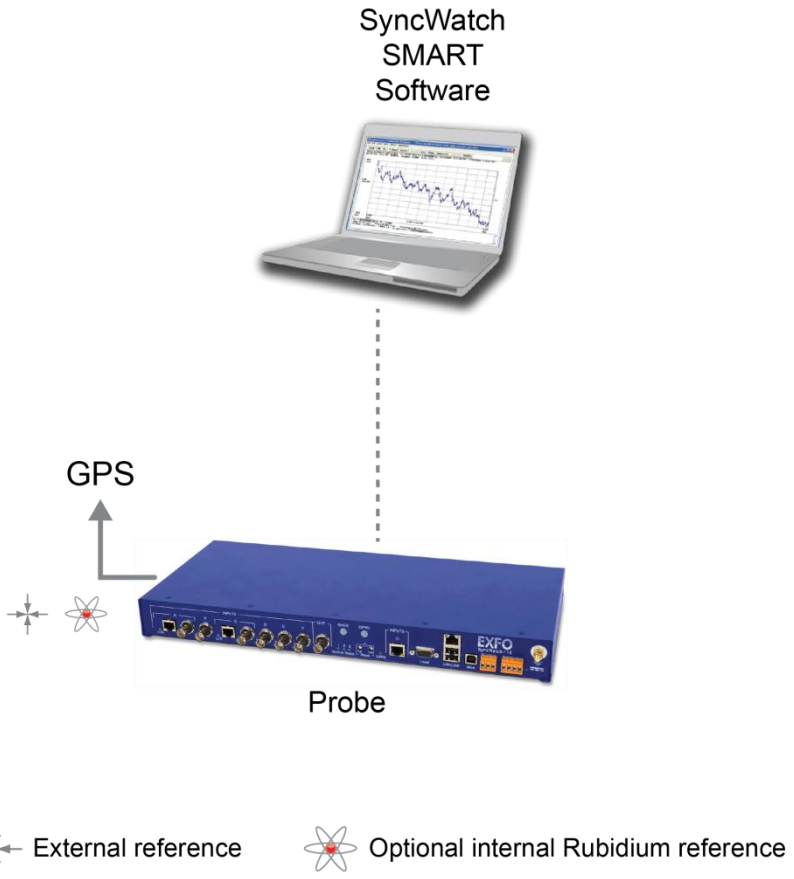
USB Measurement Configurator software

- Graphical User Interface

The USB Measurement Configurator software can only be used to configure a probe; the SyncWatch SMART software can be used to configure a probe and to post process measurement results.

Standalone mode

In Standalone mode the SyncWatch probe communicates directly with the SyncWatch SMART software to display real-time measurements. This mode is particularly useful for lab-based, bench-top testing or field based commissioning and fault diagnosis.



The current version of the SyncWatch probe supports both PTP packet and frequency monitoring in Standalone mode

SyncWatch probe hardware

- Small form-factor
- Low power consumption
- Flexible input types
- Common telecom traffic/clock signals
- Common test and measurement signals
- Powerful on-board processing capability
- Internal GPS receiver module with Rubidium oscillator (optional)
- Internal GPS receiver module with OCXO oscillator (optional)
- Internal PTP monitoring module (optional)

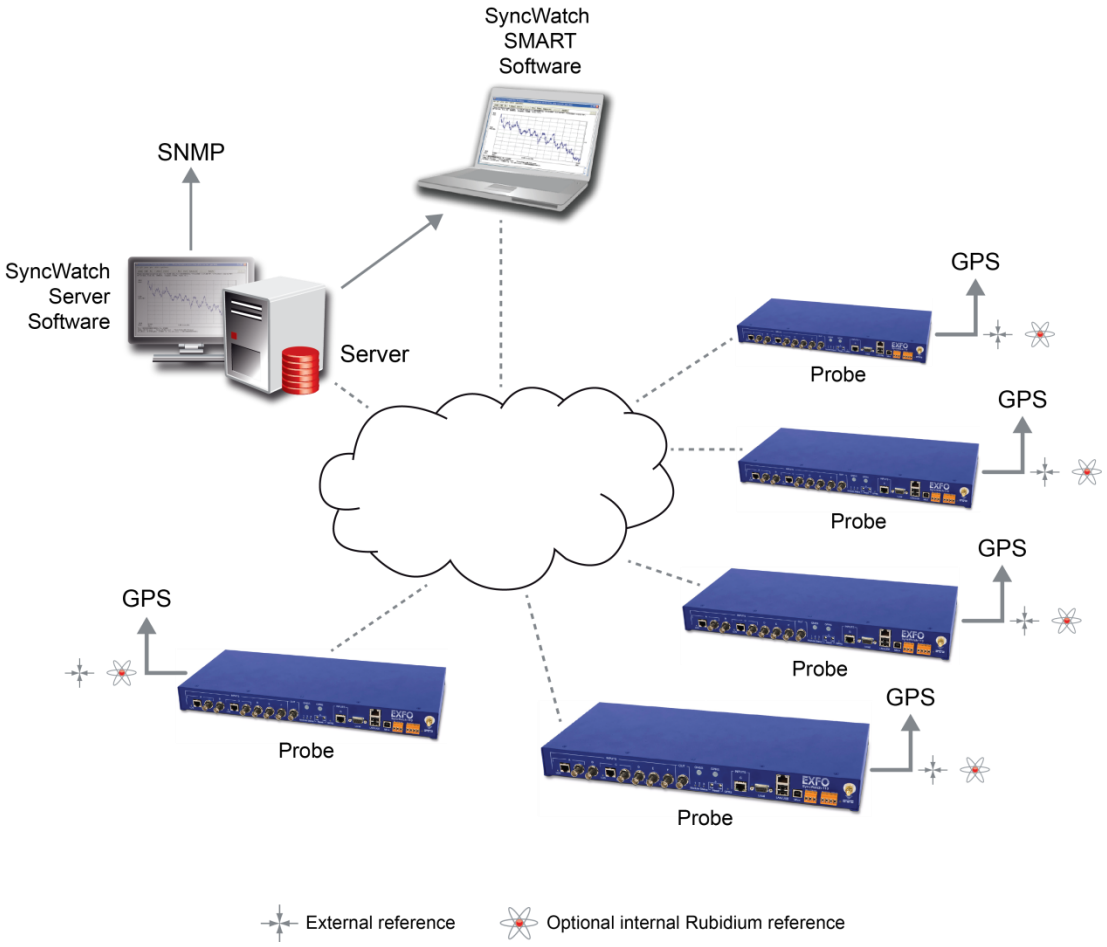
SyncWatch SMART software

- Graphical User Interface
- Live TIE and MTIE plots
- Industry standard MTIE masks
- Live PTP delay plots

Managed mode

In Managed mode SyncWatch is a scalable solution for continuously monitoring the performance of a synchronization network from a central point without the need for site visits. This mode is ideal for permanent, integrated performance monitoring as part of existing network operational procedures.

The system can consist of a single or multiple SyncWatch probes, deployed at various locations in the operator's network to be monitored. A centrally located SyncWatch server communicates with system users via a browser-based interface.



The current version of the SyncWatch probe does not support PTP packet monitoring in Managed mode

SyncWatch probe hardware

- Small form-factor
- Low power consumption
- Flexible input types
- Common telecom traffic/clock signals
- Common test and measurement signals
- Powerful on-board processing capability

- Internal GPS receiver module with Rubidium oscillator (optional)
- Internal GPS receiver module with OCXO oscillator (optional)
- GSM/GPRS modem (optional)

NetSMART software

- Scalable and easy to use
- Multi-user
- Used for permanent monitoring
- TIE and MTIE plots
- MTIE based performance thresholds
- Industry standard MTIE masks
- Custom-defined MTIE masks
- Remote probe firmware upgrade
- SNMP

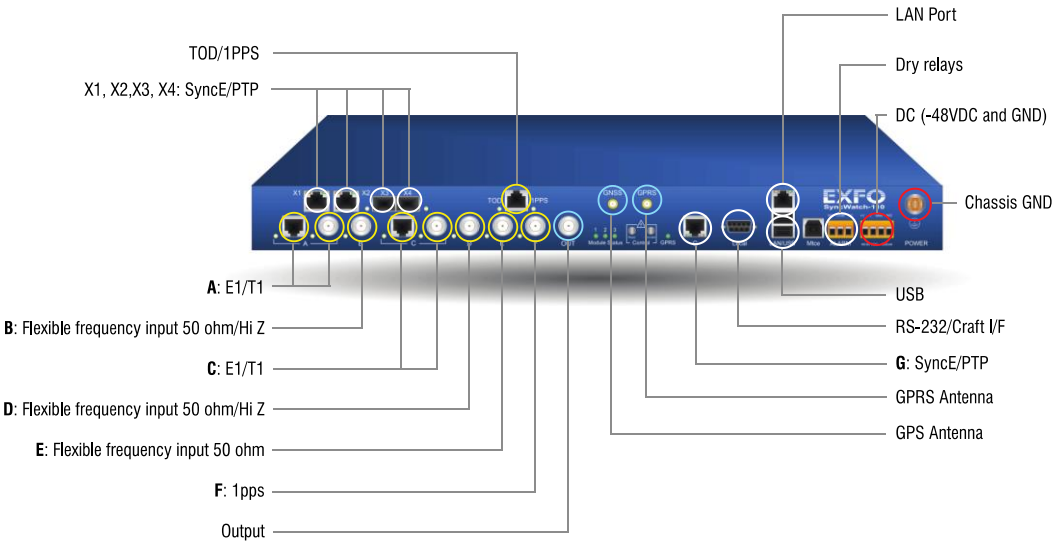
SyncWatch SMART software (optional)

- Graphical User Interface
- Post process TIE and MTIE data
- Industry standard MTIE masks

NetSMART software can only display up to 24 hours of MTIE and 30 min of TIE data. Up to 4 weeks of daily TIE data can be downloaded from NetSMART and post processed using the SyncWatch SMART software.

5. Hardware

Front panel connections



Signal and interface connections

Inputs

Inputs	Connector type	Impedance	Supported Signal type	Notes
A	RJ48	100/120 Ω*	2.048 Mbit/s (E1) 2.048 MHz (E1) 1.544 Mbit/s (T1)	E1: ITU G.703 sec 9 (2.048 Mbit/s) and sec 13 (2.048 MHz) TI: ITU G.703 sec 5 *Impedance automatically configured depending on signal type
	BNC	75 Ω	2.048 Mbit/s (E1) 2.048 MHz (E1)	
B	BNC	50 Ω	64 KHz to 200 MHz	Multiples of 8 KHz only
C	RJ48	100/120 Ω*	2.048 Mbit/s (E1) 2.048 MHz (E1) 1.544 Mbit/s (T1)	E1: ITU G.703 sec 9 (2.048 Mbit/s) and sec 13 (2.048 MHz) TI: ITU G.703 sec 5 *Impedance automatically configured depending on signal type
	BNC	75 Ω	2.048 Mbit/s (E1) 2.048 MHz (E1)	
D	BNC	50 Ω	64 KHz to 200 MHz	Multiples of 8 KHz only
E	BNC	50 Ω	1, 1.544, 2.048 Mhz 5,10 Mhz	
F	BNC	100 KΩ	1 PPS	1 PPS measurements are affected by cable delay, please see note on page 44 in "1 PPS port" section
TOD / 1PPS	RJ45	-	TOD/1 PPS	
G	RJ45	-	100 M Sync E/PTP	Sync E only supported on electrical 100 M Ethernet
X1 / X2	RJ45	-	100 M / 1000 M Sync E/PTP	
X3 / X4	SFP	-	100 M / 1000 M Electrical / Optical SFP - SyncE/PTP	Sync E only supported on optical SFP. Refer to SyncWatch Specification section for supported SFPs.

Outputs and other connections

Output	Connector type	Impedance	Supported Signal type	Notes
OUT	BNC	75 Ω		Buffered clock frequency copy of I/P signal (except Mbit/s).

Other	Connector type	Impedance	Supported Signal type	Notes
GNSS	SMA	50 Ω	L1 GPS	
GPRS	SMA	50 Ω	Quad Band GSM*	*850/900/1800/1900 MHz
Local	DE9	-	RS232	
LAN/USB	RJ45/USB	-	Ethernet / USB	
ALARM		-		Currently unsupported
+V-V GND		-	DC	Main DC supply power for probe
GND	Post	-	-	Chassis GND

Overview of signal connections

Flexible frequency ports

- Inputs B and D can support many frequencies in the range 64 KHz – 200 MHz (in 8 KHz steps).
- Inputs B, D and E impedance is fixed at 50 Ohm.
- Voltage levels B and D - min: 250 mV p-p, max: 10 V p-p.
- Voltage levels E - min: 75 mV p-p, max: 5 V p-p.

E1/T1 ports

- Inputs A and C can support E1/T1 signals. E1 signals that conform to ITU G.703 section 9 (2.048 Mbit/s) and section 13 (2.048 MHz) can be supported.
- T1 signals that conform to ITU G.703 section 5 (1.544 Mbit/s) can be supported.
- Voltage levels: Defined in G.703 sections 9 & 13 for E1 and section 5 for T1.
- Voltage levels A and C BNCs - min: 65 mV (Attenuated E1).

SyncE/PTP port

- Input G can support the extraction of a physical layer clock from Synchronous Ethernet (SyncE) signals at 100 M. This input can also support IEEE1588 defined PTP timing packets. (Requires an optional PTP monitoring module to be fitted into the SyncWatch probe).

SyncE/PTP ports

- Inputs X1, X2, X3 and X4 can support the extraction of a physical layer clock from Synchronous Ethernet (SyncE) signals at 100 M / 1000 M. This input can also support IEEE1588 defined PTP timing packets. (Requires an optional PTP monitoring module to be fitted into the SyncWatch probe).

1 PPS port

- Input F can support a 1 PPS signal; an internal GPS receiver module is required to provide a UTC traceable PPS signal as a reference source.
- Voltage level - TTL min: 2.6 V, max: 5 V.
- To comply with G.8271.1 the measurement input cable should not exceed 3 Meters in length when doing 1PPS measurements.

TOD / 1 PPS port

- This port can support RS-422/V.11 Time of Day and PPS signals.
- Voltage level - ±6 V
- Port settings
  - Baud: 9600.
  - Data bits: 8.
  - Start bit: 1(low level)
  - Stop bit: 1(high level)
  - Idle frame: High level
  - Parity: None.

See Appendix A, TOD Signal Specifications for additional information about the TOD signal.

Output port

- The ‘OUT’ connector can be software configured to generate a buffered copy (square wave) of any internal or external clock source (except E1 2.048 Mbit/s and T1 1.544 Mbit/s)
- Voltage level: 3.3 V p-p.

GNSS port

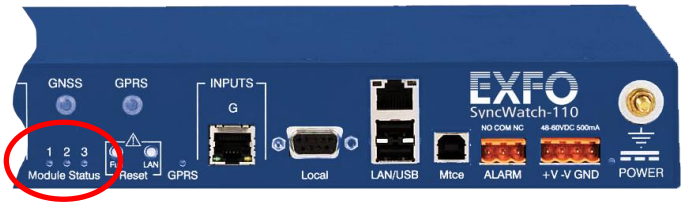
- This port supports connection to a GPS antenna; requires an optional GPS receiver to be fitted into the SyncWatch probe.

GPRS

- Supports connection to a GSM/GPRS antenna; requires an optional GSM/GPRS modem to be fitted into the SyncWatch probe.

Front panel Module Status LEDs

There are three Module Status LEDs located in the center of the probe front panel:



Module Status 1: Shows the operational state of the optional PTP or PTP/SyncE module.

Module Status 2: Shows the operational state of the optional TOD / 1PPS module.

Module Status 3: Shows the operational state of the optional GPS module.

Seven independent states are defined for each of the module LEDs, these are:

LED State	Condition
OFF	No Activity – module or input not configured or not present
Steady RED	Error, Alarm or other abnormal state
Steady AMBER	Warning or Degradation of performance
Steady GREEN	All OK, operation as expected
Flashing RED	Transitory state, Hardware unavailable, e.g. due to firmware upgrade
Flashing AMBER	Transitory state, e.g. GPS in Survey mode
Flashing GREEN	Normal operation, but with some other significance to the user, e.g. GPS/Rb module using Rb in holdover/free-run

Front panel Control buttons

There are two buttons located near the center of the probe front panel:

Control Reset button: Pressing the button will restart the SyncWatch firmware stopping any measurement.

Control Function button: Pressing the button will stop a USB measurement.

Optional internal modules

CTL202 TOD / 1PPS Module: Supports RS-422/V.11 Time of Day and PPS signals.

CTL411 GPS Receiver: With OXCO oscillator supplying 2.048 MHz and 1 PPS signals.

CTL431 GPS Receiver: With Rubidium oscillator supplying 2.048 MHz and 1 PPS signals.

CTL435 GPS Receiver: With Enhanced Rubidium oscillator supplying 2.048 MHz and 1 PPS signals.

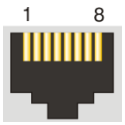
CTL611 PTP Module: Supports IEEE1588v2 protocol and can generate 2.048 MHz signal.

CTL612 Advanced Sync Module: Supports IEEE1588v2 protocol and can generate 2.048 MHz signal.

Signal connections – pin assignment

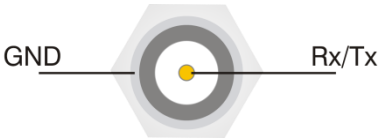
All of the pin assignments below refer to the front panel probe connectors. The Installer will need to make appropriate mating connections.

Balanced (INPUTS A and C)

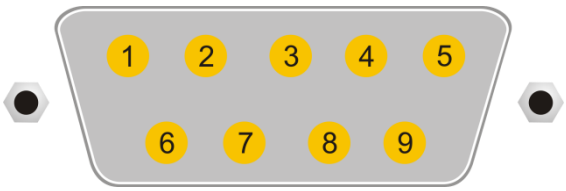


RJ48	Signal
1	Ring - Negative
2	TIP - Positive
3	GND

BNC connectors (INPUTS A-F and OUT)

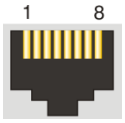


RS232 (Local)



DB9	Signal
2	TD
3	RD
5	GND

Sync E (INPUT G)



RJ45	Signal
1	Tx+
2	Tx-
3	Rx+
6	Rx-

LAN port (LAN)

RJ45	Signal
1	Tx+
2	Tx-
3	Rx+
6	Rx-

TOD / 1PPS

RJ45	Signal
3	PPS-
4	GND
5	GND
6	PPS+
7	ToD-
8	ToD+

6. Installation

This section explains the procedures to install the SyncWatch probe.

Unpacking and preparing

Installation tools and equipment

The following tools and equipment are needed to install the SyncWatch probe:

- Standard tool kit that includes a PH1 driver and 8mm socket
- Two ring lugs (U.L listed) for grounding connections
- Crimping tool to crimp the ring lug
- Shielded cabling of the appropriate impedance required by the specific signal type for signal wiring, also including GPS and Ethernet
- Electrical grounding and power cables at minimum 1.5 mm^2 (15 AWG). Cable identifiers and/or appropriate cable colors must conform to the appropriate wiring standards applicable to the required country electrical code.
- Mating connectors for terminating signal wiring
- Fasteners for mounting the probe in the rack
- Multi-meter for verifying the power connection
- PC with terminal emulator software for probe configuration

Unpacking the probe

The SyncWatch probe is packaged to protect it from normal shock, vibration and damage.

Unpack and inspect the unit as follows:

- Inspect the packaging for signs of damage. If the packaging appears to be damaged, notify both the courier and your SyncWatch distributer. Retain the packaging material for them to inspect
- Open the packaging, being careful to cut only the packaging tape
- Locate and set aside the CD, printed information, and paperwork that is included within the packaging
- Locate and set aside any smart parts that are included in the packaging
- Remove any accessory packs if included and set aside

- Verify that the model and item number matches that shown on the shipping documentation. Contact your SyncWatch distributor if these do not match. The item number is located on the rating label on the underside of the probe.
- The hardware probe revision is located on the rating label, note for future reference. .

For instructions on how to install the GSM/GPRS SIM card into the probe refer to page 54.

Caution: Wear a properly grounded protective wrist strap or other ESD protective device when inserting the SIM card.

Rack mount

The probe is designed for mounting in a standard ETSI (600mm wide), or 19-inch (482.6mm wide) rack. Two different bracket types are provided with a probe, one for each of the rack widths. These brackets can be fitted to the side of the probe using the 4 small cross head screws (supplied). The smaller brackets can be fitted for 19' rack mounting and the larger brackets can be fitted for 600mm ETSI rack mounting. Follow the rack manufacturer's instructions for mounting the probe. Avoid the following conditions:

- Elevated Operating Temperatures: If the probe is installed in a closed or multi-unit rack assembly, the ambient temperature of the rack environment may be greater than the probe's Maximum Ambient Operating Temperature (TMA) of 50 °C/122 °F. Install the probe in an environment that is compatible with the probe's operating temperature range, which is quoted in the specifications section
- Reduced Air Flow: Position the probe with enough space above, below, and adjacent to the chassis to allow an adequate flow of air so that it may operate safely. The manufacturer recommends leaving 3.6 cm. (1.4 in) above and below the probe or enough space to allow 85 l/min (5 CFM) air flow
- Uneven Mechanical Loading: Mount the equipment so as to avoid uneven mechanical loading that could cause hazardous conditions
- Circuit Overloading: Observe the power ratings on the probe's nameplate and the additional load the probe may place on the supply circuit
- Proper Grounding: Maintain reliable grounding (earthing) of rack-mounted equipment

Power (-48 vDC)

The power supply connector is located on the far right of the front panel and is shown in the diagram below, circled in red. It has four pins: from the left, pin 1 is the positive voltage V+, nominally 0V; pin 2 is the negative voltage, nominally -48 V; pin 3 is ground; pin 4 is unused.

When connecting the DC power supply to the probe:

- Use an appropriately sized DC circuit breaker in series with the DC power source.

- As per the national electrical code (NEC) in North America the circuit breakers are required to be a minimum 15 A or higher. Do not connect the unit directly to a DC source without provision for a current limiting device.
- If the circuit breaker does not also function as a switch, provide an additional circuit disconnect, with the appropriate voltage/current rating, in series with the DC Power input. The probe does not include a power switch
- The minimum recommended wire size is 1.5 mm^2 (15 AWG) for DC power source connection and ground within the power supply connector. Securely tighten the terminal screws on the input power block
- The DC Power supply in the probe is DC isolated. The DC Power inputs are polarity protected so reversed DC connections will not power the unit but will also not harm the unit
- The unit chassis must be grounded for proper safety

Grounding the probe

- Connect the Chassis Grounding point on the front and rear panel and the ground terminal 3 in the power connector to a reliable ground
- The minimum recommended wire size is 1.5 mm^2 (15 AWG) for the ground connection cables
- Verify that the equipment rack is grounded correctly

The manufacturer recommends that the user connect the chassis grounding screw to a reliable earth ground.

GPS antenna installation

This part of the guide helps the user through the process of selecting a good site for the GPS antenna, installing the antenna and how to use GPS when a good site isn't available.

Safety considerations

- Avoid electrocution and RF safety hazards such as power lines and high-energy radio transmission antennas
- Where potential hazards exist, have a qualified technician perform the installation
- Observe local codes and regulations
- Use a lightning arrestor in accordance with the local building codes
- Safe Antenna and Cable Connection: An outside antenna or cable system must be properly grounded to provide some protection against built up static charges and voltage. Section 810 of the National Electrical Code, ANSI/NFPA 70 (In Canada, part 1 of the Canadian Electrical Code) provides information regarding proper grounding of the mast and supporting structure, grounding of the lead-in wire to an antenna discharge unit, size of grounding conductors, location of antenna discharge unit, connection to grounding electrodes, and requirements for the grounding electrode.
- Keep Antenna Clear of High Voltage Power Lines or Circuits: Locate an outside antenna system well away from power lines and electric light or power circuits so it will never touch these power sources should it ever fail. When installing an antenna, absolutely never touch power lines, circuits, or other power sources, as this could be fatal.

Selecting a site for the antenna

Roof antenna placement

When selecting a site for the roof antenna, find an outdoor location that provides the best visibility of the sky and horizon. In most cases, this means locating the antenna in a high location, such as a rooftop. Avoid obstructions that could block GPS satellite signals and delay acquisition. A short mounting mast and hose clamps are provided with the roof antenna to mount the antenna to a pole or the apex of a building. The mounting mast and clamps are well suited to attach the antenna to a vent pipe or mast affixed to the roof. The pipe must be rigid and able to withstand high winds without flexing.

Typical roof antenna mounting

GPS receivers can be susceptible to reflected GPS signals called multipath signals. Multipath interference is caused by reflected signals that arrive at the antenna out of phase with the direct signal. This interference is most pronounced at low elevation angles from 10 to 20 degrees above the horizon. The height of the mast/antenna may be extended upward to lessen multipath interference. The antenna should also be at least 3 – 6 feet (1 - 2 metres) from a reflecting surface. Use the criteria below to select a good outdoor site for the GPS antenna. The best locations provide:

- Unobstructed views of the sky and horizon
- Low electro-magnetic interference (EMI) and radio frequency interference (RFI) - away from high-power lines, transmitting antennas, and powerful electrical equipment
- Convenient access for installation and maintenance
- Reasonable access for the antenna cable to reach the probe.
- Safety from hazards to people and equipment

Avoid:

- Overhanging foliage
- Blocked views
- Strong EMI RFI interference
- Multipath interference (caused by adjacent structures that reflect GPS signals)

Mounting structures:

- GPS antenna masts, vent pipes, or railings are usually satisfactory
- Radio towers may require the services of a specialist, and may be subject to signal interference
- Must be able to withstand very high winds

Installing the GPS antenna

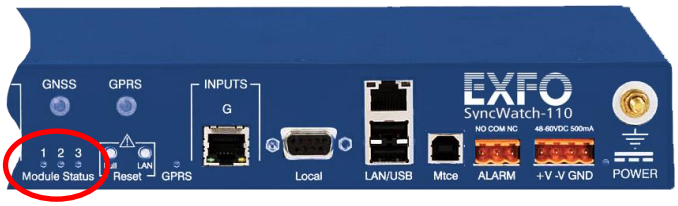
Ensure compliance with all relevant safety precautions and building code regulations.

Avoid:

- Electrocution, RF, lightning, and falling hazards
- RFI and EMI sources such as transmitting antennas
- Crimping or making sharp bends in the cable.

Procedure:

- Mount the GPS antenna at the selected site
- Position the GPS antenna vertically, with its top pointing toward the sky, and the mounting mast and connector pointing down
- Secure the mounting mast to the structure selected for the antenna
- Run the antenna cable to the probe. Use a lightning arrestor and grounding, as required to meet building and safety codes
- Connect the antenna cable to the GNSS connector on the front panel
- Check that the Module Status 3 LED on the SyncWatch front panel turns green, this may take up to 20 minutes



The status of the GPS signal can be checked by connecting directly to the SyncWatch probe using a PC with terminal emulator software as described in section 7.

The length / type of GPS antenna cable used for the installation will introduce a delay (Typical 4.3 nS/m) in the 1PPS signal from the SyncWatch GPS receiver, this will impact 1 PPS measurements. Compensate for the cable delay by entering the delay value in the GPS receiver configuration settings – Refer to section 7 : Hardware configuration or section 9 : Configure a reference source for additional information.

Negative delay values need to be entered in the cable delay to compensate for a lagging 1 PPS signal, positive values to compensate for a leading 1 PPS signal.

GSM/GPRS SIM card

It is recommended that the SIM card is sent in advanced to the SyncWatch distributor for installation prior to the dispatch of the probe.

Warning: Probe GSM/GPRS fitting requires the case to be opened by competent personnel. This must only be done with the power line disconnected.

Caution: Wear a properly grounded protective wrist strap or other ESD protective device when inserting the SIM card.

To insert or replace a SIM card the probe's lid must be removed. This requires removing the rack ears (if fitted) and the 2 screws on each side, removing the 11 screws on the underside of the probe lid and the 5 screws on the top side of the probe lid. Insert or replace the SIM card into the GSM/GPRS socket modem that is located in the rear right side of the probe; this can be found by tracing the GSM antenna cable back from the casing if required. Ensure that the SIM card is inserted correctly so that proper contact is made.

The following should be noted for operation of SyncWatch over GSM/GPRS:

- The SIM card must be registered to the network and must not require a PIN
- For GSM the SIM must be enabled to communicate over the analogue data channel; contact the service provider to enable this
- Mobile network signals are inherently unpredictable and as such are out of the control of the SyncWatch probe. It is recommended that the network signal is tested prior to on-site installation.

The GSM/GPRS modem option is only available on SyncWatch in Managed mode.

Software installation

SyncWatch SMART

From the SyncWatch software CD copy the *SyncWatch SMART.exe* file to PC. Double click on this file to run the application.

USB measurement configurator

From the SyncWatch software CD copy the *SyncWatch-110MeasurementConfigurator.exe* file to PC. Double click on this file to run the application.

NetSMART

Please refer to the 'NetSMART Administrator Guide' included in the NetSMART software CD for instructions on how to install and configure the NetSMART software.

7. Initial probe configuration (all modes)

This section applies to the SyncWatch product when operating in USB, Standalone and Managed mode. Configuration procedures exclusive to each mode are described in subsequent sections.

Communicating with the probe

On or prior to installation the SyncWatch probe will need to be set to the required mode of operation: USB, Standalone or Managed. This can be done either via the Local or LAN port on the SyncWatch probe using a PC with terminal emulator software e.g. PuTTY

Local port

Use a serial cable (straight through) to connect PC to Local port on the SyncWatch probe. Open PuTTY and set Connection type to Serial with the following settings:

- Baud: 115200.
- Data bits: 8.
- Stop bits: 1.
- Parity: None.
- Flow Control: None.

LAN port

Connect PC to SyncWatch probe over the LAN network or directly using a straight through standard Ethernet cable.

Open PuTTY and set Connection type to SSH.

Enter IP address of the probe.

The default IP address of the probe is set to 192.168.1.30. DHCP is disabled.

The Windows' standard hyper-terminal program will not correctly connect to the probe, so an alternative application is required. It is recommended to use 'Putty', which is available from **http://www.chiark.greenend.org.uk/~sgtatham/putty/**

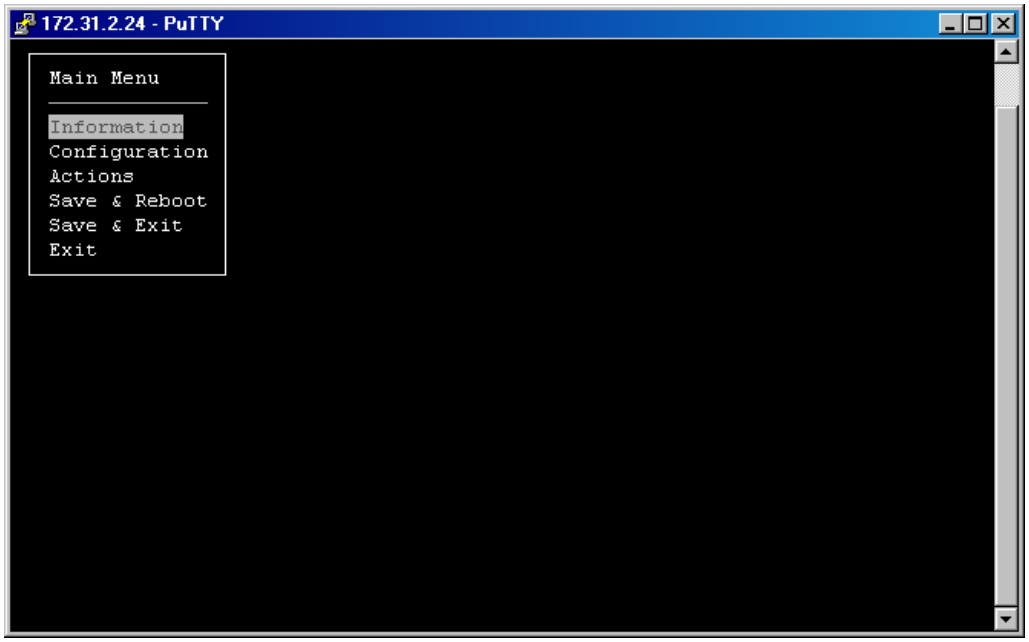
Configuration

Connect to the SyncWatch probe as described above and a login screen will show.

Enter the username *swconf* and when prompted enter the password *fr7ebi*.

This will load the menu-driven configuration interface as shown below:

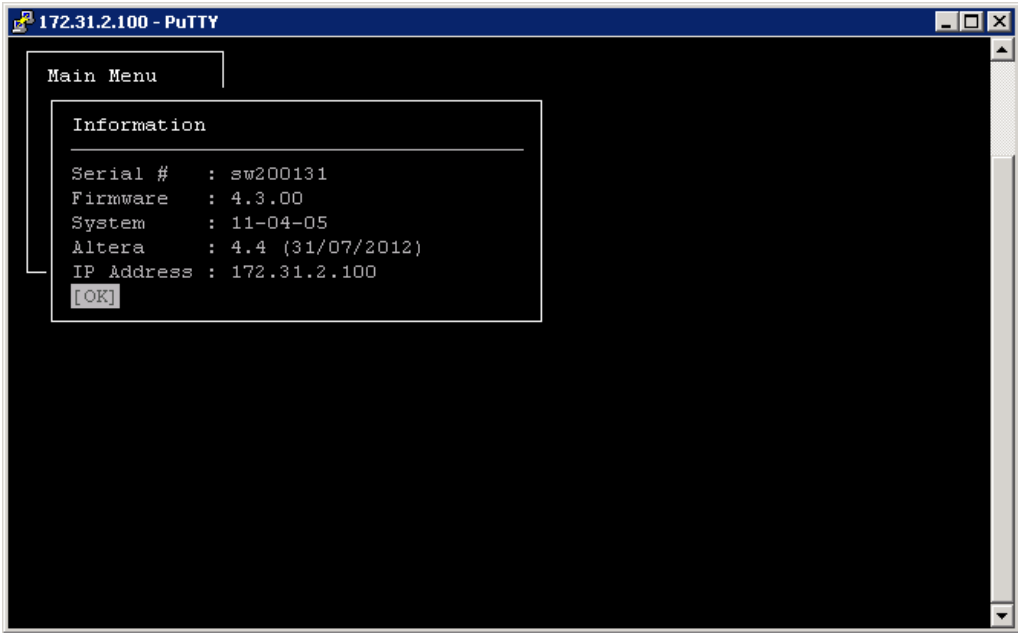
Main menu



Use the keyboard up and down arrows to select the desired menu item and press **Enter** to select that menu option.

Information menu

The information menu displays the probe serial number, firmware revision and IP address as shown below:



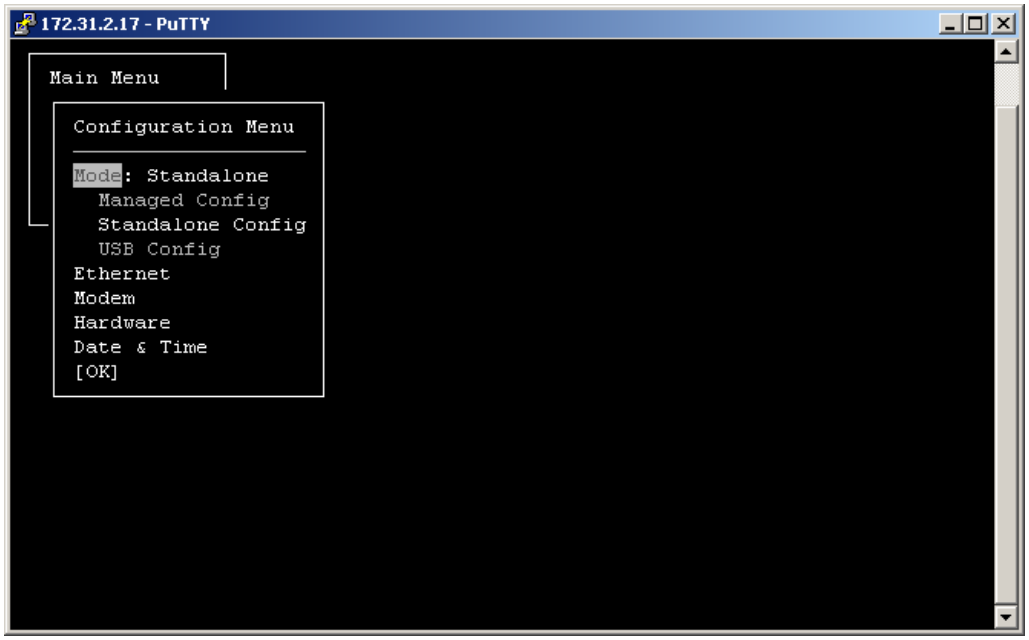
Configuration menu

To select and configure a specific mode of operation, use left and right arrows to select **Managed, Standalone** or **USB** mode.

Use the up and down arrows to select **Managed Config, Standalone Config** or **USB Config** to load the respective configuration menus.

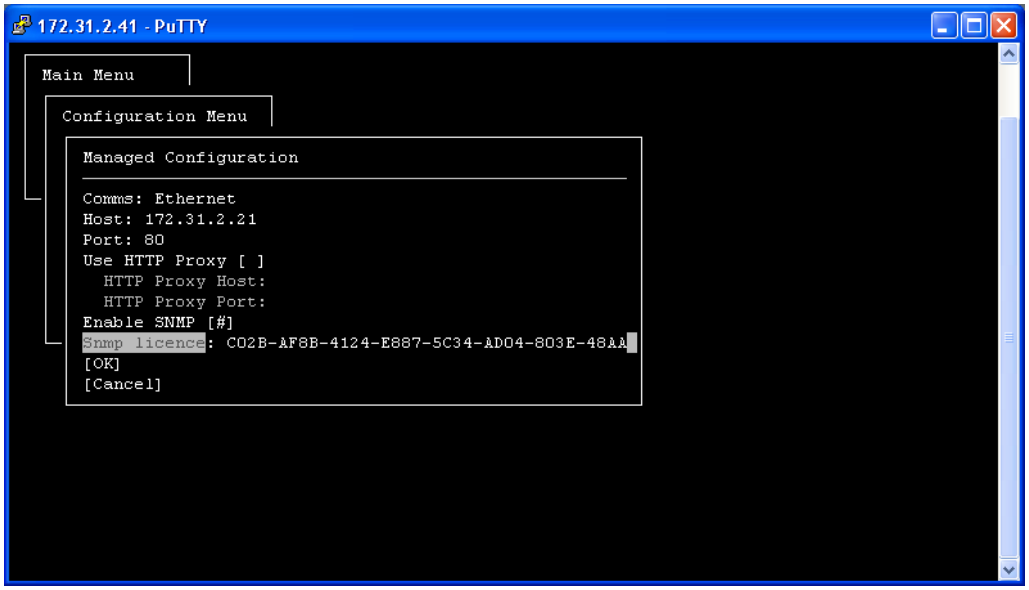
Use the up and down arrow keys to select and configure the Ethernet, Modem, Hardware and **Date & Time** menus.

The following sections provide full details of how to configure each parameter.



Managed Config and Standalone Config menus can only be accessed if the mode selected is Managed or Standalone

Managed configuration



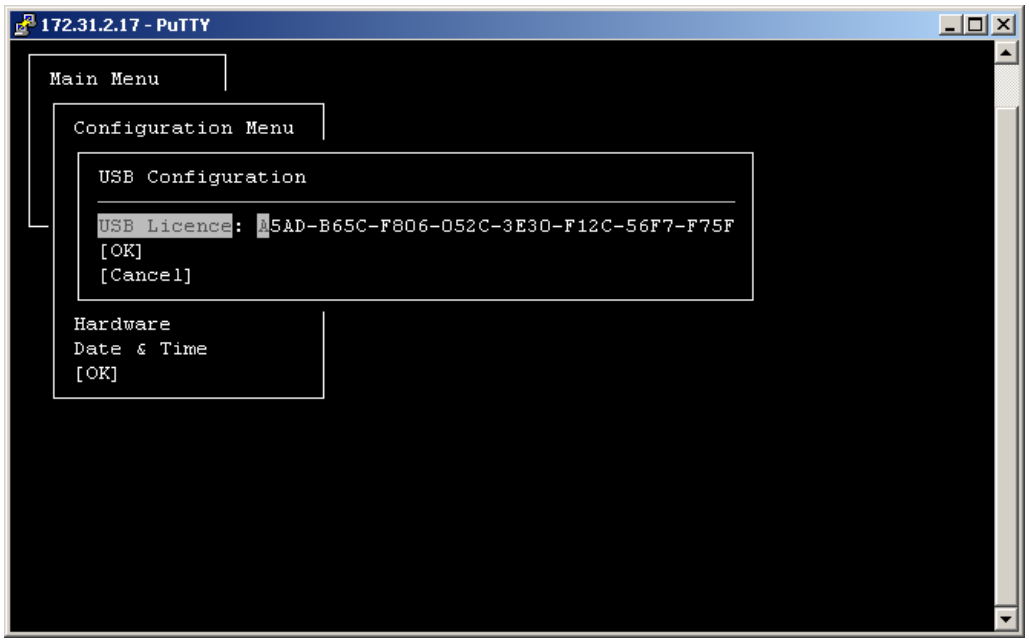
Configure the following:

Comms:	Select whether Ethernet or Modem is to be used to communicate to the server. Use left and right arrows to select the required method.
Host:	This is the IP address or domain name (e.g. www.syncwatch.com) of NetSMART. A domain name can only be used with DHCP, if a DNS address is entered in the Ethernet menu.
Port:	This is the port number on which access is provided at NetSMART (default 80).
HTTP Proxy Host:	This is the IP address or domain name of the proxy server. This field should only be filled in if a proxy server is used.
HTTP Proxy Port:	This is the port number on which HTTP proxying is available on the proxy server. This is not required to be filled unless a proxy server is used; it will be specific to the network that the probe is connected to.
Enable SNMP:	If this is enabled then the module will respond to SNMP GET requests. A hash [#] indicates that SNMP is enabled, a blank [ ] indicates it is disabled. Toggling between enabled and disabled is achieved using the space bar.
SNMP License:	This license key, if entered, unlocks the SNMP capability of the probe. The License key is supplied with the probe or can be obtained from your SyncWatch distributor.
[OK]:	After appropriate changes are made, use the down arrow to select this. Then press **Enter**. The previous menu will then be displayed.
[Cancel]:	Select this and then press **Enter** – any changes made will be cancelled and the previous menu will be displayed.

To execute this mode of operation, select **Save & Reboot** in Main Menu.

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

Standalone configuration



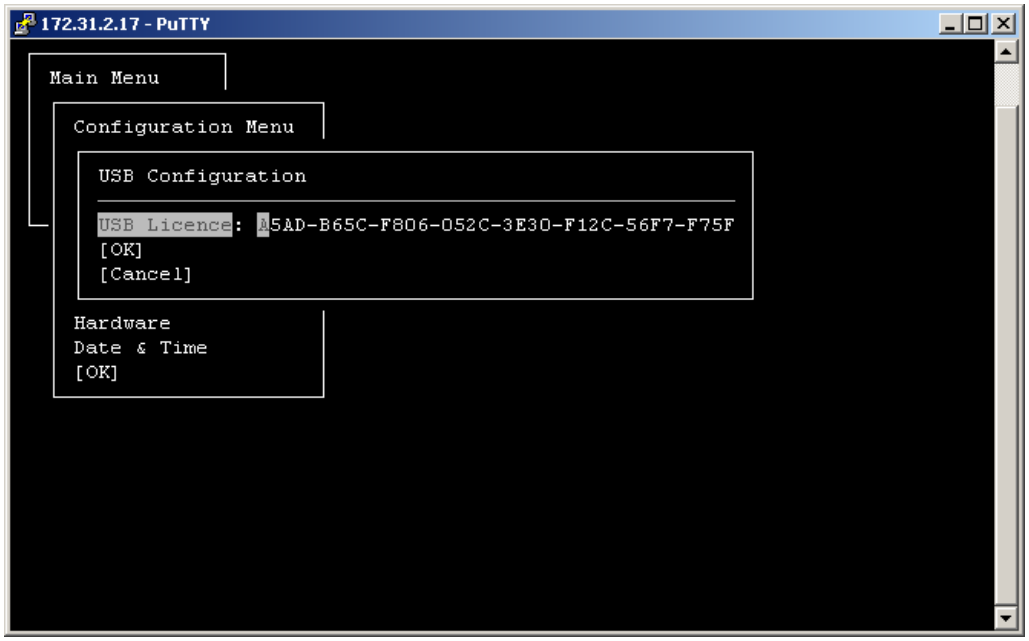
Configure the following:

Lab Licence: This license key, if entered, unlocks the standalone mode of operation.The License key is supplied with the probe or can be obtained from your SyncWatch distributor.

To execute this mode of operation, select **Save & Reboot** in Main Menu.

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

USB configuration



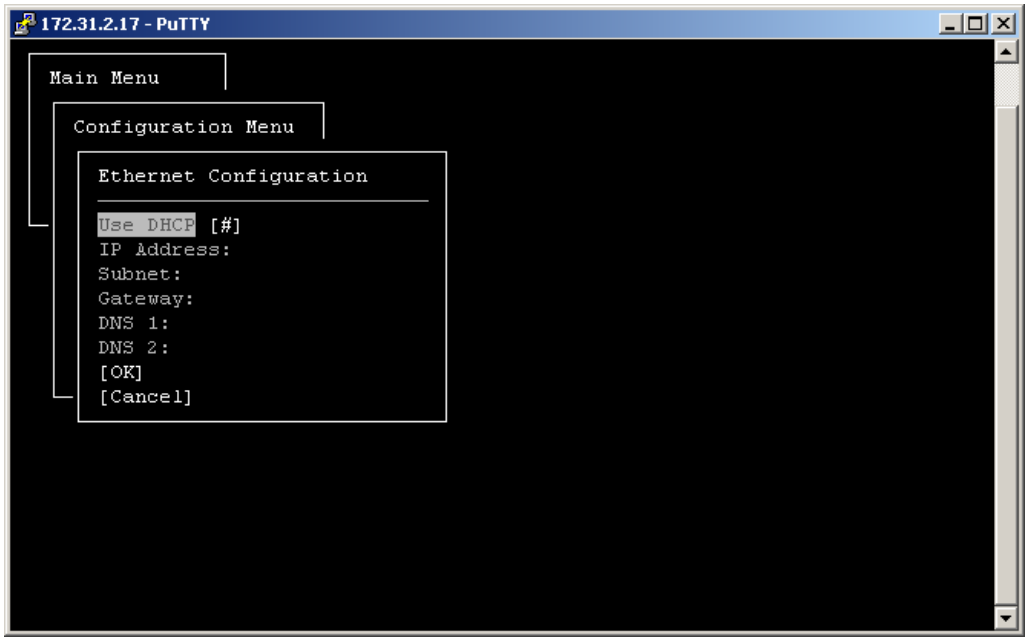
Configure the following:

USB License: This license key, if entered, unlocks the USB mode of operation. The license key is supplied with the probe or can be obtained from your SyncWatch distributor.

To execute this mode of operation, select **Save & Reboot** in Main Menu.

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

Ethernet configuration



Configure the following:

Use DHCP: If this is enabled then the module will request its Ethernet configuration over the network. IP address, subnet mask, gateway and DNS addresses do not need to be entered unless DHCP is disabled. A hash [#] indicates that DHCP is enabled, a blank [ ] indicates it is disabled. Toggling between enabled and disabled is achieved using the space bar.

IP Address: The IP address of the probe. It may only be entered if DHCP is disabled.

Subnet: The subnet mask of the network that the probe is connected to (e.g. 255.255.255.0). It may only be entered if DHCP is disabled.

Gateway: The IP address of the probe's default gateway. It may only be entered if DHCP is disabled.

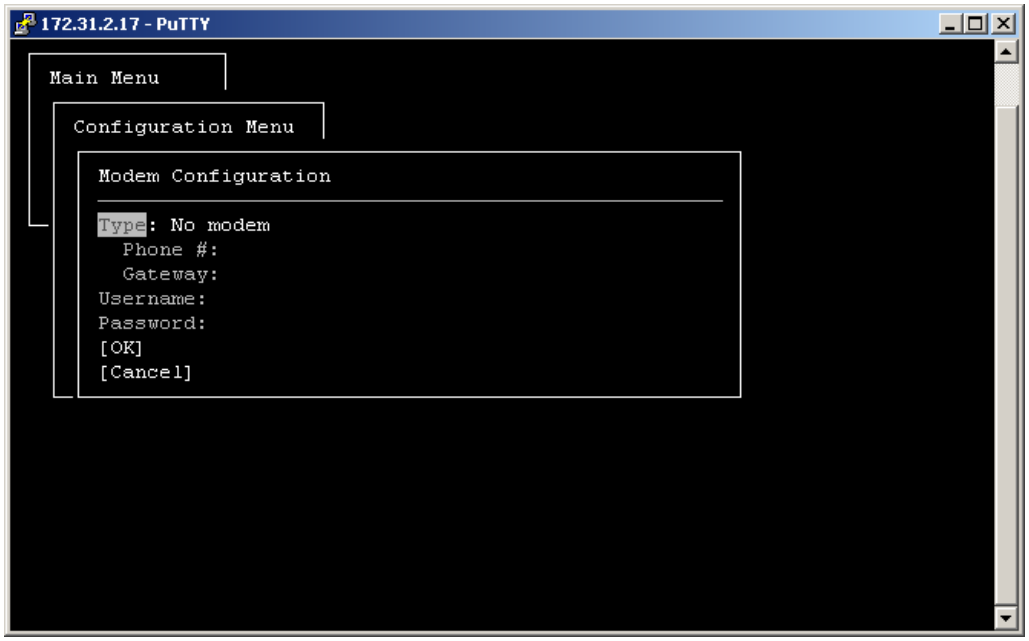
DNS 1: The IP address of the primary Domain Name Server. This is not required if no domain names are used on this screen (i.e. all addresses are IP addresses). It may only be entered if DHCP is disabled.

DNS 2: The IP address of a secondary Domain Name Server. This is optional, and may only be entered if DHCP is disabled.

To execute these settings select **Save & Reboot** in Main Menu.

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

Modem configuration



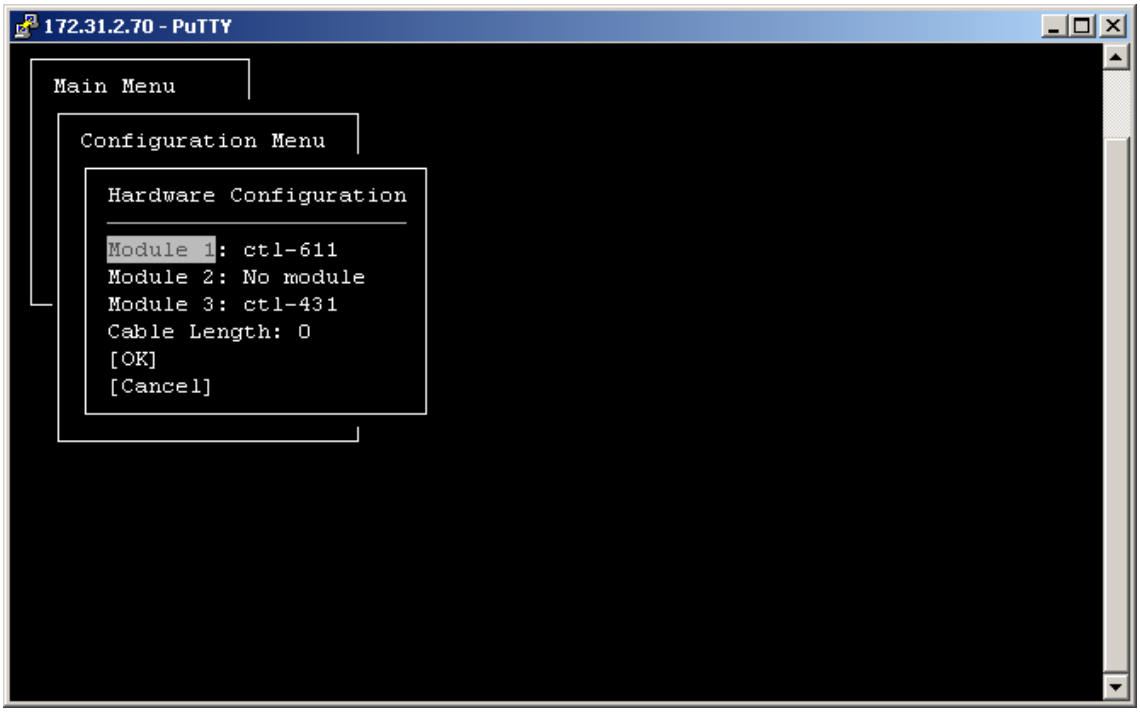
Configure the following:

Type:	Use the left and right arrows to select GSM or GPRS.
Phone #:	The Dialup number of the remote access server (RAS) that the probe will dial into. This field is only required if communication type is GSM.
Gateway:	The access point name (APN). This field is only required if communication type is GPRS.
Username:	The username for GPRS or RAS dialup access.
Password:	The password for GPRS or RAS dialup access.

To execute these settings select **Save & Reboot** in Main Menu

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

Hardware configuration



Configure the following:

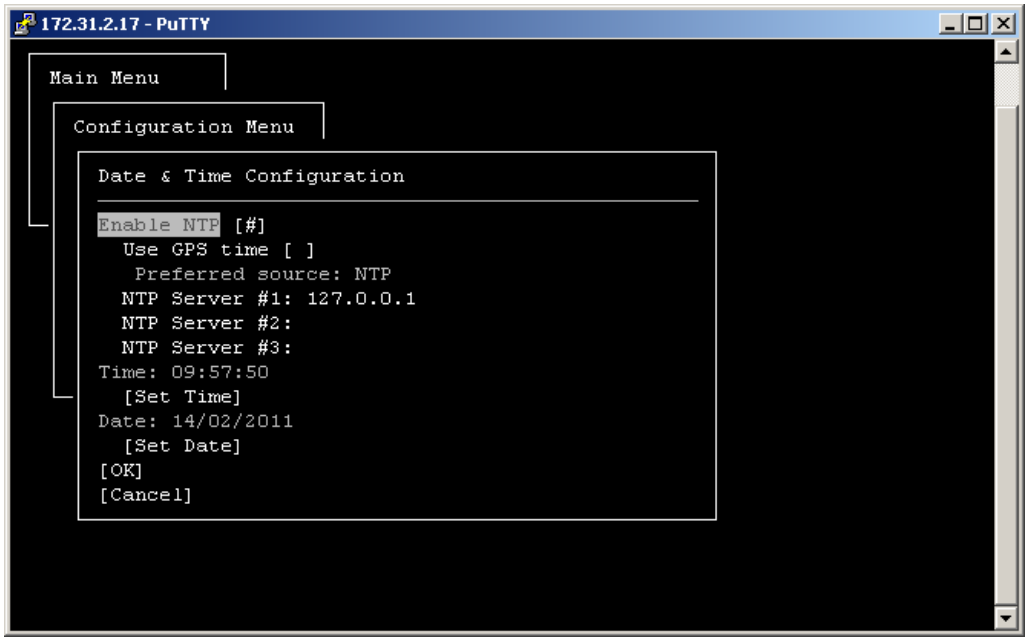
Module 1:	Hardware details of optional PTP module.
Module 2:	Hardware details of optional TOD/1PPS module.
Module 3:	Hardware details of optional GPS module.
Cable Delay:	Value is in nanoseconds and is intended to compensate for timing delay introduced by the GPS cable. Enter a negative value to compensate for a lagging 1PPS signal.

To execute these settings select **Save & Reboot** in Main Menu.

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

The values for Module 1, 2, and 3 are factory set and must not be changed.

Date and time configuration



Configure the following:

Enable NTP: Use Network Time Protocol (NTP) as a mechanism for controlling probe time. A hash [#] indicates that NTP is enabled, a blank [ ] indicates it is disabled. Toggling between enabled and disabled is achieved using the space bar.

Use GPS time: GPS module to be selected as a source for NTP. A hash [#] indicates that GPS time is enabled, a blank [ ] indicates it is disabled. Toggling between enabled and disabled is achieved using the space bar.

NTP Server #1: IP address of the first NTP server.

NTP Server #2: IP address of the 2nd NTP server.

NTP Server #3: IP address of the third NTP server.

Time: Can be manually set using Set Time.

Date: Can be manually set using Set Date.

*The system time/date are immediately updated when closing the set time/ date pop-up control windows. All other configuration changes are completed after selecting **Save & Reboot** in Main Menu.*

To execute these settings select **Save & Reboot** in Main Menu.

The Time and Date can not be changed whilst a measurement is in progress.

All the input port LEDs on the front panel will light red for approximately 1 minute after which the probe is ready for operation.

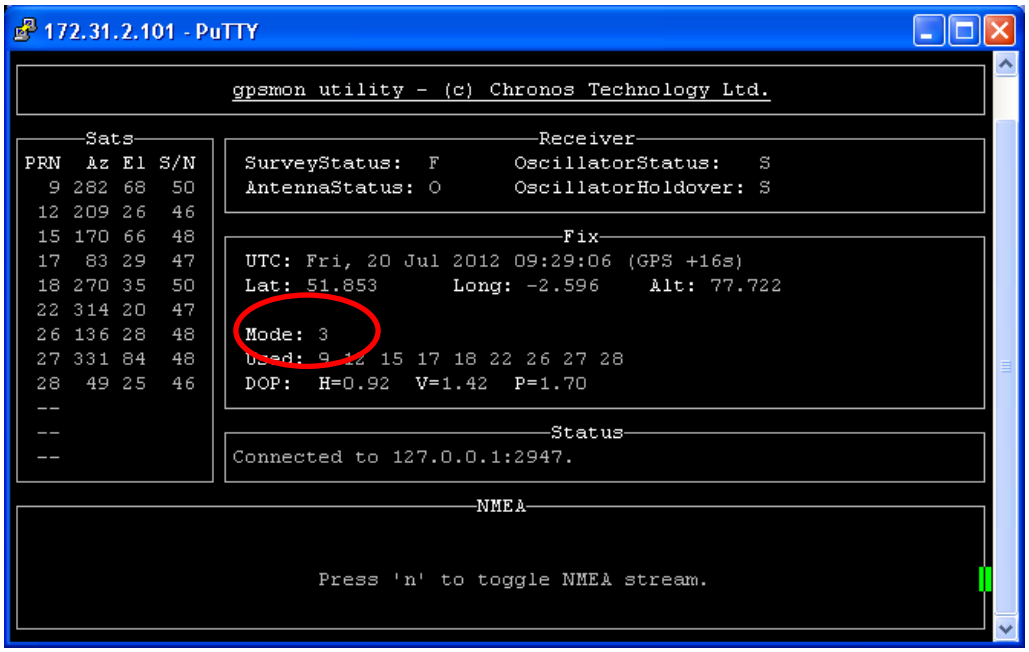
GPS status check

Carry out the following to check the current status of the GPS signal:

Connect to the probe using a PC as described earlier in this section.

After connection a login screen will show.

Enter the username *gpsmon* and when prompted enter the password *fr7ebi*. The following screen showing the GPS status will appear:



A valid GPS signal will be indicated as 3 (see red circle above); any other value indicates a fault / GPS start-up condition.

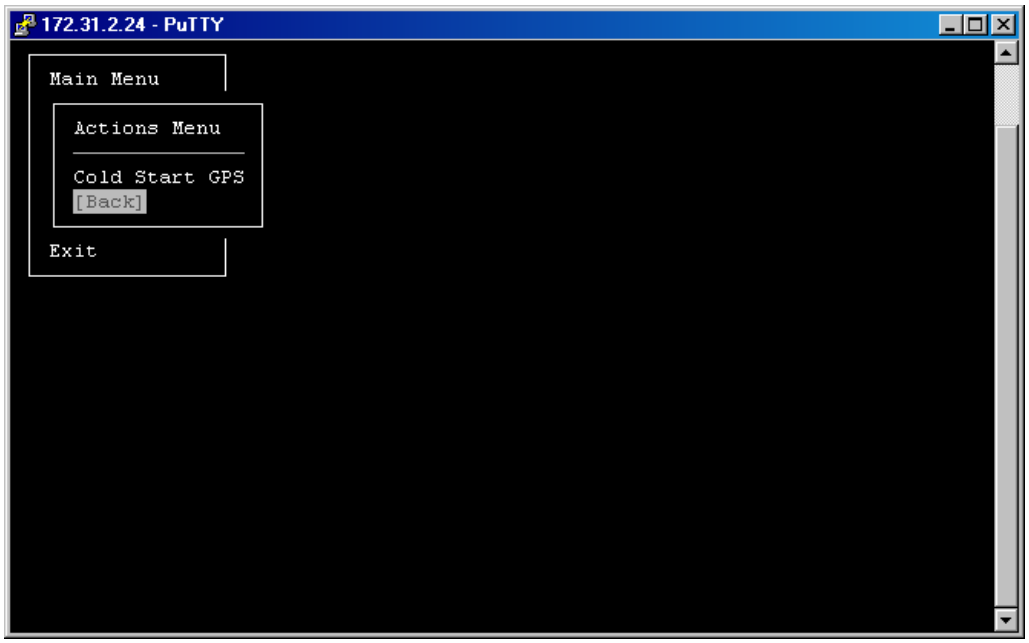
The SyncWatch GPS status alarm which monitors additional parameters will clear approximately 30 minutes after the mode initially displays the value 3.

Definition of Receiver codes:

Field	Optimum Code	Comment
Survey Status	F	'S' = Survey, 'F' = Fixed Position
Antenna Status	O	'O' = antenna OK 'L' = antenna open circuit 'H' = antenna short circuit
Oscillator Status	S / ?	'S' = Synchronized 'U' = Unlocked 'L' = Locked '?' = N/A (CTL411 GPS Module Only)
Oscillator Holdover Status	S	'S' = steered by GPS 'F' = free run

Actions menu

The actions menu displays the Cold Start GPS option as shown below. Selecting the option will restart the GPS module, wait for the GPS module LED to go green prior to starting any measurement.



8. USB mode - configuration

SyncWatch in USB mode uses an external USB storage device (typically a USB Flash Drive, or USB ‘Stick’) to configure a measurement and store measurement result files.

The USB storage device must have single FAT32 partition format.

Before starting the measurement configuration, ensure the SyncWatch probe is set to USB mode as described in section 7.

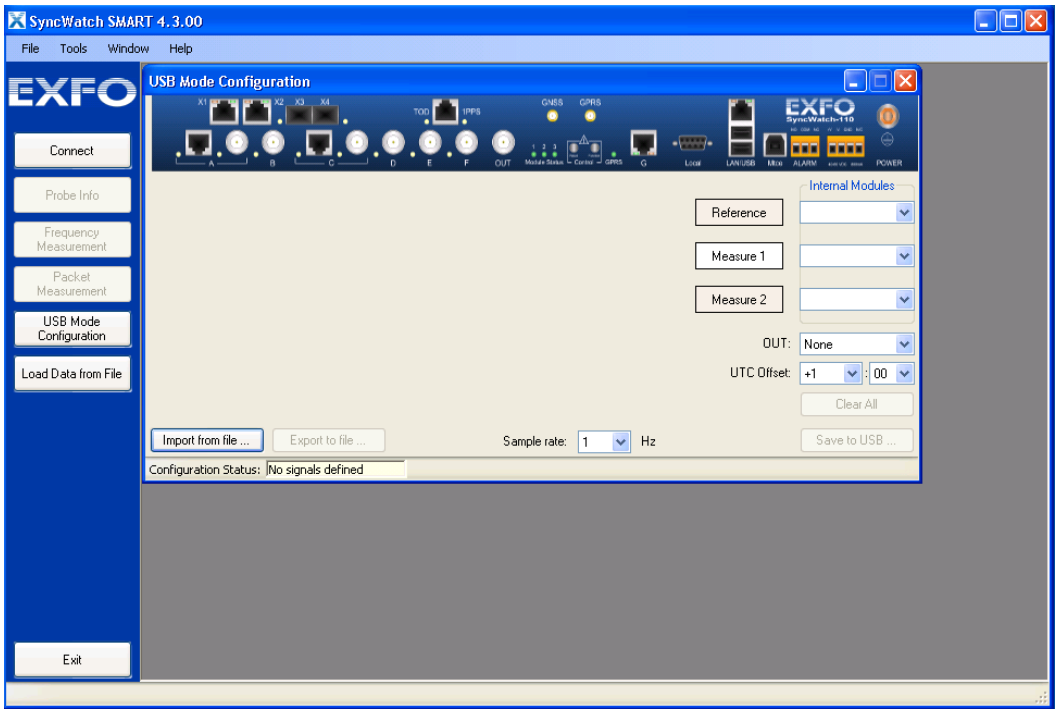
Typical workflow is shown below, please refer to following sub-section: ‘Measurement configuring‘ for more detail:

1. Insert USB stick into a PC
2. Run the supplied SyncWatch SMART or USB Measurement Configurator software application
3. Configure measurement or load existing configuration
4. Save measurement configuration to USB stick
5. Remove the USB stick from the PC
6. Verify the measurement feeds are connected correctly to the probe
7. Insert the USB stick into the probe
8. Check the visual feedback from the probe that shows the measurement configuration is OK; the measurement will then start automatically (measurement will continue to run until it is manually stopped)
9. Manually stop the measurement and remove the USB stick from the probe
10. The measurement result file stored on the USB stick can be analyzed using the SyncWatch SMART application

The current version of the SyncWatch probe does not support PTP packet monitoring in USB mode.

Measurement configuration

Start the SyncWatch SMART software and click on the **USB Mode Configuration** button on the left-hand menu bar, the following screen will appear:



The GPS module option may not be available on all SyncWatch probes. The PTP module including SyncE is not supported in USB mode, this includes inputs X1, X2, X3 and X4.

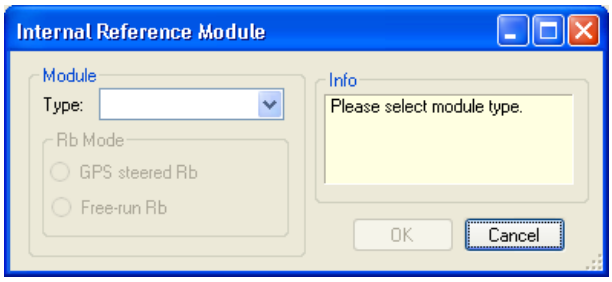
The USB Measurement software can be used to manually configure a new measurement or to load an existing configuration by clicking the Load Config button. To manually configure a new measurement configuration, follow the procedures below:

To configure a reference source

Click on the **Reference** box.

Click on the required input port or select from Internal Modules drop down menu to select it as a reference source.

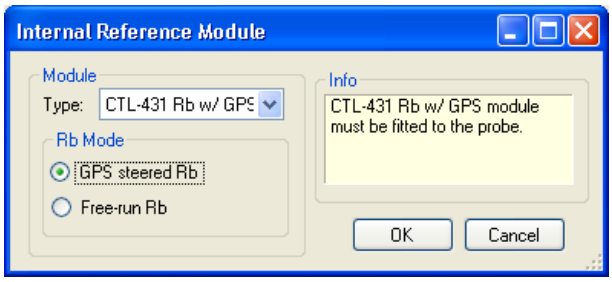
In this example the GPS internal module is selected. The following window with drop-down menu will appear:



Whenever selecting GPS, either as a reference or measurement source, the correct hardware option will need to be chosen:

Select the required module type.

In this example the Rubidium mode also needs to be selected. The following modified screen will appear:



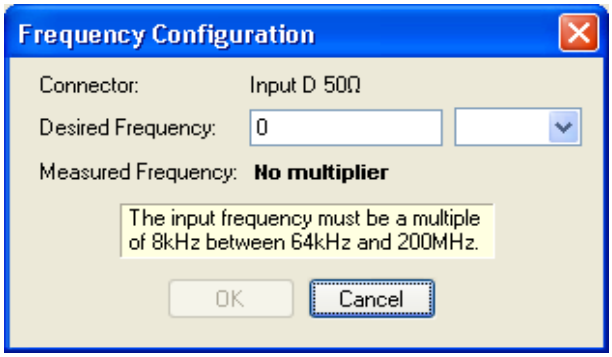
Once an input port or internal GPS module is selected, it cannot be selected again

To configure a measurement source

Click on the **Measure1** box.

Click on the required input port or internal GPS module to select it as a measurement source.

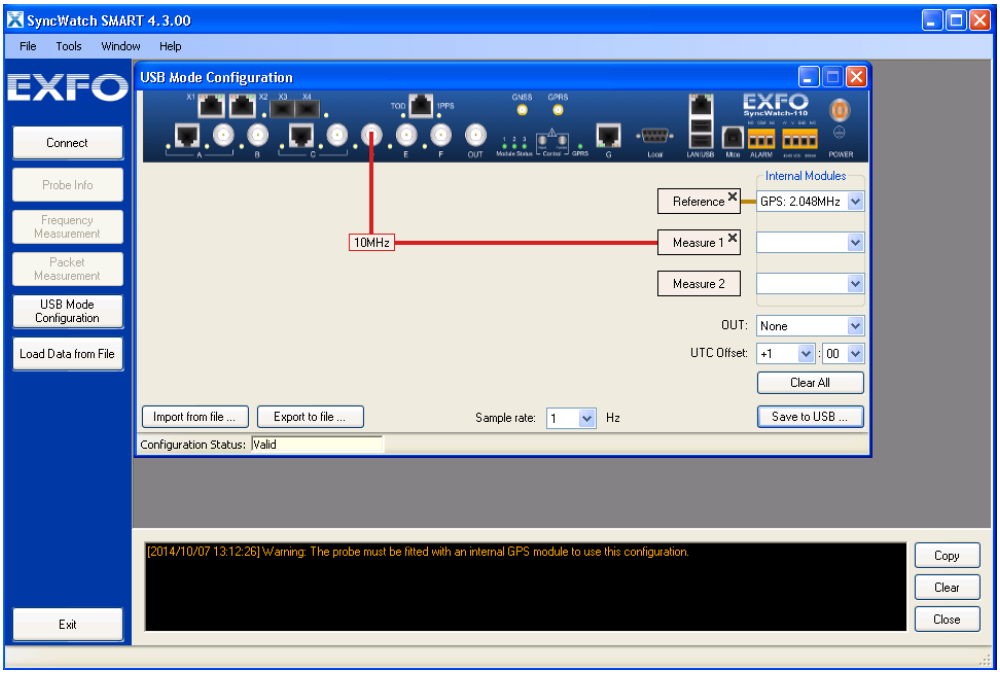
In this example Input D is selected. The following window will appear:



Whenever selecting a Flexible Frequency input (Input B and D), either as a reference or measurement source, the frequency value needs to be entered manually:

Enter the required frequency.

In this example 10 MHz is selected. The modified screen will appear as shown below:



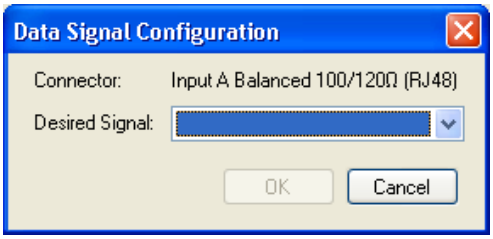
Once an input port or internal GPS module is selected, it cannot be selected again.

To configure a second measurement source

Click on the **Measure2** box.

Click on one of the available input ports or internal modules to select it as a measurement source.

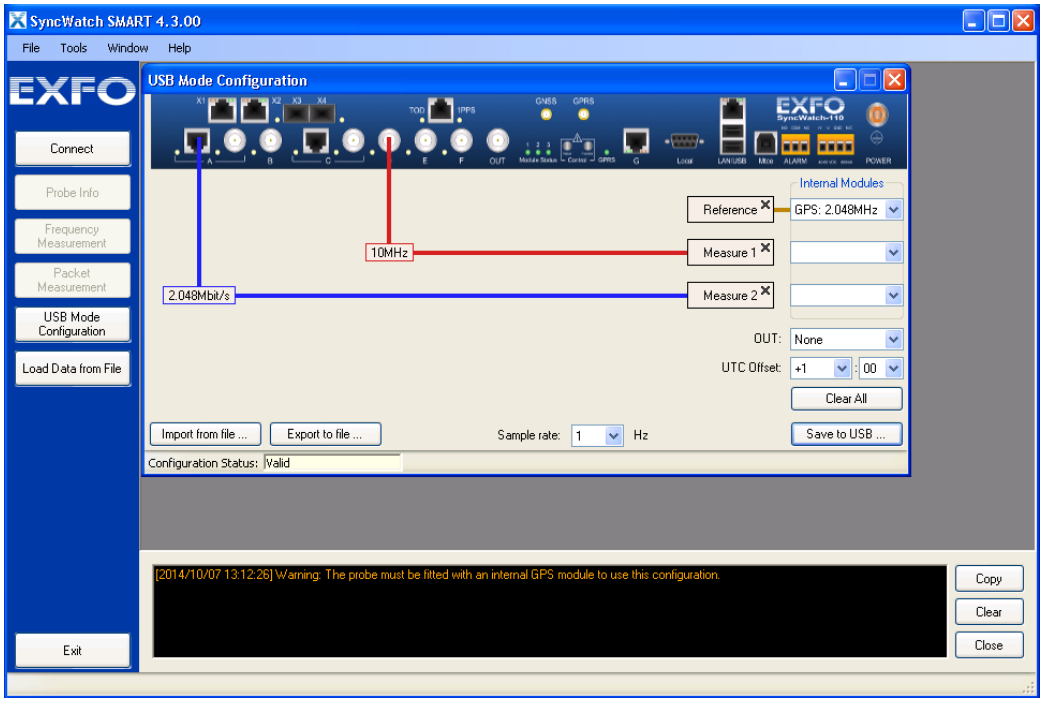
In this example Input A is selected. The following window with drop-down menu will appear:



Whenever selecting an E1/T1 input (Input A or C), either as a reference or measurement source, the required signal type needs to be selected:

Select the required signal configuration.

In this example E1 - 2.048 Mbit/s is selected. The modified screen will appear as shown below:



Once an input port or internal GPS module is selected, it cannot be selected again

Monitor output

The **OUT** connector can be configured to generate a buffered copy of any internal or external clock source (except E1 2.048 Mbit/s and T1 1.544 Mbit/s). Use the drop down menu to select required source.

UTC offset

The measurement result files show the start time in UTC. This feature allows the local time offset value to be recorded in the results file.

Export to USB

When the measurement configuration is complete, to save the configuration file to a USB stick:

Click the **Export to USB** button.

The USB stick can then be plugged into the SyncWatch probe to start the measurement run.

The default filename is set to 'measurement.conf' and must not be changed or else the SyncWatch probe will not recognize it as a valid configuration file.

Save config

Click the Save Config button to save the configuration file to the PC,

Start measurement

Insert the USB key containing the *measurement.conf* file into either one of the USB ports in the combined LAN/USB connector.

The probe will recognize the USB key and the contents of the *measurement.conf* file will be validated. If the contents are OK, all the LEDs will flash green once and the probe will start the measurement, logging the readings directly to the USB device. The measurement will continue to run until it is manually stopped.

1. *If the contents of the USB key are incorrect or corrupt the probe will flash all LEDs red and the measurement will NOT be started. Check the configuration again to make sure settings are correct*
2. *DO NOT insert the USB key into a probe that is booting. All probe front panel LEDs are red during the boot sequence*
3. *If a red GPS module LED is present at the start of the measurement, wait until the LED becomes green. Stop the measurement, remove USB key and wait for the flashing LEDs to stop. Restart measurement by inserting USB key.*
4. *Please contact SyncWatch support if you are unable to overcome the above issues.*

End measurement

To end the measurement:

Press and hold the recessed button marked **Function** until the LEDs begin flashing green.It is now safe to remove the USB device.

The USB device will now contain a file for each measurement channel that was configured, the file name will be in the format ‘measurement-<probe serial number>-<channel>-<date>-<time>.swt’ e.g. *measurement-sw200033-2-2009-08-02-17-15-45.swt.*

The measurement result file stored on the USB stick can be analyzed using the SyncWatch SMART software application. See section 9 for more details.

9. Standalone mode – Operation

Multiple instances of SMART are supported on a PC. The number of instances of SMART will be limited by the specification / performance of the PC.

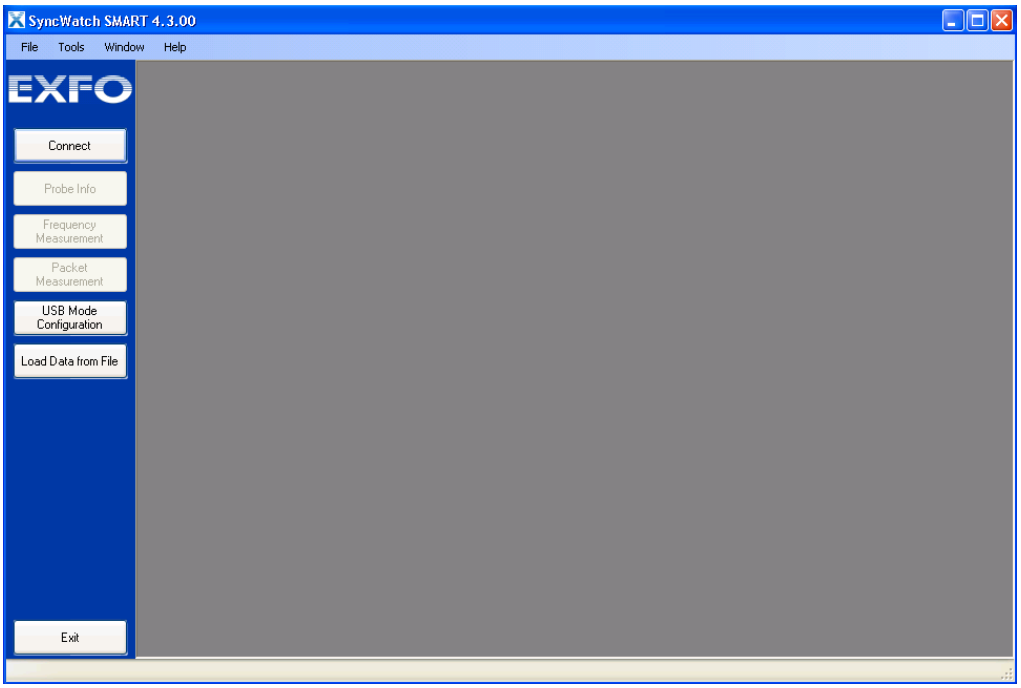
This section details the operation of the SyncWatch probe in Standalone mode. It is assumed that the probe has already been configured to operate in this mode, as described in section 7.

In Standalone mode, the measurement configuration, data collection and post-processing is handled by the supplied SyncWatch SMART software application. The probe communicates with SyncWatch SMART over an Ethernet/IP connection. The IP address of the probe is required by SyncWatch SMART so it knows where to send configuration commands. See section 7 for details on setting the probe's IP address.

Both frequency and PTP packet monitoring is supported in Standalone mode and can be run simultaneously.

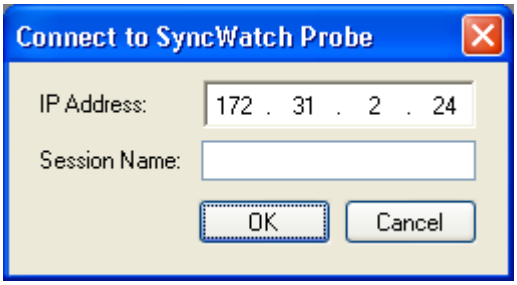
Connect to probe

Start the SyncWatch SMART software application and the following window will appear:



Click the Connect button on the left-hand menu bar to connect to a SyncWatch probe.

The following dialogue box will appear:



Enter the IP address of the SyncWatch probe.

To find the IP address of a SyncWatch probe allocated by a DHCP server, connect to the probe directly via a Local port and navigate to the Information menu as described in section 7.

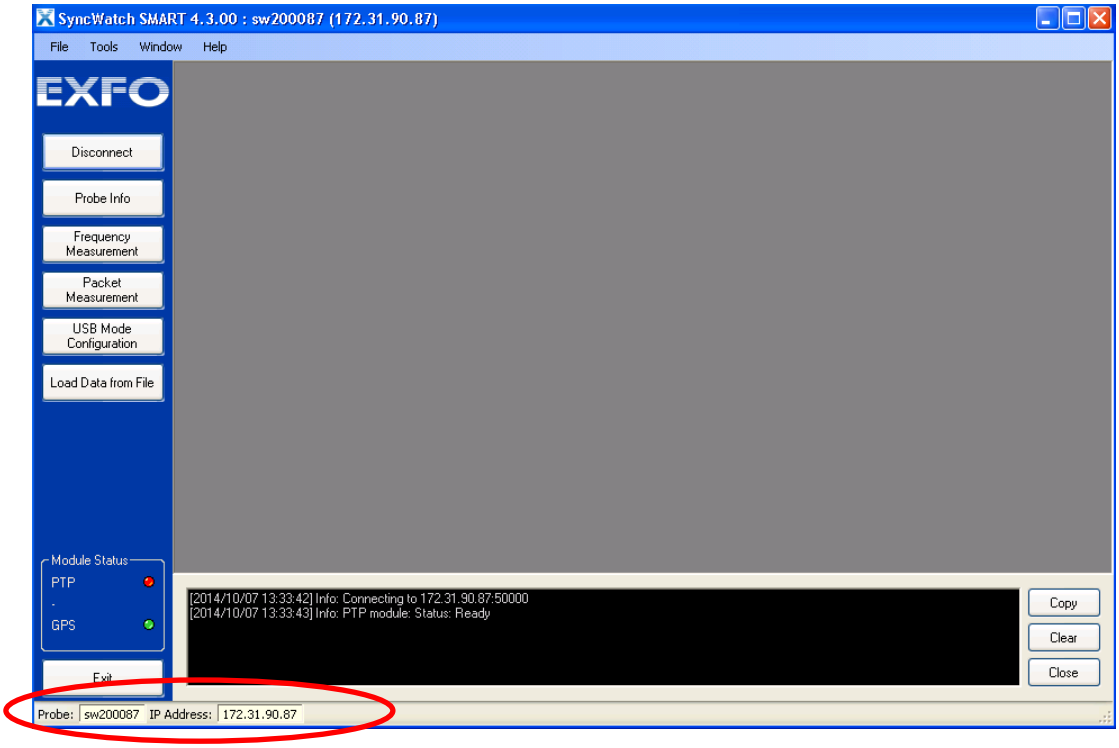
The default IP address of the probe is set to 192.168.1.30. An optional Session Name can be entered which will then appear on the title bar. Once successfully connected the serial number of the probe will be displayed in the top field in the left-hand column.

To view information regarding the probe's serial number, firmware and internal modules:

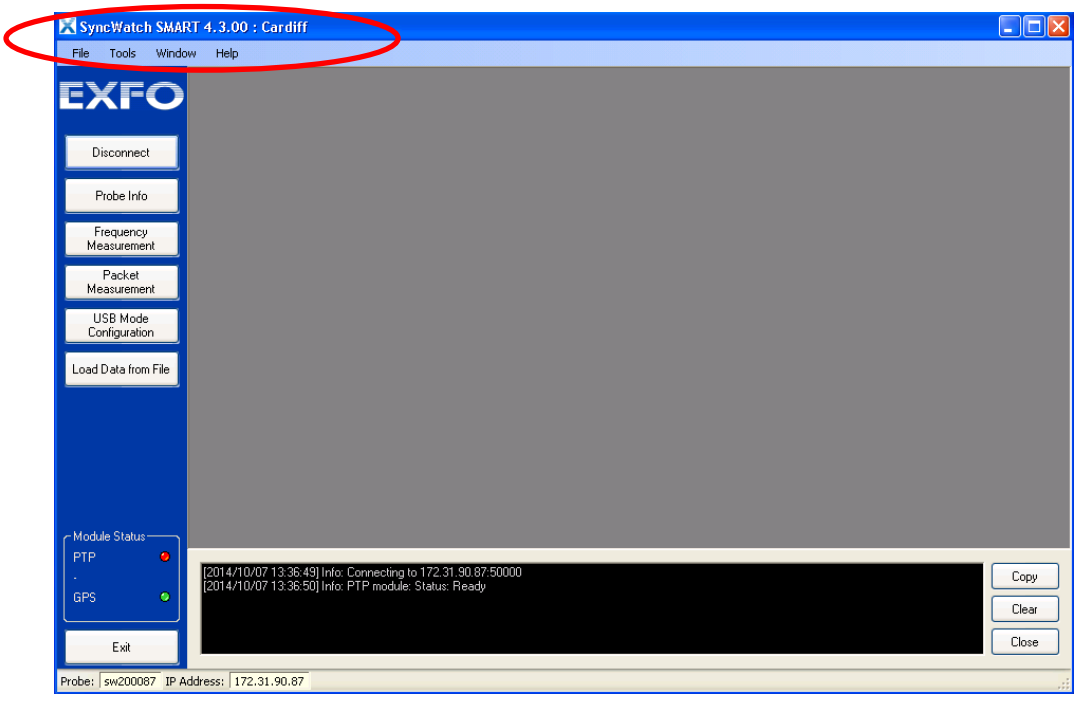
Click the **Probe Info** button on the left-hand menu bar.

*Click the **Download Diagnostics** button to download encoded system information from the probe. The information may be requested by SyncWatch support when remote fault finding. The location and file name are displayed in SMART console window.*

After connection to the probe the window footer displays the probe serial number "sw200087" and the IP address of the probe '172.31.90.87.'



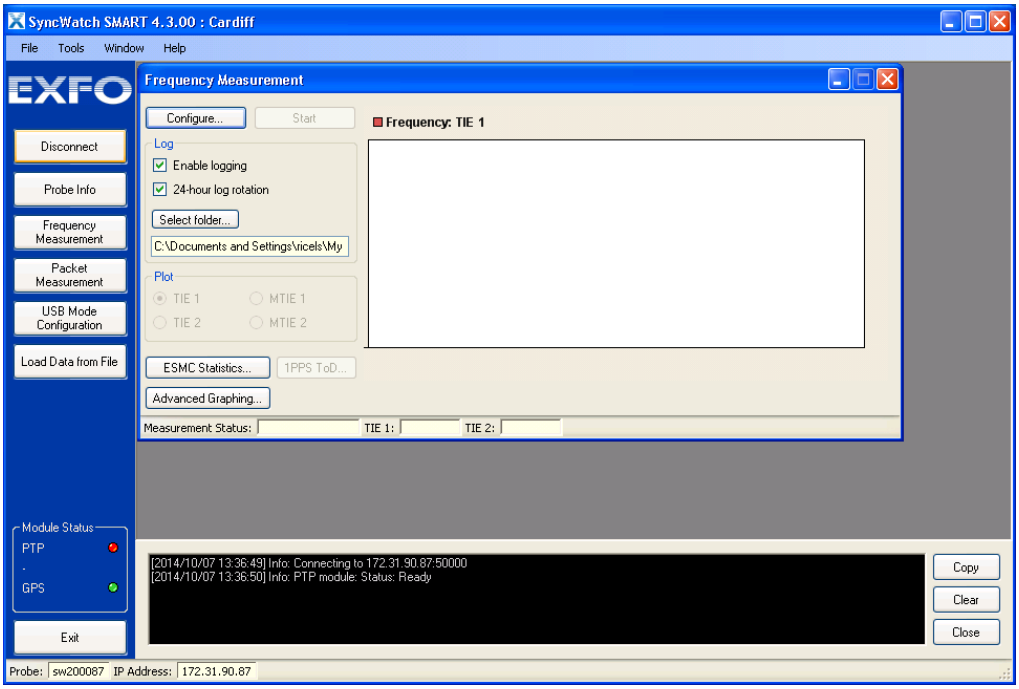
If the user has opted to add a session name 'Connect to SyncWatch probe' dialogue box, the session name will appear in the window header.



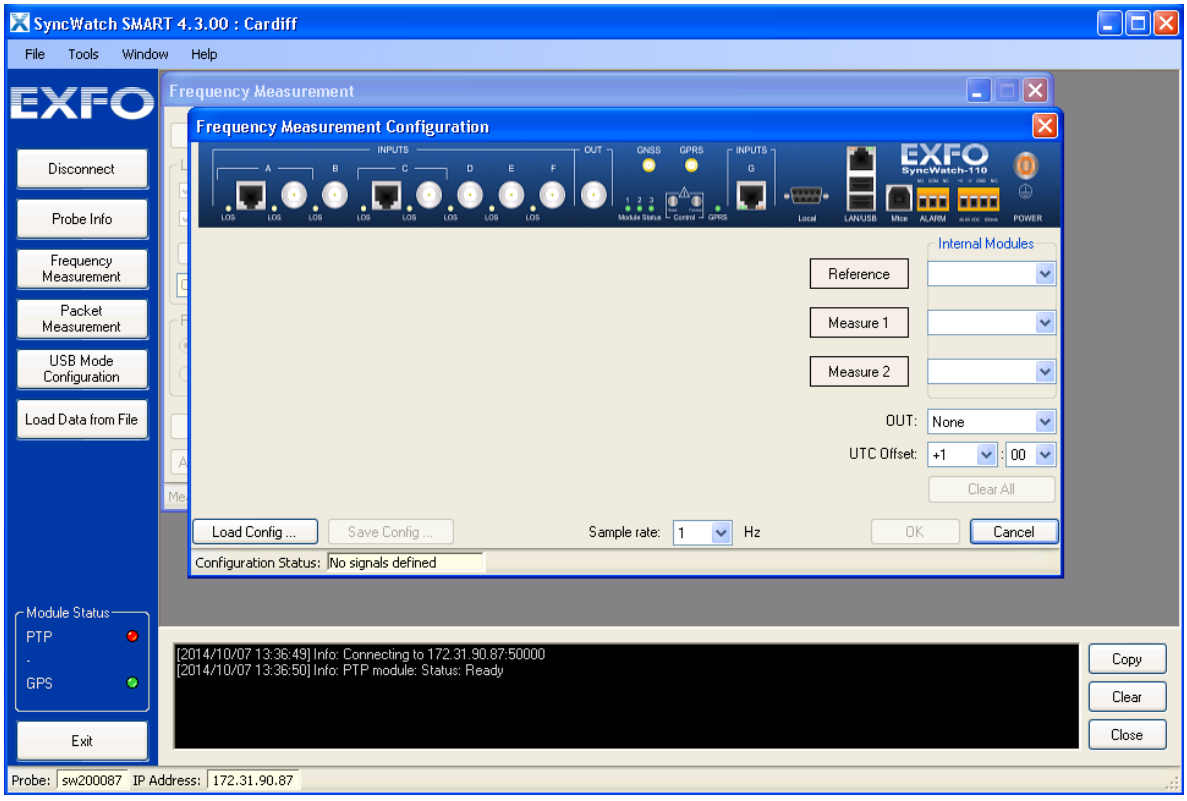
Frequency measurement

Click on the **Frequency Measurement** button on the left-hand menu bar.

This action will open the following window:



To configure a measurement click the **Configure** button. The following window will appear:



To load an existing configuration:

Click the **Load Config** button.

To manually configure a new measurement configuration, follow the procedures below:

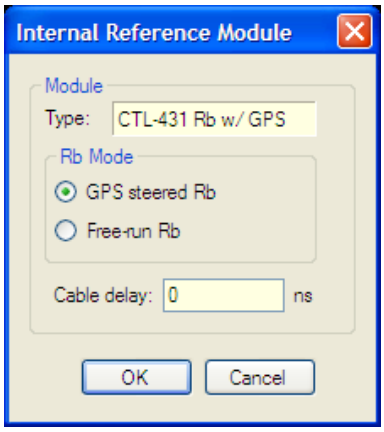
The GPS and PTP internal modules are both optional and may not be available on all SyncWatch probes. To use PTP module it must be connected to a Grandmaster clock as described in Packet measurement on page 92.

Configure a reference source

Click on the **Reference** box.

Click on the required input port or select from Internal Modules drop down menu to select it as a reference source. In this example the GPS internal module is selected.

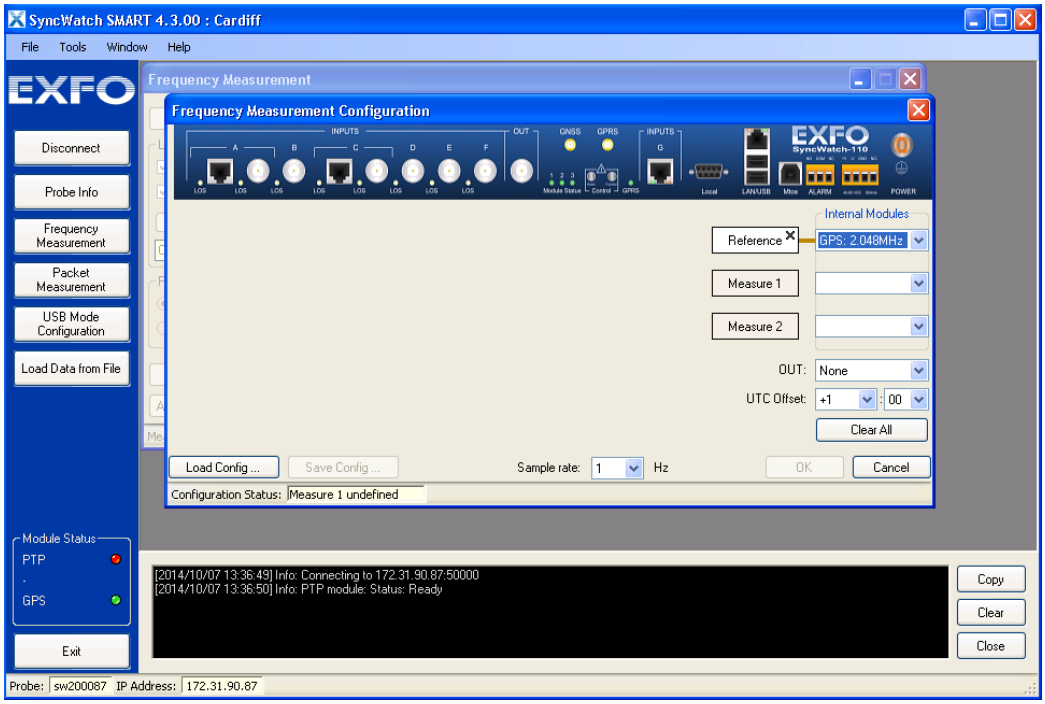
Whenever selecting the GPS module, either as a reference or measurement source, the following window will appear showing the hardware type and available modes of operation:



Select the required mode of operation.

Changing the Cable delay will restart the GPS Internal Reference Module, affecting measurements for upto 5 minutes. Enter a negative value to compensate for a lagging 1 PPS signal.

Click the OK button. The modified screen will appear as below:



Once an input port or an internal module is selected, it cannot be selected again until that measurement connection has been removed individually by selecting the 'x' on the port attached to the "Phase Measurement Engine" or by selecting the "waste bin" icon which removes all measurement connections.

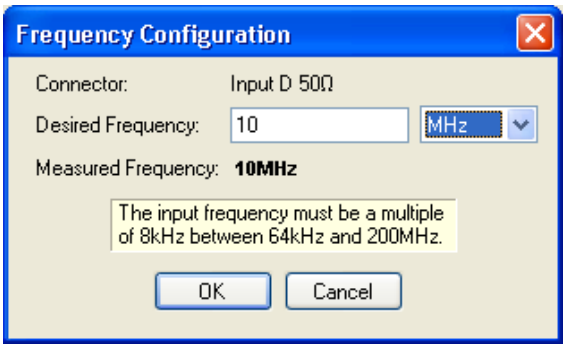
Configure a measurement source

Click on the **Measure1** box.

Click on one of the available input ports or internal modules to select it as a measurement source.

In this example Input D is selected.

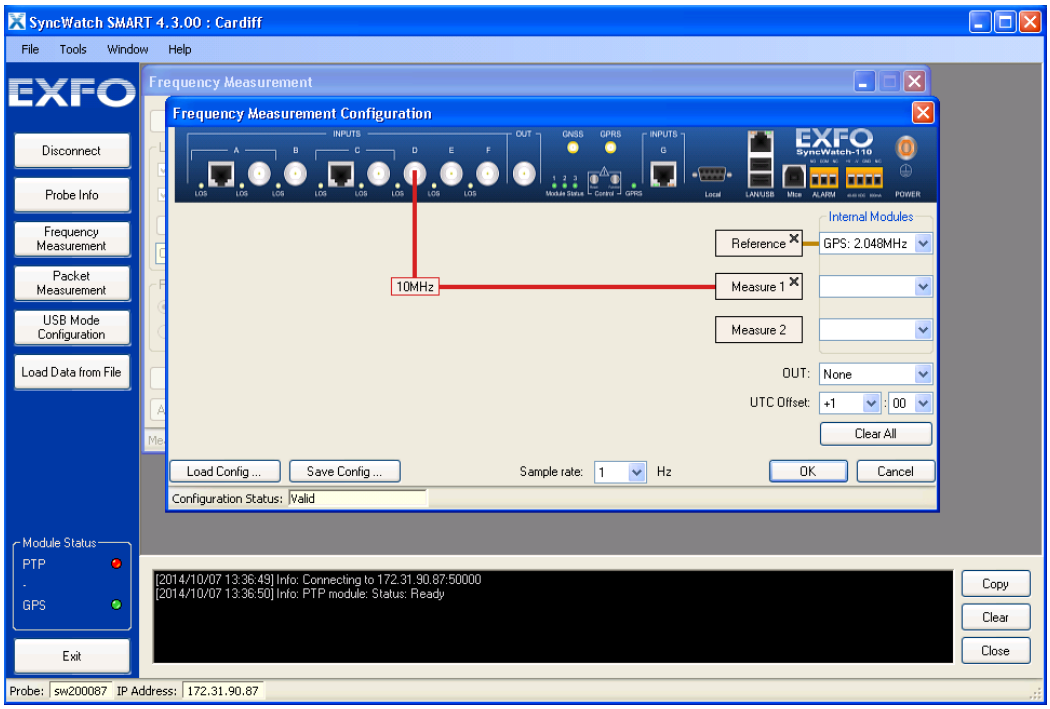
Whenever selecting a Flexible Frequency input (Input B and D), either as a reference or measurement source, the following window will appear:



Enter the required frequency value.

Click the **OK** button.

The modified screen showing the frequency value will appear as below:



*Once an input port or an internal module is selected, it cannot be selected again until that measurement connection has been removed individually by selecting the 'x' on the port attached to the "Phase Measurement Engine" or by selecting the **Clear All** button which removes all measurement connections.*

Configure a second measurement source

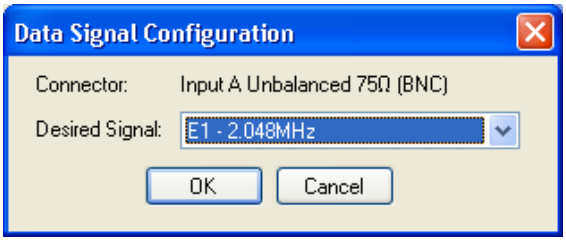
Only when a second measurement source is required, these steps should be followed:

Click on the **Measure2** box.

Click on one of the available input ports or internal modules to select it as a measurement source.

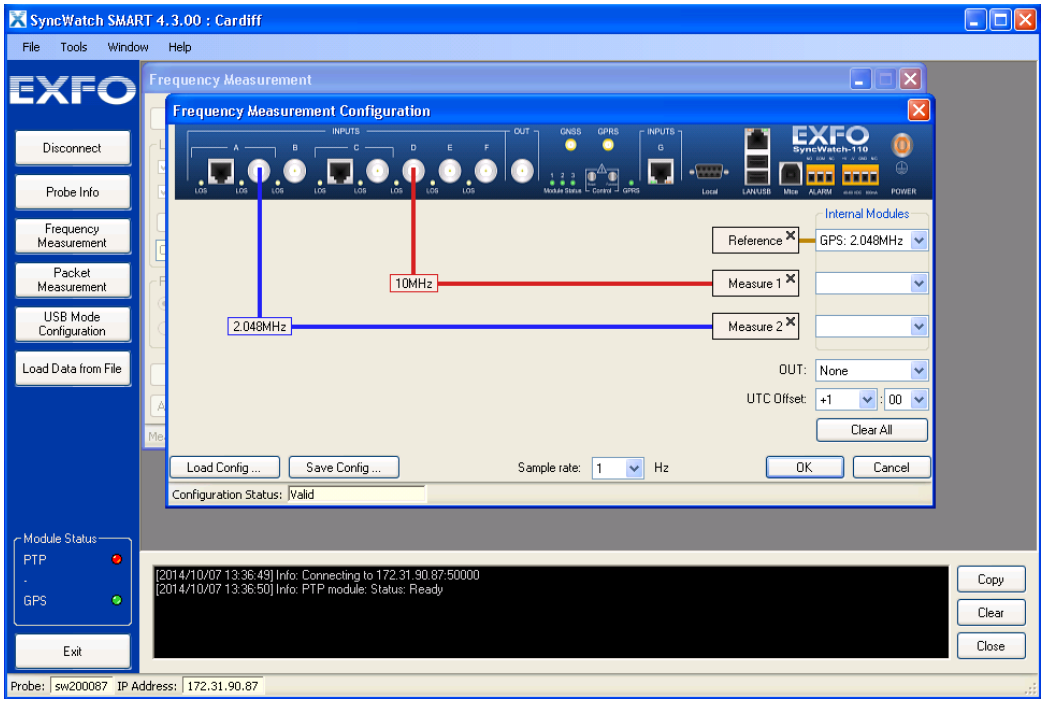
In this example Input A is selected.

Whenever selecting an E1/T1 input (Input A and C), either as a reference or measurement source, the following window will appear:



Use the drop-down menu to select the required signal type.

The modified screen showing the signal type will appear as below:



*Once an input port or an internal module is selected, it cannot be selected again until that measurement connection has been removed individually by selecting the '**x**' in the measurement connection or by selecting the **Clear All** button which removes all measurement connections.*

Sample rate

Can be set to 10 Hz, 1 Hz or 0.1 Hz (i.e. 1 result every 10 seconds).

Monitor output

The **OUT** connector can be configured to generate a buffered copy of any internal or external clock source (except E1 2.048 Mbit/s and T1 1.544 Mbit/s). Use the drop down menu to select required source.

UTC offset

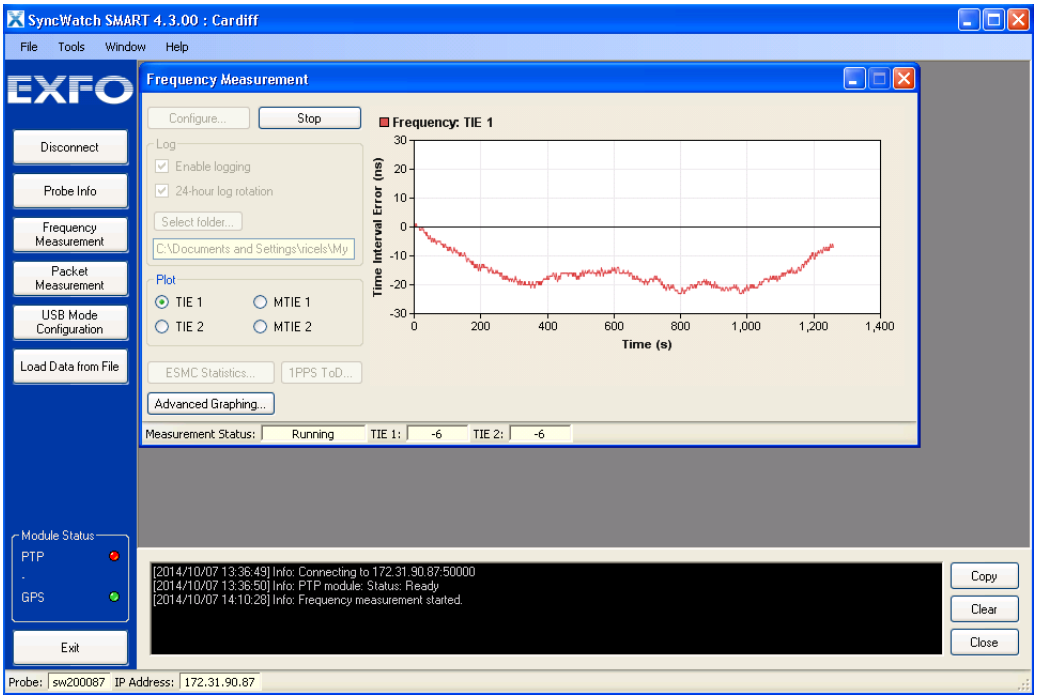
The measurement result files show the start time in UTC. This feature allows the local time offset value to be recorded in the results file.

Save config

Click the **Save Config** button to save the configuration file to PC that can be later re-loaded.

Start measurement

1. When the configuration is completed click the **OK** button to return to the Frequency Measurement window.
2. Tick the ‘Enable logging’ checkbox to create a results file, click the ‘Select folder’ button to choose a location to save the results file.
3. Tick the 24-hour log rotation to limit log files to 24 hours of data. Multiple files will be generated for measurement durations over 24 hours.
4. Click the **Start** button to begin the measurement run. Select the required plot to view live TIE or MTIE data as shown below:

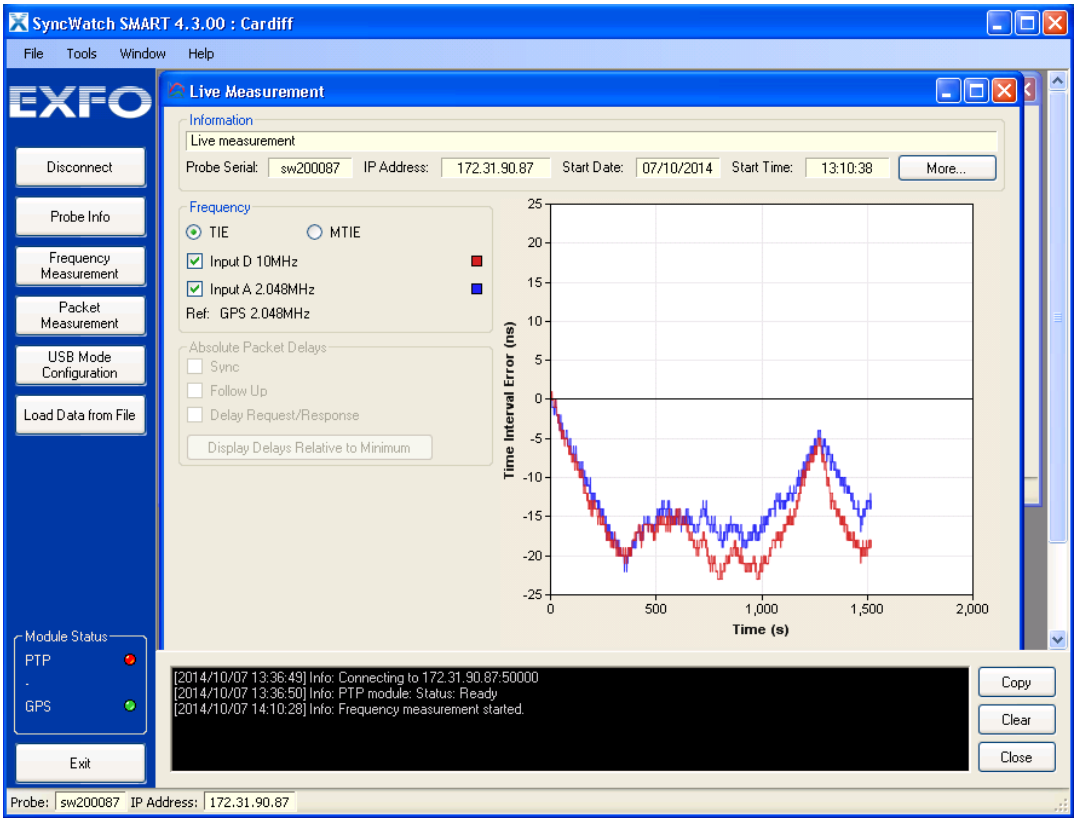


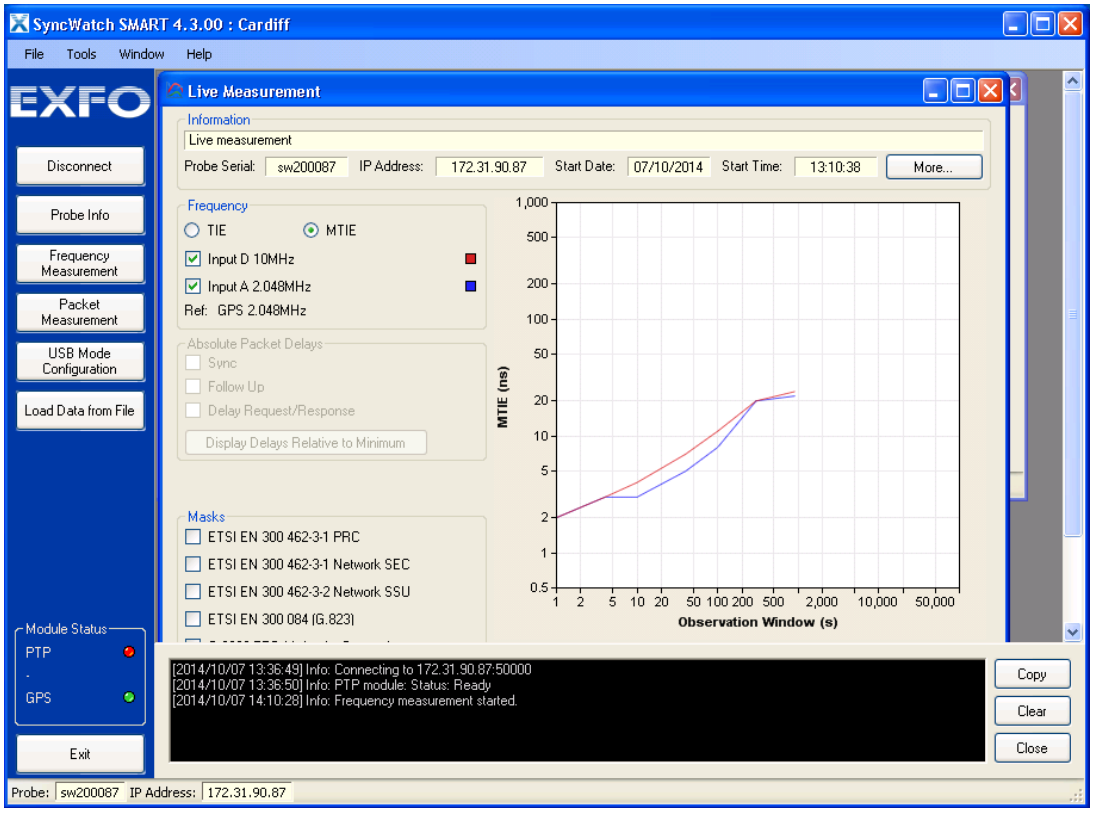
Advanced graphing (Frequency data analysis)

Click the **Advanced Graphing** button in the Frequency Measurement Window.

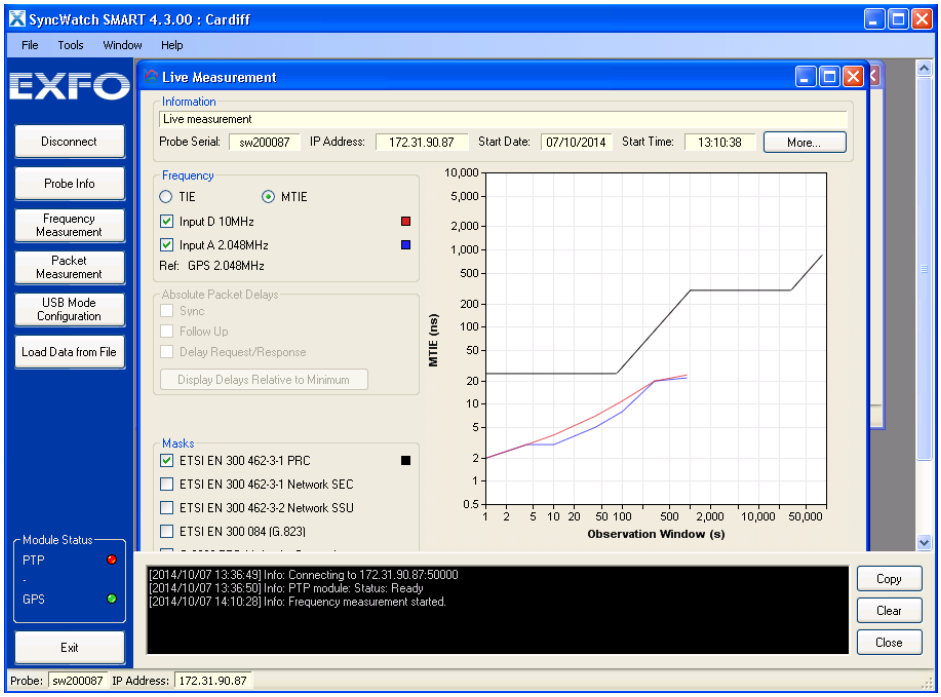
This action takes you to the Advanced Graphing window where multiple TIE and MTIE data can be shown.

Tick the appropriate **Frequency** checkboxes to select the data to be displayed.


SyncWatch SMART 4.3.00 : Cardiff
File Tools Window Help
EXFO
Live Measurement
Information
Live measurement
Probe Serial: sw200087 IP Address: 172.31.90.87 Start Date: 07/10/2014 Start Time: 13:10:38 More...
Disconnect
Probe Info
Frequency Measurement
Packet Measurement
USB Mode Configuration
Load Data from File
Frequency
TIE MTIE
Input D 10MHz
Input A 2.048MHz
Ref: GPS 2.048MHz
Absolute Packet Delays
Sync
Follow Up
Delay Request/Response
Display Delays Relative to Minimum
Time Interval Error (ns)
Time (s)
Module Status
PTP
GPS
Exit
[2014/10/07 13:36:49] Info: Connecting to 172.31.90.87:50000
[2014/10/07 13:36:50] Info: PTP module: Status: Ready
[2014/10/07 14:10:28] Info: Frequency measurement started.
Copy
Clear
Close
Probe: sw200087 IP Address: 172.31.90.87

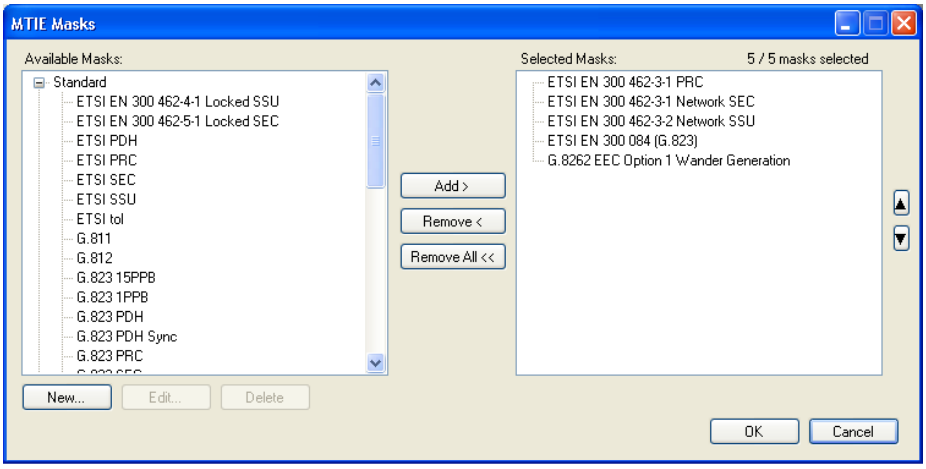

SyncWatch SMART 4.3.00 : Cardiff
File Tools Window Help
EXFO
Live Measurement
Information
Live measurement
Probe Serial: sw200087 IP Address: 172.31.90.87 Start Date: 07/10/2014 Start Time: 13:10:38 More...
Disconnect
Probe Info
Frequency Measurement
Packet Measurement
USB Mode Configuration
Load Data from File
Frequency
TIE MTIE
Input D 10MHz
Input A 2.048MHz
Ref: GPS 2.048MHz
Absolute Packet Delays
Sync
Follow Up
Delay Request/Response
Display Delays Relative to Minimum
Masks
ETSI EN 300 462-3-1 PRC
ETSI EN 300 462-3-1 Network SEC
ETSI EN 300 462-3-2 Network SSU
ETSI EN 300 084 (G.823)
MTIE (ns)
Observation Window (s)
Module Status
PTP
GPS
Exit
[2014/10/07 13:36:49] Info: Connecting to 172.31.90.87:50000
[2014/10/07 13:36:50] Info: PTP module: Status: Ready
[2014/10/07 14:10:28] Info: Frequency measurement started.
Copy
Clear
Close
Probe: sw200087 IP Address: 172.31.90.87

To view the MTIE masks, select the appropriate **Mask** checkbox.



Because MTIE plots have logarithmic axes and TIE plots have linear axes, they cannot be viewed together on the same graph.

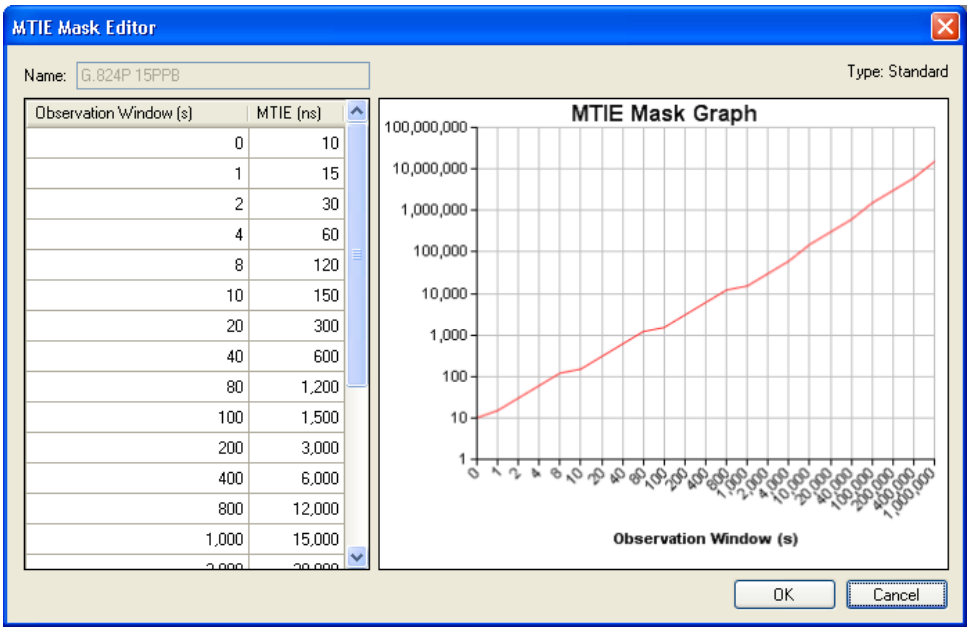
Click the **Customise Masks** button to displayed additional masks that can be selected.



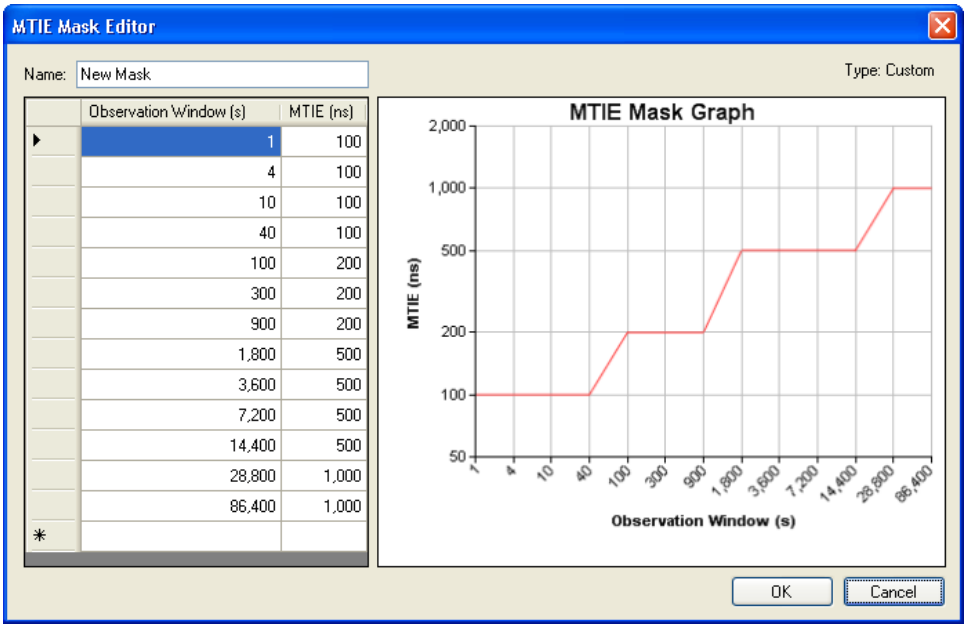
Select the required mask. Click the **Add>** or **Remove<** buttons to select the five masks that will be displayed in the Advance Graphing window. The list of available masks is presented on the left-hand side of the MTIE Masks window, and a list of currently selected masks is presented on the right-hand side. Any of the predefined standard mask or customs masks present in the Available Masks list can be selected.

Standard masks cannot be edited or deleted from the SMART interface. If they are removed from the file system, SMART will replace them on next start-up.

Select the required mask and click the **View…** button to view values of the standard and custom masks as displayed in the MTIE Masks Editor window below.



Click the **New…** button in the **MTIE Masks** window to create a custom mask. Enter mask name and values for the Observation Windows in seconds and the corresponding MTIE values in nanoseconds in the table. The resulting masks will be displayed on the graph as shown below.

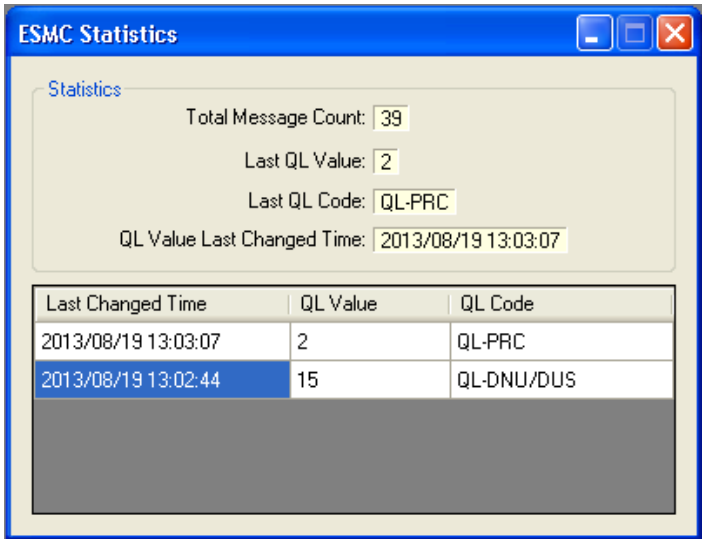


Click the **Delete…** button in the **MTIE Masks** window to remove the custom masks from both the current instance of SMART and from the masks repository on the file system.

ESMC statistics

Click the **ESMC Statistics** button in the Frequency Measurement Window.

This action takes you to the ESMC Statistics window as shown below.



The ESMC statistics window displays the current QL-value of the ESMC messages that are being received during the SyncE measurement from the connected node. The QL-values are as defined in ITU G.781 and G.8261/8264. These values are shown numerically and as their G.781 SSM-QL equivalents and show the perceived quality level of the source of the SyncE synchronisation chain. Message counts and last changed times are also displayed.

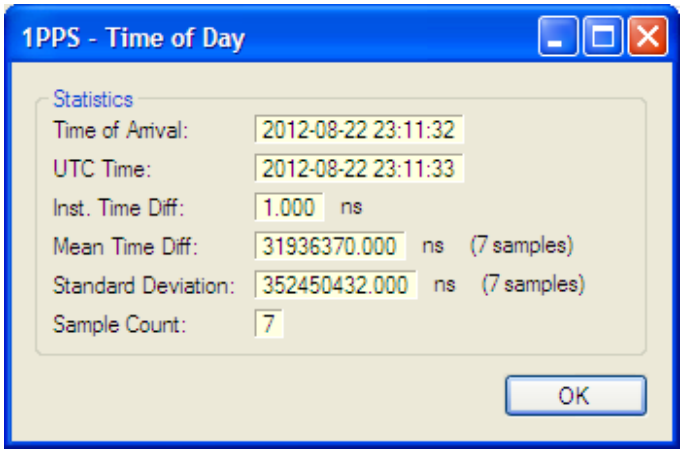
ESMC statistics can only be display if a SyncE frequency measurement is in progress and ESMC messages are being received from the connected node.

If two SyncE frequency measurements have been selected, only ESMC statistics from measurement 1 will be displayed.

1PPS TOD statistics

Click the 1PPS ToD button in the Frequency Measurement Window.

This action takes you to the 1PPS - Time of Day window as shown below.



The 1PPS - Time of Day window displays the following information:

Time Of Arrival	The extracted Time of Day value from ToD packet in the format YY-MM-DD HH:MM:SS + the TIE offset of the PPS signal under test wrt the probe's internal GPS module.
UTC Time	UTC synchronised time of the probe when the ToD packet was received, taken from the probe's internal GPS engine.
Inst. Time Difference	TIE of ToD 1 PPS signal under test vs. the probe's internal GPS module.
Mean Time Difference	Running mean of the last 100 PPS TIE samples.
Standard Deviation	Standard deviation of last PPS 100 TIE samples.
Sample Count	Total number of PPS/ToD samples recorded

1 PPS - Time of Day statistics can only be displayed if a TOD: 1 PPS frequency measurement is in progress and TOD messages are being received from the connected node.

If logging is enabled, Time of Day data is logged to a ToD log file which is written to the same folder used to store TIE measurement log files, as configured on the frequency measurement window. The default folder location is “C:\Documents and Settings\<my username>\My Documents\SyncWatch SMART\log”.

The ToD log filenames are dated with the timestamp of the start of the measurement and take the following format:

YYYY-MM-DD_HH-MM-SS.tod

The ToD log file format consists of six header lines giving information about the measurement followed by the ToD data on a sample-per-line basis, each line containing five comma-separated fields holding the following information:

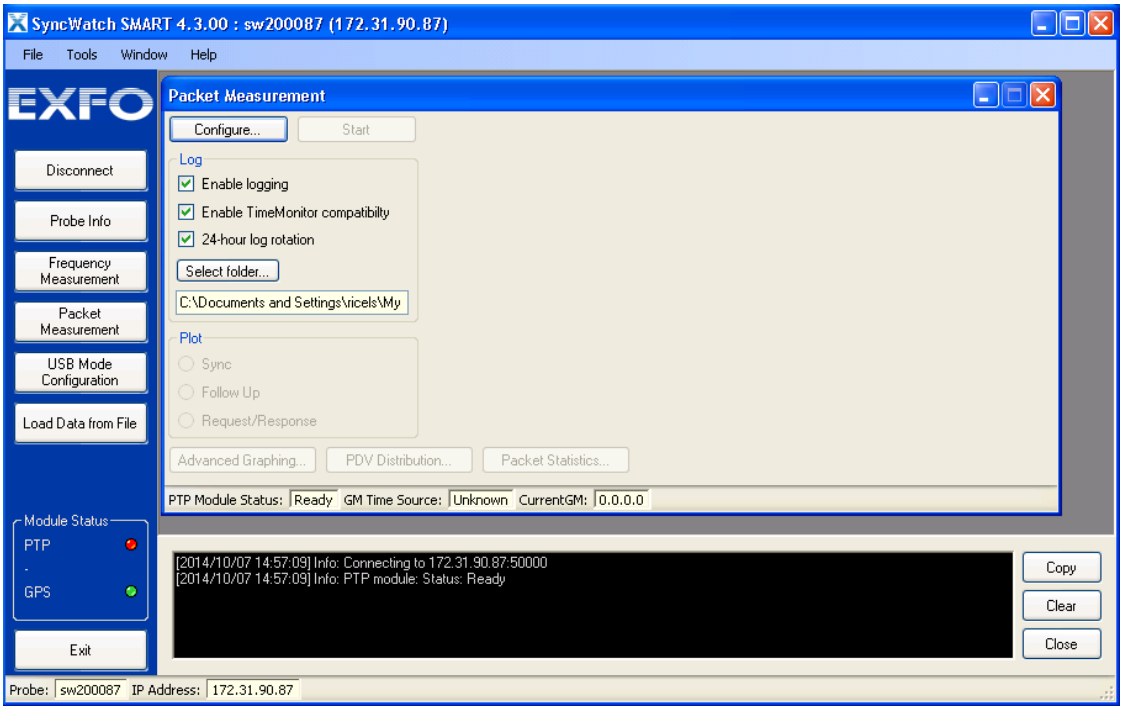
- Time of arrival
- UTC time
- Instantaneous time difference (ns)
- Mean time difference (ns, 100 samples)
- Standard deviation (ns, 100 samples)

Packet measurement

Connect to the probe using SyncWatch SMART as described earlier in this section.

Click the **Packet Measurement** button on the left-hand menu bar.

The following window will appear:



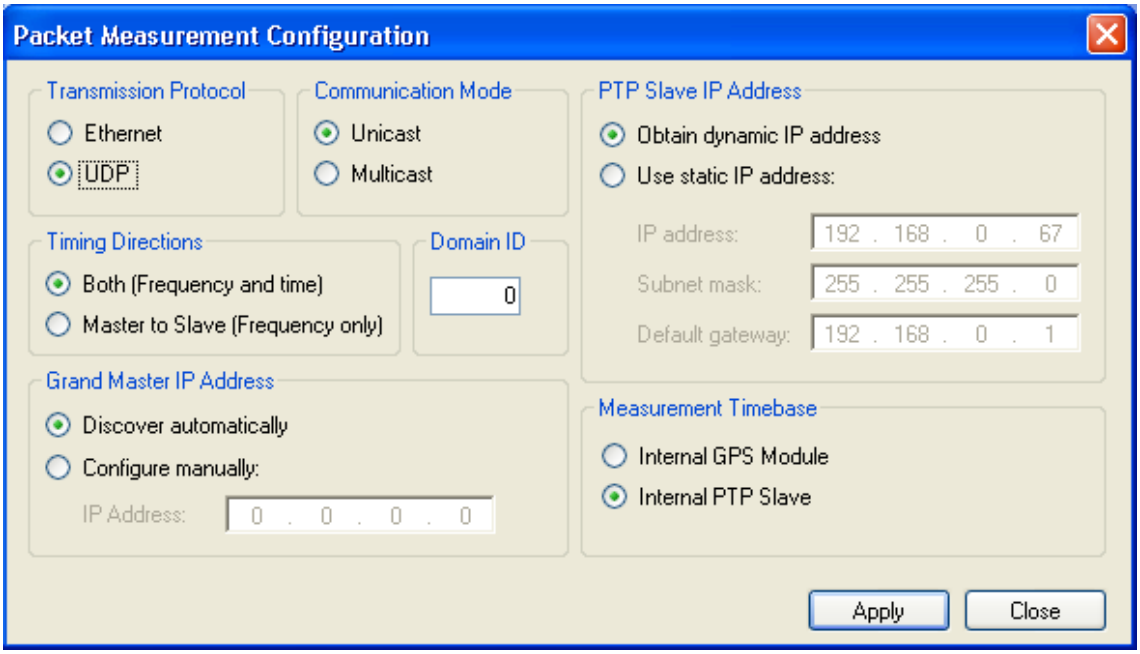
Click the Probe Info button on the left-hand menu bar. Module 1 will show the version of PTP module installed.

Proceed to CTL611 PTP Module or CTL612 Advanced Sync Module configuration:

CTL611 PTP Module

Click on the **Configure** button.

The following window will appear:



Select the required Transmission Protocol: Ethernet - Link layer / Layer 2 or UDP - Transport layer / Layer 3.

Select the Communication Mode of operation, Unicast or Multicast.

Select the Timing Directions, Both (Frequency and time) or Master to Slave (Frequency only).

Enter the Grandmaster Domain ID - Default 0.

Select the Configure manually option to manually enter the IP address or MAC address of the Grandmaster clock. If the Discover automatically option is selected the PTP module will discover the available Multicast Grandmaster clock in the network.

The PTP Client IP Address can be set manually, select Use static IP address. Obtain dynamic IP address will obtain the required IP address from the DHCP Server. If there is no DHCP server then the IP address of the internal PTP module will need to be entered manually.

The IP address of the PTP module is different from that of the SyncWatch probe

Select the required Measurement Timebase. The Internal GPS Module timebase allows the PTP packet delay to be monitored in each direction independently and with much greater accuracy using UTC reference. This feature is only available if the SyncWatch probe is installed with a CTL411, CTL431 or CTL435 GPS module and is connected to a valid GPS signal.

*If GPS reference is not used, SyncWatch will use the **Internal PTP Slave's** derived clock for PTP measurements. This clock is subject to wander proportional to the magnitude of the Packet Delay Variation of the very PTP flow that is being measured. This manifests itself as spurious 'wander' in the PDV measurement, however it does not necessarily make the data invalid depending on the intended function of the test.*

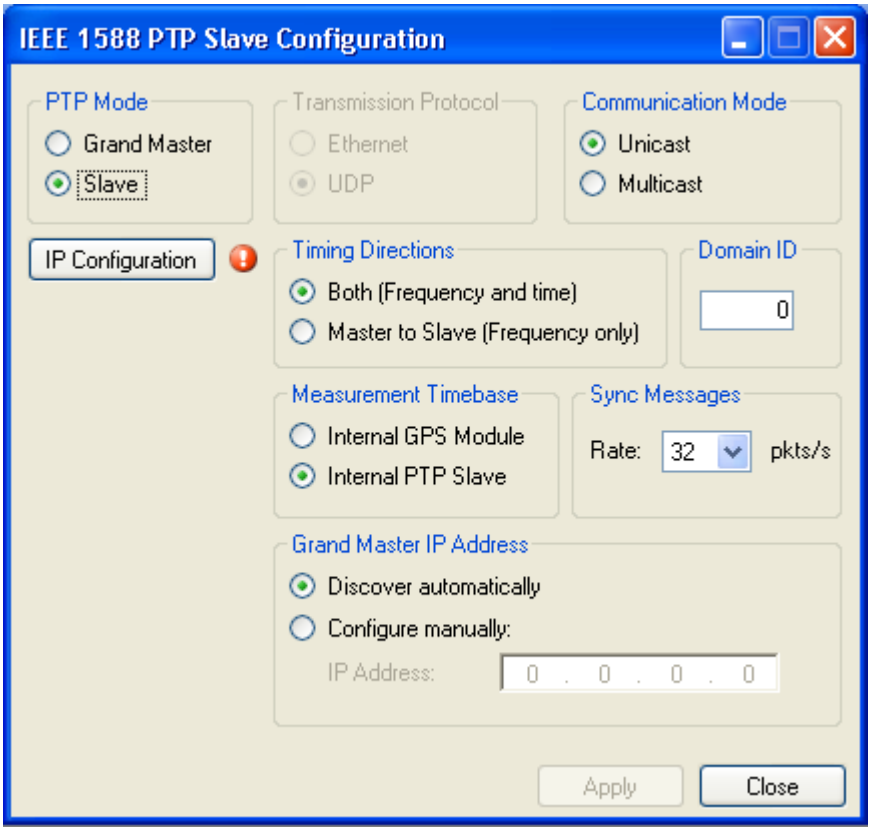
Click **Apply** to return to the Packet Measurement window.

Clicking APPLY will cause the CTL611 PTP module to re-initialize with new settings. This will result in a delay before the measurement commences. Click CANCEL to exit the window without any settings being applied.

CTL612 Advanced Sync Module

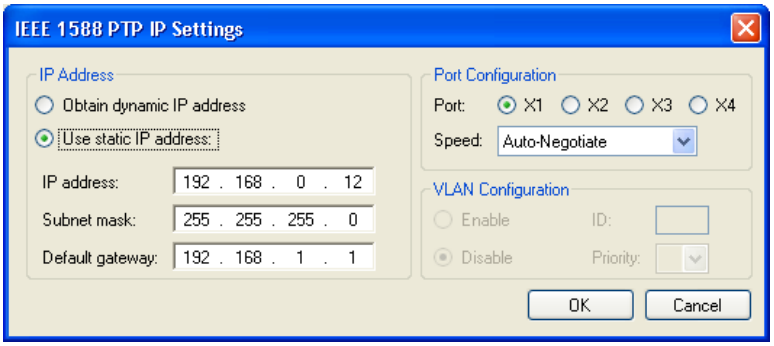
Click on the Configure button.

The following window will appear:



Click on the IP Configuration button.

The following window will appear:



The PTP Client IP Address can be set manually, select Use static IP address. Obtain dynamic IP address will obtain the required IP address from the DHCP Server. If there is no DHCP server then the IP address of the internal PTP module will need to be entered manually.

The IP address of the PTP module is different from that of the SyncWatch probe

Set Port Configuration by selecting required port connection (X1, X2, X3 or X4) and the port speed. The speed selected must match the speed of the unit under test to avoid link-flap.

Enable VLAN if required. Set required VLAN ID (number between 0 and 4095) and VLAN priority (number between 0 and 7)

Click OK to return the main configuration window.

Set the PTP Mode to Slave.

Select the required Transmission Protocol: Ethernet - Link layer / Layer 2 or UDP - Transport layer / Layer 3.

Select the Communication Mode of operation, Unicast or Multicast.

Select the Timing Directions, Both (Frequency and time) or Master to Slave (Frequency only).

Enter the Grandmaster Domain ID - Default 0.

Select the required Measurement Timebase. The Internal GPS Module timebase allows the PTP packet delay to be monitored in each direction independently and with much greater accuracy using UTC reference. This feature is only available if the SyncWatch probe is installed with a CTL411, CTL431 or CTL435 GPS module and is connected to a valid GPS signal.

*If GPS reference is not used SyncWatch will use the **Internal PTP Slave's** derived clock for PTP measurements, this clock is subject to wander proportional to the magnitude of the Packet Delay Variation of the very PTP flow that is being measured. This manifests itself as spurious 'wander' in the PDV measurement, however it does not necessarily make the data invalid depending on the intended function of the test.*

*If the **Internal PTP Slave's** derived clock for PTP is selected and the PTP port is directly connected to a Grandmaster, negative and asymmetrical Packet Delays may be seen. The negative values are caused by slight asymmetry that is present within the Advanced Sync Module rate adaptation firmware. The Advanced Sync Module has been profiled against a range of Grandmasters to reduce negative values, however varying specifications of Grandmaster design mean that some Grandmasters may appear to give negative packet delay values.*

Select the Sync Message rate from the drop down box. This is only required when the communication mode is set to Unicast.

Select the Configure manually option to manually enter the IP address or MAC address of the Grandmaster clock. If the Discover automatically option is selected the PTP module will discover the available Multicast Grandmaster clock in the network.

Click Apply to return to the Packet Measurement window.

Clicking Apply will cause the CTL612 PTP module to re-initialize with new settings. This will result in a delay before the measurement commences. Click CANCEL to exit the window without any settings being applied.

It can take several minutes for the PTP module to initialize as it searches for a valid Grandmaster source. Once the PTP Module Status at the bottom of the window displays Slave, the module is ready for operation.

When using the internal GPS reference for PTP packet timesatmping, there is no significance in the status of the PTP module, other than it shows that the configuration parameters have been input correctly, and the PTP module is communicating with the expected GM.

'Lock Validity' is a useful indicator of the state of the PLLs and algorithm within the PTP module. It is shown mainly as an aid to diagnosing possible connection/network issues between the GM and PTP module should they arise. It has no bearing whatsoever on the independent packet timestamps obtained when using the GPS module as a timebase. In normal operation Lock Validity starts at 0.0 and will reach a maximum value, up to 0.9.

Definitions of the PTP module status are as follows:

Ready: The PTP module (Slave) is waiting for user configuration before it can begin to communicate with the Grandmaster.

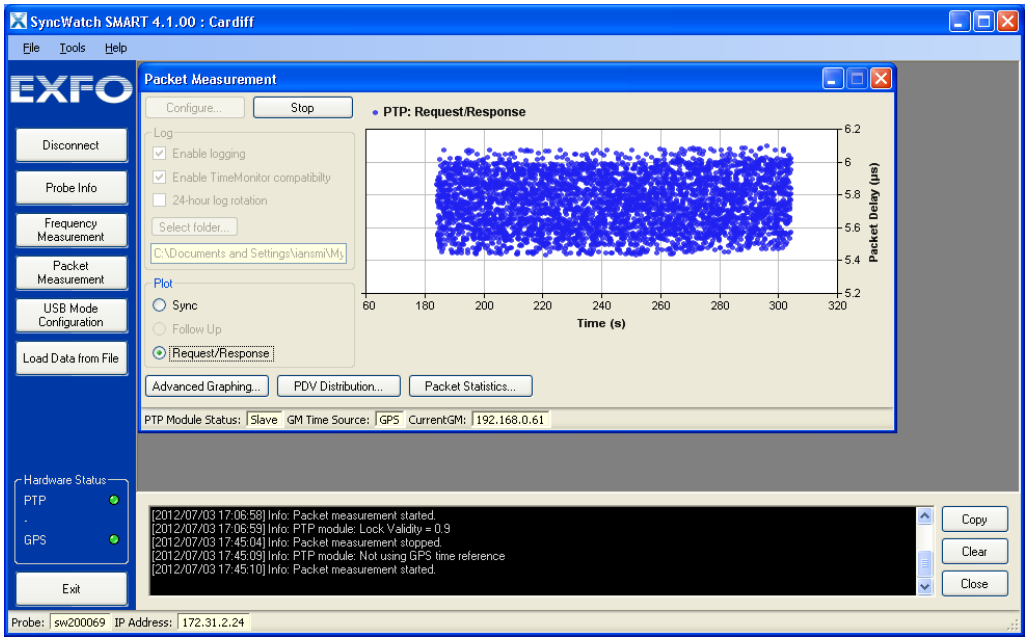
Calibrating: The PTP module is analyzing the network delays and is beginning to align its time base with that of the Grandmaster. The alignment process is dependent on the packet delay variation in the network and could take several minutes to complete. A Client connected directly to a Grandmaster will take up to 3 minutes to align.

Slave: The PTP module is ready to begin a measurement

Tick the Enable logging checkbox to create a results file, ticking the Enable TimeMonitor compatibility will create additional files that are compatible with TimeMonitor software. Click the Select folder button to choose a location to save the results file.

Tick the 24-hour log rotation to limit log files to 24 hours of data. Multiple files will be generated for measurement durations over 24 hours.

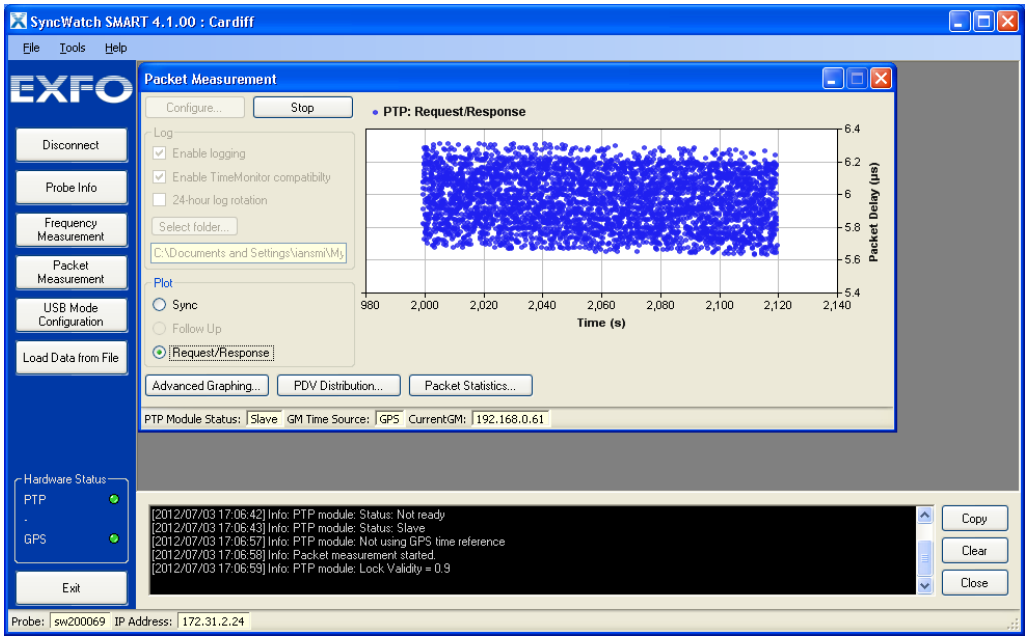
Click the Start button to begin the measurement run. Select the required PTP stream (Sync, Follow Up and Request/Response) to view live packet delay data as shown below:



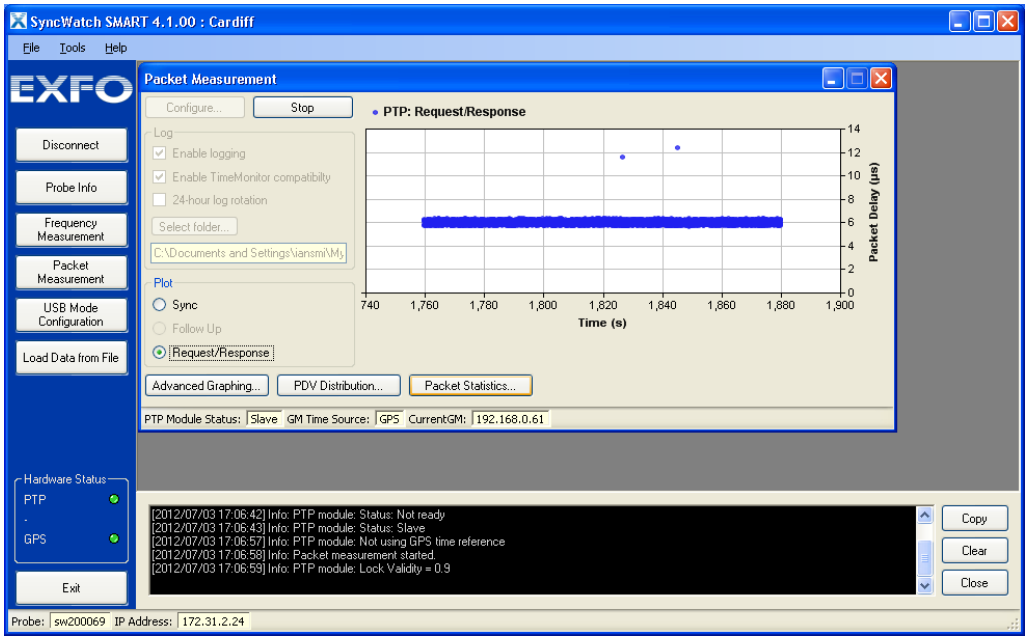
Each live packet delay plot shows the last 3840 packet delays.

It should be noted that if any single packet should experience a delay significantly in excess of any of those also being displayed in the rolling window (i.e. below) then when this packet is no longer displayed then the packet window will again auto scale. This auto scale change is normal and should not be misinterpreted as a problem.

The following three graphs show the auto scale feature:

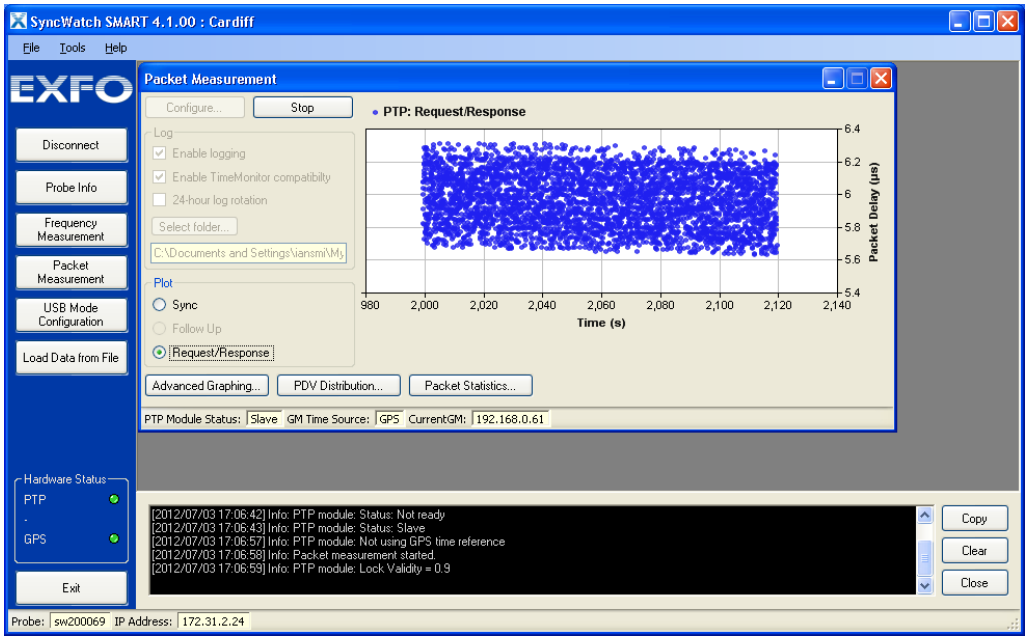


The graph above shows packet delay times all clustered around 6 µs.



The graph above still shows significant clustering of packets around the 6 µs range. Two packets that experienced more delay have caused the “auto scaling” that makes the appearance of the graph to change radically to that before (see previous picture).

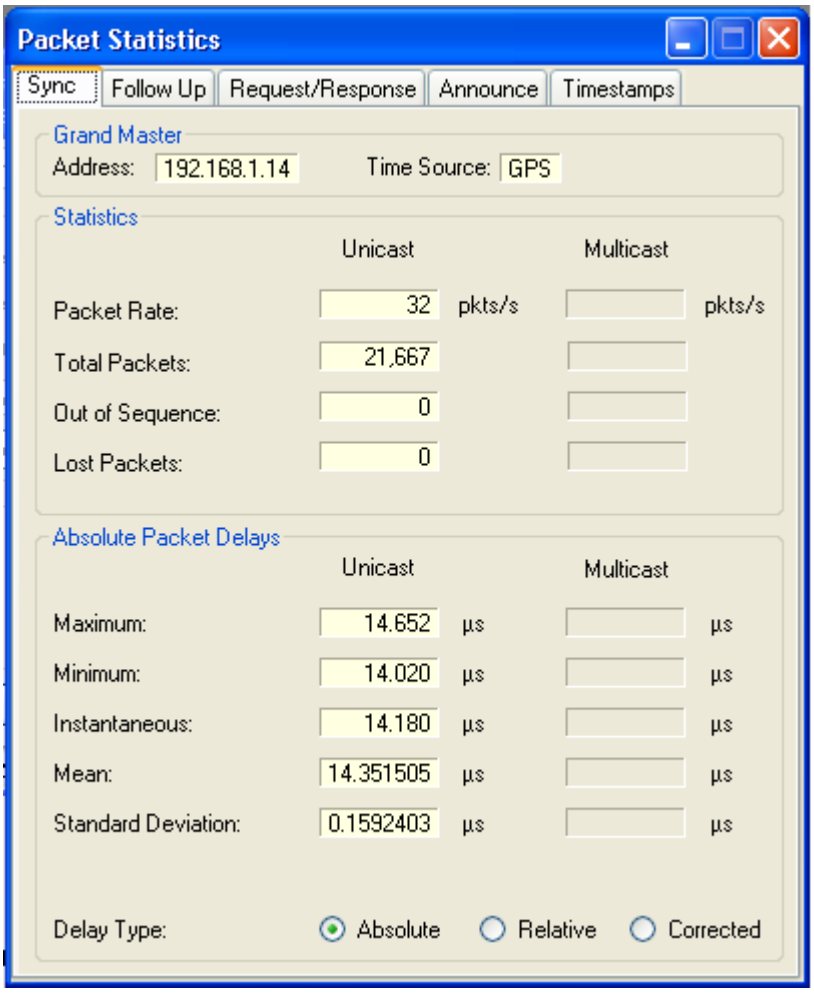
Not all Grandmaster clocks generate Follow Up packets.



After two of the ‘outlying’ packets have passed out of the rolling display window the graph again auto scales. This is normal operation.

Packet statistics

Click the Packet Statistics button in the Packet Measurement window.



Select the required packet stats tab, four types of PTP packet stats can be displayed. They are “Sync”, “Follow up”, “Request/Response” and “Announce” packets. Packet “Timestamps” can also be displayed.

Select the required packet **Delay Type**.

Absolute	The data displayed is the absolute measured packet delay.
Relative	The data displayed is the absolute packet delay offset by the minimum packet delay.
Corrected	The data displayed is the absolute packet delay offset by the value in the packet correction field.

Corrected packet delay measurements are only available with the CTL612 Advanced Sync Module.

For each category of PTP message it is possible to see the following information.

Total Packets:	This is the total number of PTP packets that have been received since the packet measurement began.
Out of Sequence:	This is the number of the PTP packets that have arrived out of sequence i.e. they may have been delayed more than other packets.
Lost Packets:	This is the number of PTP packets that failed to arrive in the probe.
Maximum (µs):	This is the Maximum time taken for a PTP packet to travel between the GrandMaster Clock source and the probe.
Minimum (µs):	This is the Minimum time taken for a PTP packet to travel between the GrandMaster Clock source and the probe.
Instantaneous (µs):	This is the time taken for one PTP packet to travel between the GrandMaster clock source and the probe in a one second sample period.
Mean (µs):	This is the arithmetic mean or average of all PTP packet times between GrandMaster clock source and the probe. Values are calculated on the last 100 sample times received during the measurement.
Standard Deviation (µs):	This is a measure of variation of all PTP packet times between GrandMaster clock source and the probe from the mean value. Values are calculated on the last 100 sample times received during the measurement.

*The **Lost Packets** and **Out of Sequence** counts may be invalid if the PTP signal is physically disconnected or a network element causes the link to fail during the PTP measurement.*

Definitions of the timestamps are as follows:

T1: Time noted by the master of the Sync message at which it was sent.

T2: Time noted by the PTP module of the Sync message on reception.

T3: Time noted by the PTP module of the Delay Request message at which it was sent.

T4: Time noted by the master of the Delay Request message on reception.

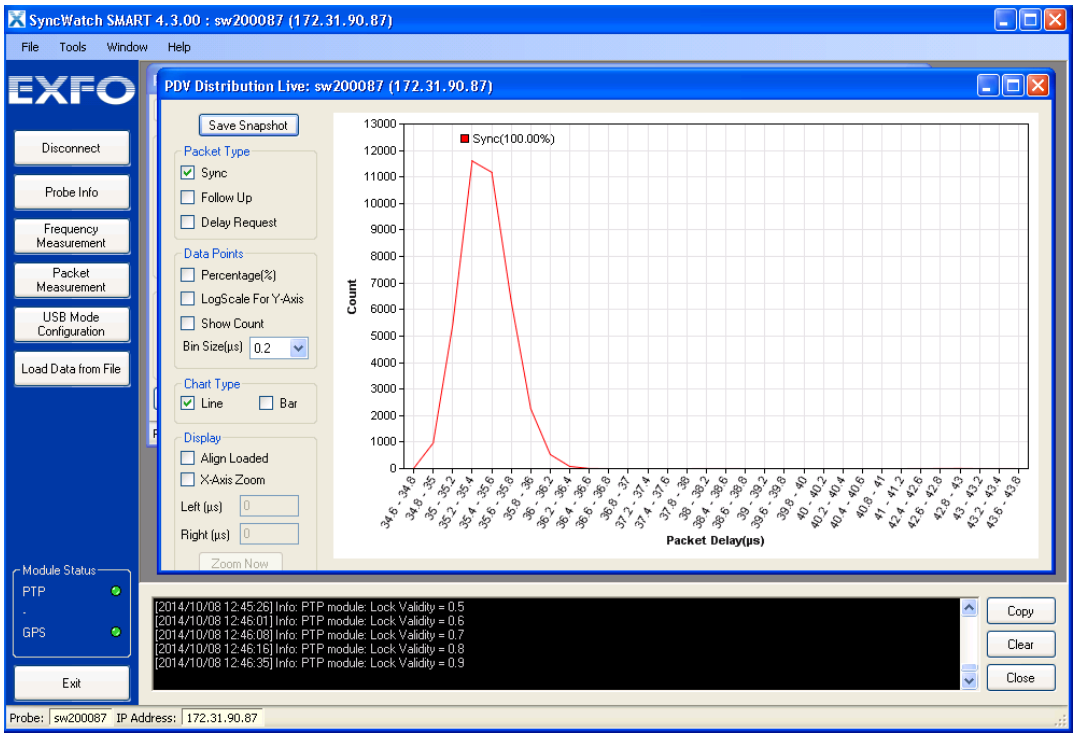
The times displayed are that of the last packet in the 1 second observation window. The 'Correction Time' shows the total residence time of packets in the transparent clocks across the PTP network.

PDV Distribution Graph

Click the PDV Distribution button in the Packet Measurement window.

This enables access to the PDV Distribution graph window where multiple packet type line graphs are displayed. A bar chart will be provided as a selectable option in a future release. The line graph has been chosen because it allows the user to more easily view multiple plots than having bars that may obscure another set of bars

Tick the appropriate Packet Type checkboxes to select the data to be displayed.



Tick the appropriate **Data Point** checkboxes. The default scales of the Y-Axis are actual values, **Percentage** or **Logarithmic Scales** can be selected. Actual counts or percentage values can be added to the data points by ticking the **Show Count** checkbox. The granularity of the graph can be changed by selecting the required Bin Size from the dropdown menu.

Save Snapshot

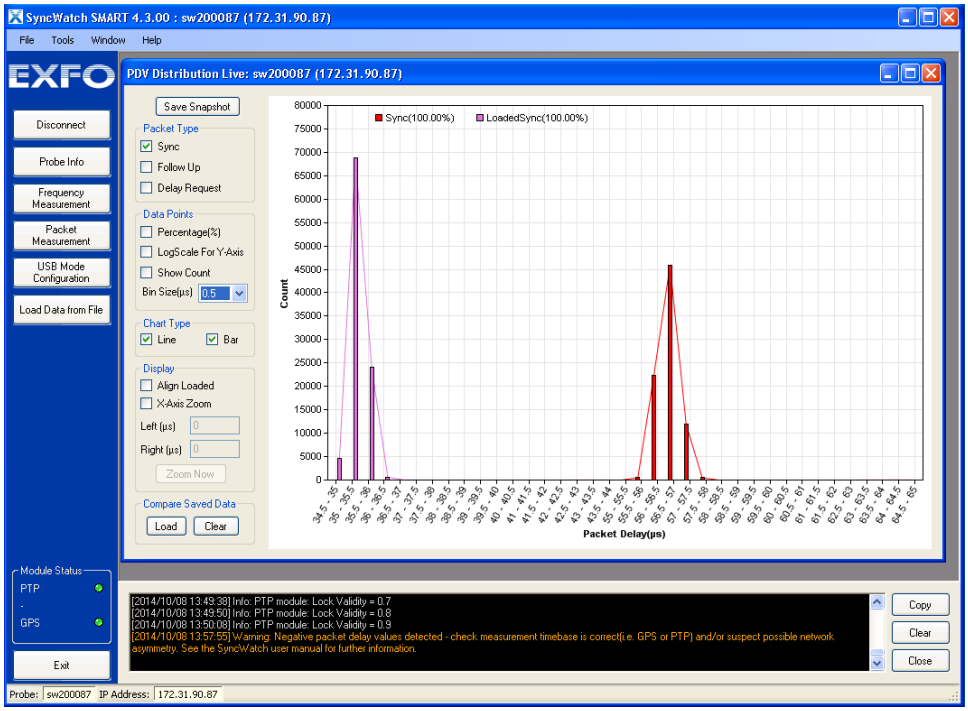
To create a SyncWatch PDV Distribution logs file (*.pdd) for later comparison click the **Save Snapshot** button.

Compare Saved Data

To compare the live PDV Distribution graph with a saved SyncWatch PDV Distribution logs file (*.pdd) or SyncWatch PDV logs file (*.pdv) click the **Load** button.

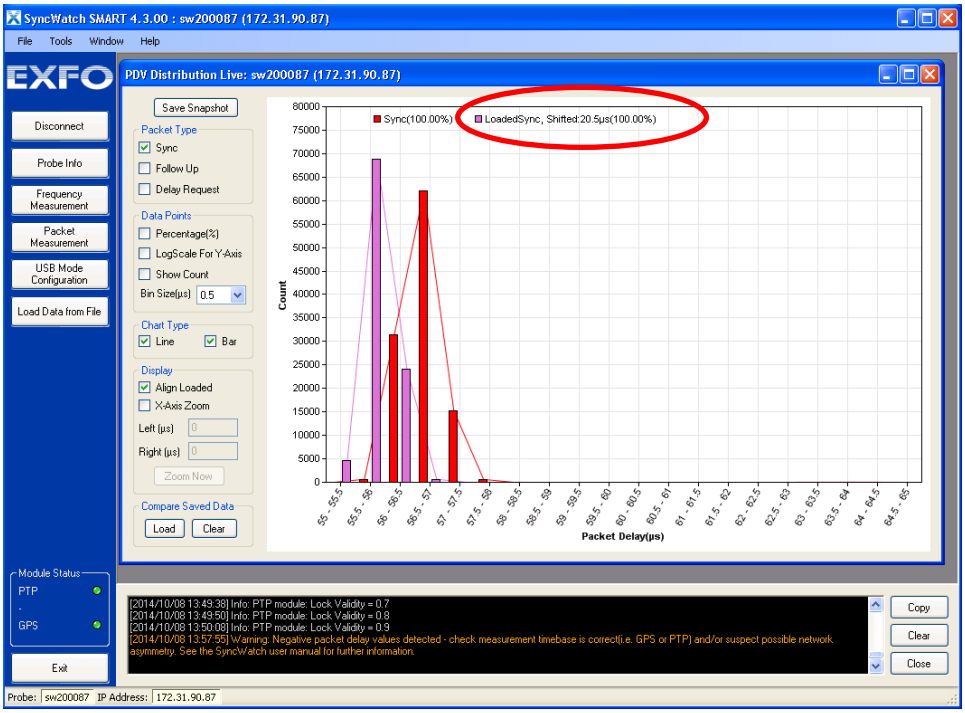
Only one comparison data file can be display on the graph.

The comparison data can be removed by selecting the **Clear** button.



Display

The comparison data and live data can be aligned by ticking the **Align Loaded** checkbox. The legend of the comparison data will indicate the size of the shift required in microseconds.



To change the x-axis values:

Tick the **X-Axis Zoom** checkbox and enter the required **Left** and **Right** graph values.

Select **Zoom Now** to update the graph.

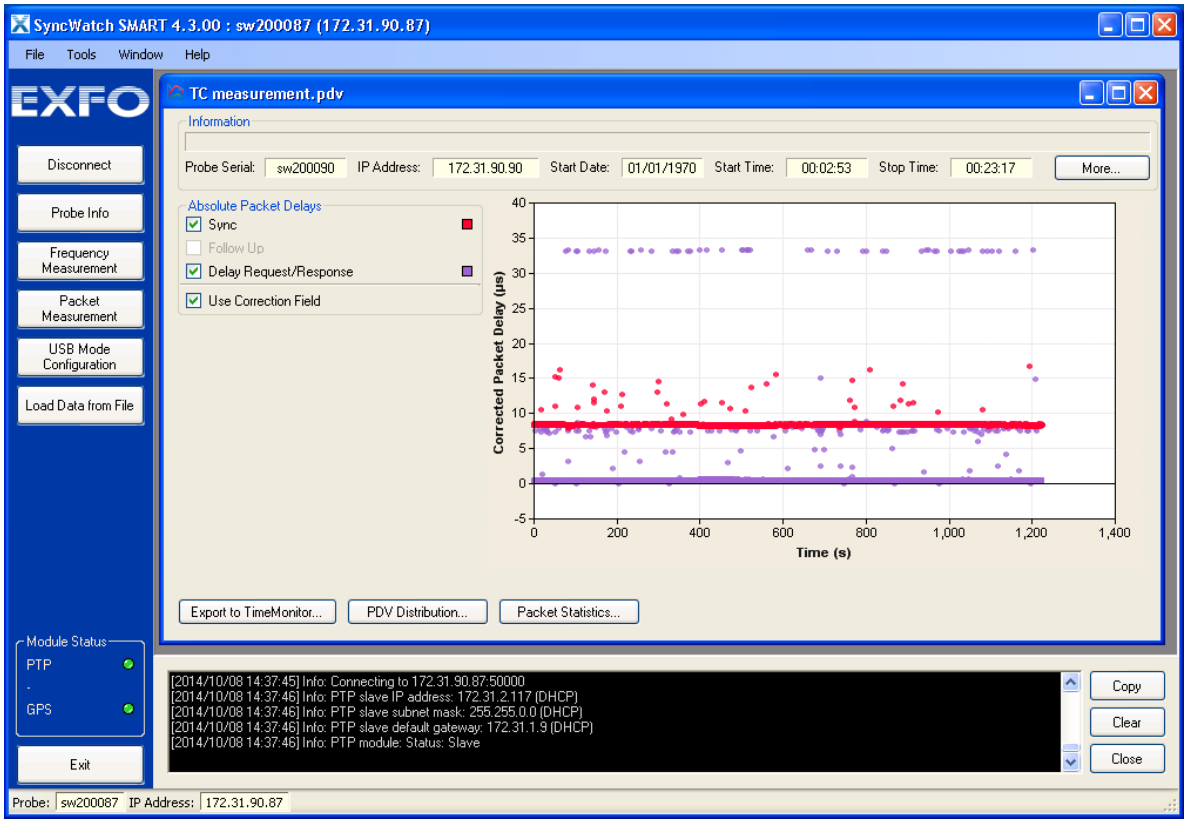
Advanced graphing (Packet data analysis)

Click the **Advanced Graphing** button in the Packet Measurement window.

This enables access to the Advanced Graphing window where multiple packet flows are displayed.

Tick the appropriate **Packet Delays** checkboxes to select the data to be displayed. The default display is absolute packet delay, click the **Display Delays Relative to Minimum** button to set the minimum packet delay as the zero delay reference point.

Tick the **Use Correction Field** checkbox to display corrected packet delays. The packet delays have been adjusted by the value in the packet correction field.



Grand Master Mode

CTL612 Advanced Sync Module

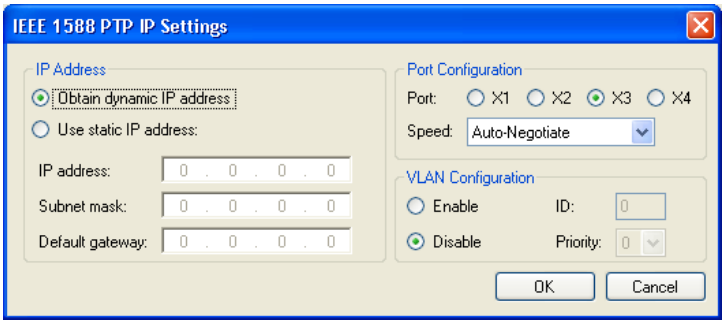
Click the Packet Measurement button on the left-hand menu bar.

Click on the Configure button.

Set the PTP Mode to Grand Master.

Click on the IP Configuration button.

The following window will appear:



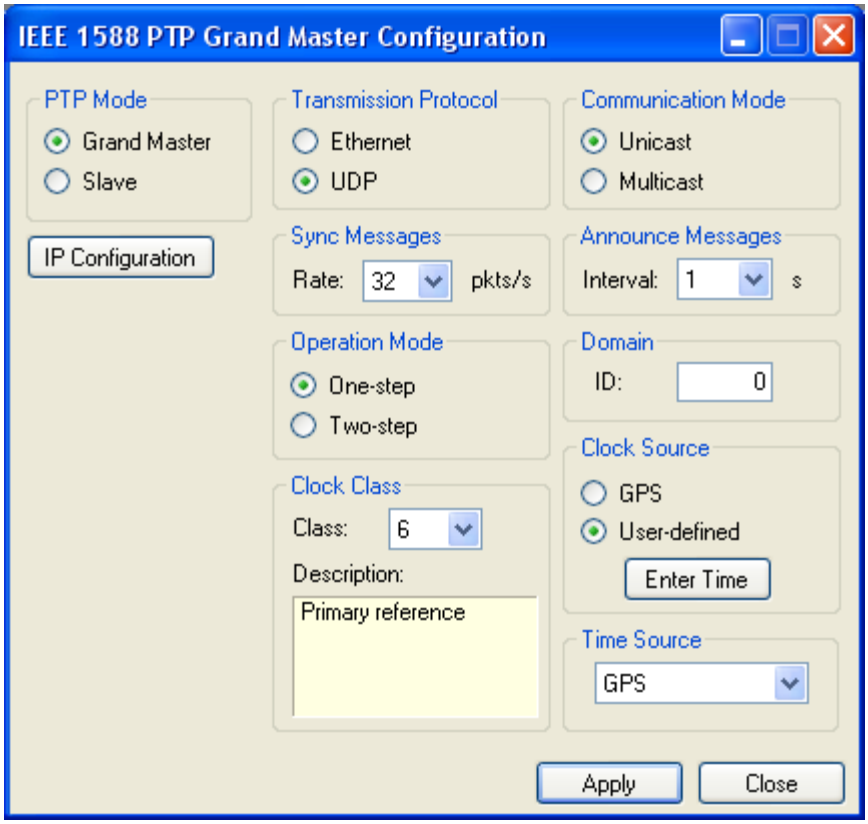
The PTP grandmaster IP Address can be set manually, select **Use static IP address**. **Obtain dynamic IP address** will obtain the required IP address from the DHCP Server. If there is no DHCP server then the IP address of the internal PTP module will need to be entered manually.

The IP address of the PTP module is different from that of the SyncWatch probe

Set Port Configuration by selecting required port connection (X1, X2, X3 or X4) and the port speed. The speed selected must match the speed of the unit under test to avoid link-flap.

Click on the OK button to return to the main configuration window.

The following window will appear:



Select the required Transmission Protocol: Ethernet - Link layer / Layer 2 or UDP - Transport layer / Layer 3.

Select Communication Mode of operation, Unicast or Multicast.

Select the Sync Messages Rate from the drop down box - Default 32 pkts/s.

Select the Announce Messages Interval from the drop down box - Default 1.

Select Operation Mode: One-step - Sync messages, Two-step - Sync and Follow Up messages.

Enter the Domain ID - Default 0.

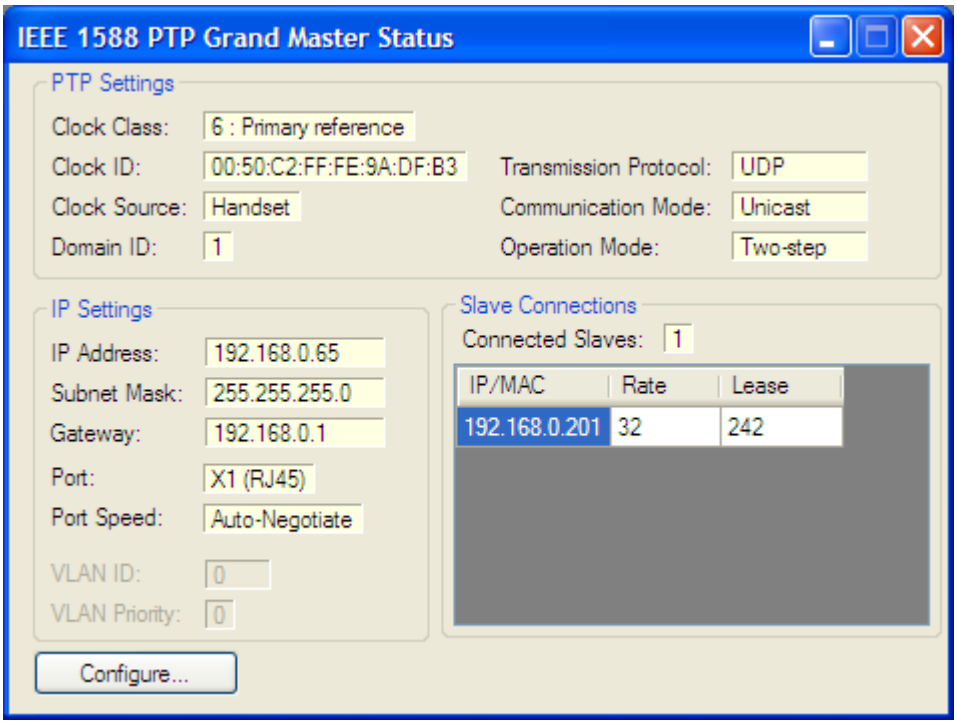
Select the Clock Source. GPS will select the Internal GPS Module time base which is UTC aligned. User-defined allows the time base to be set manually.

Select the Time Source from the drop down box. The selected source will appear in the announce messages from the Grand Master.

Select the Clock Class from the drop down box. The selected class will appear in the announce messages from Grand Master.

Click the OK button to configure the Grand Master.

The Grand Master window shows configuration settings and details of the Slaves that are connected:



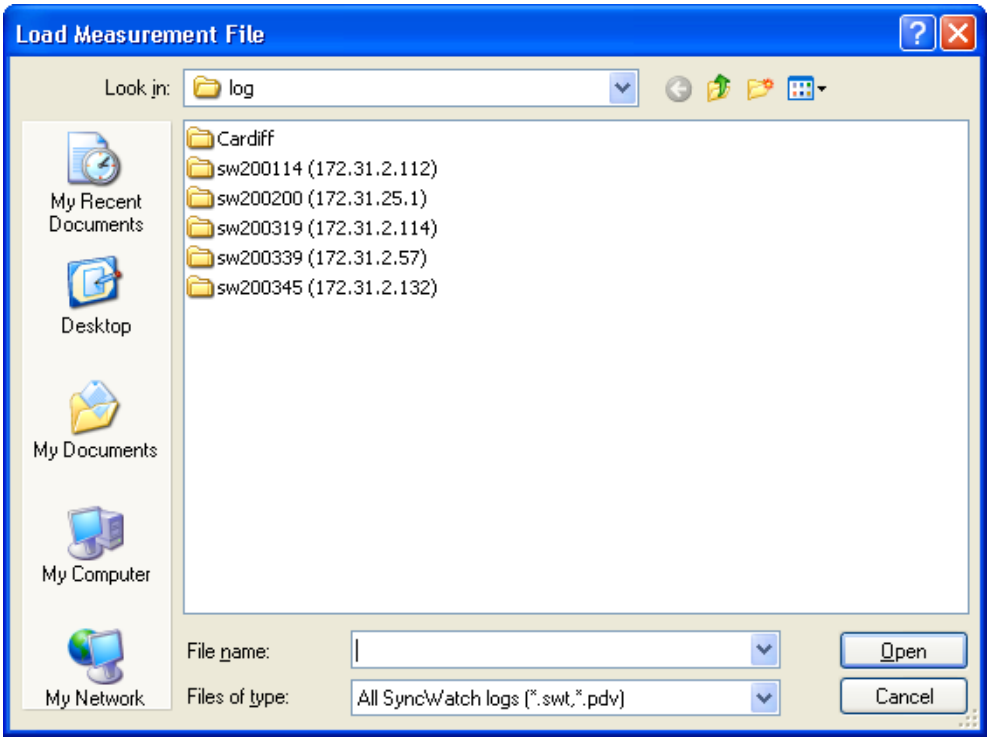
If the Grand Master configuration is set to Ethernet/ Multicast, information on connected Slaves will not be displayed. PTP systems can use proprietary techniques to create a list of Slaves when in the multicast mode by examining the received PTP delay request messages, if present. This is not a reliable technique and for that reason has not been implemented in the SMART software.

To stop the Grand Master generating packet messages, reconfigure the PTP module as a Slave.

Load measurements

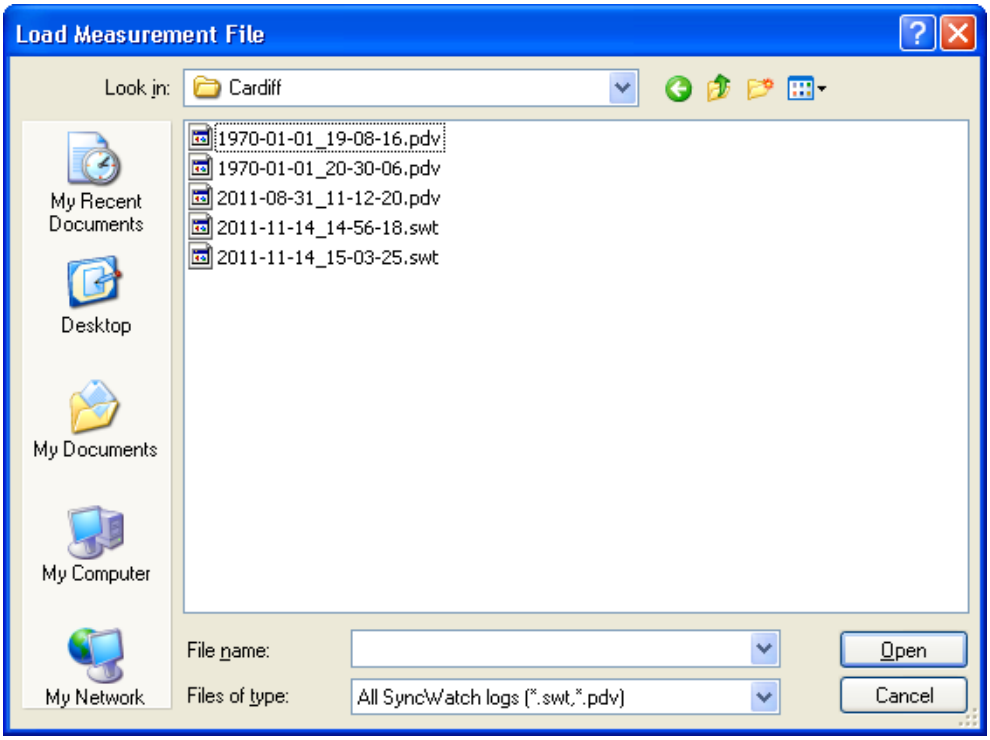
Load data from file

Previously captured frequency and packet measurement files (created by using “Enable logging”), can be reloaded for viewing and analysis.



The picture above shows the SyncWatch log folder that contains folders for the measurements taken by each probe (or session). The folder named “Cardiff” takes its name from the naming defined in “Session” field.

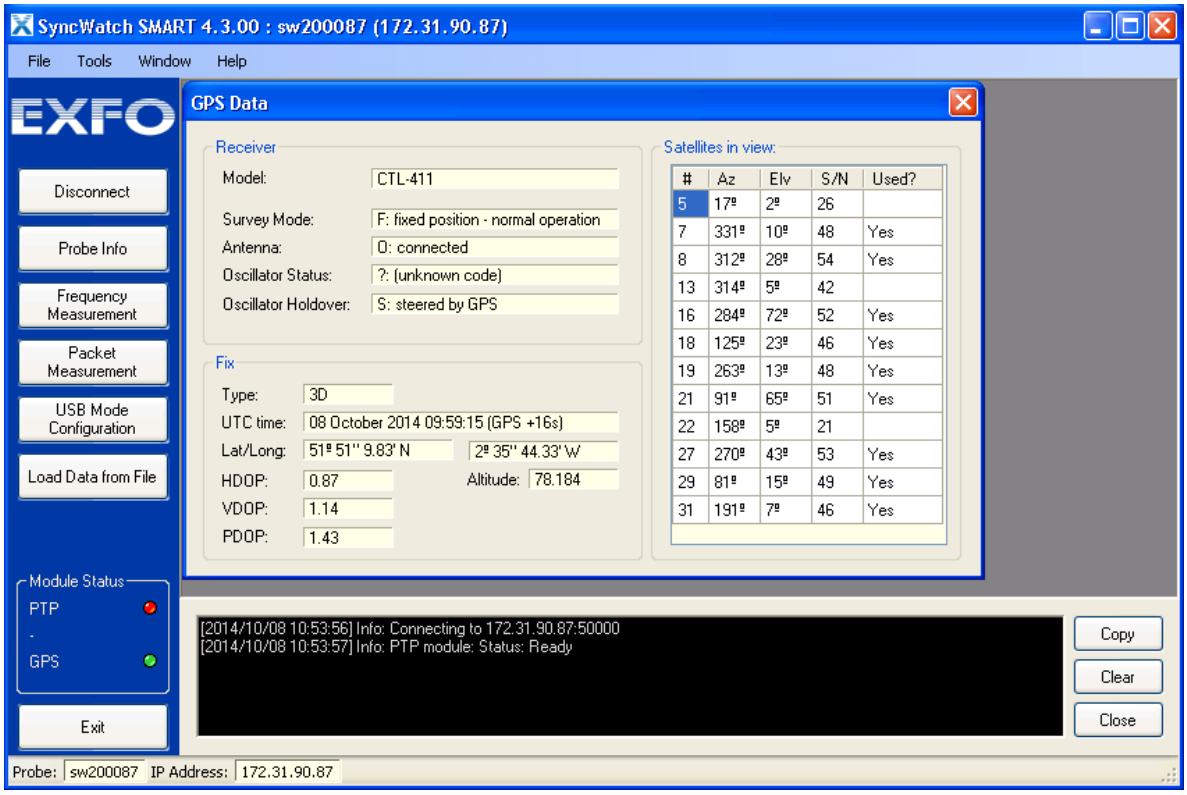
The picture below shows the contents of a measurement folder.



Module Status

GPS status check

Click the GPS/Rb window LED in the Module Status box. The GPS signal status information will be displayed. A correct GPS signal will show '3D' in the Fix Type, refer to section 6 for additional information.

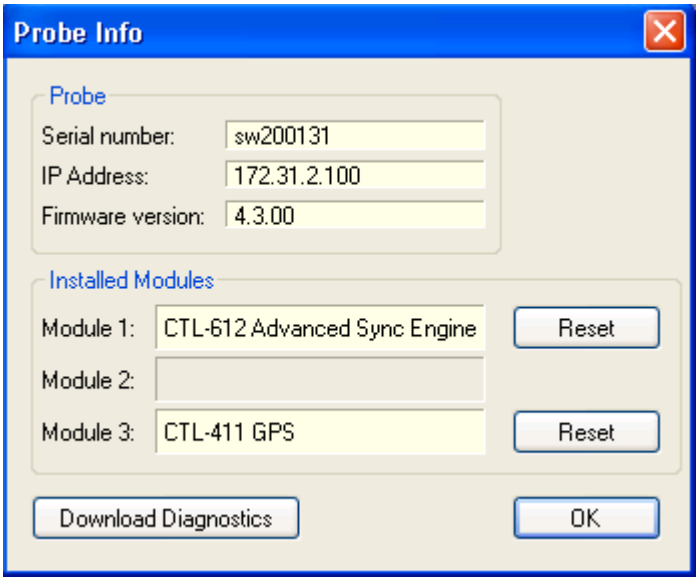


The GPS Module Status window can also be accessed by selecting Show GPS data from the Tools option on the top menu bar.

Module Reset

Probe Informatation

Click on the **Probe Info** button on the left-hand menu bar, the following screen will appear:



Click on the **Reset** button of the module that needs to be reset. A warning message will be displayed if a measurement is in progress. Select **Yes** to stop the measurement and reset the module.

10. Managed mode – operation

The SyncWatch Managed system is able to work in isolation of any other Networks Management Systems (NMS) / Operational Support Systems (OSS) system in an operational network. SyncWatch is however designed to be able to be integrated in to operators' existing management environment delivering highly valuable sync performance data right into the core of the business.

SyncWatch SNMP interfaces and the ability to launch specific GUI pages of the SyncWatch system from other NMS or OSS enable the integration operations teams require. Synchronization alarms, events and performance information, are directly available within the backend systems and at the fingertips of operations staff.

The operators' NMS / OSS systems typically provide the correlation between the alarms / events reported by SyncWatch, SSU's and Grandmaster clocks and the network elements. Results of the correlation are often visualized in NMS systems allowing Network Operations staff to rapidly identify synchronization performance degradation or failures, often before they affect service.

Contact your SyncWatch distributor for further information on SyncWatch integration with NMS & OSS systems.

In Managed mode, SyncWatch is a scalable solution for continuously monitoring the performance of a synchronization network from a central point without the need for site visits. This mode is ideal for permanent, integrated performance monitoring as part of existing network operational procedures.

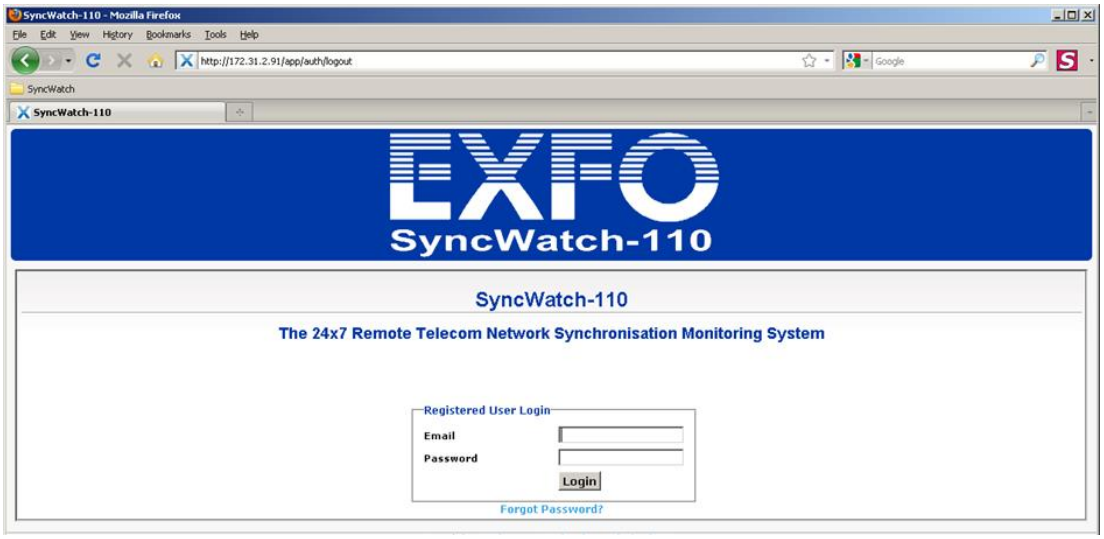
This section details how to setup and begin to use SyncWatch in Managed mode.

Starting a user session

Using a web browser such as Internet Explorer or Mozilla Firefox, enter the NetSMART URL or IP address.

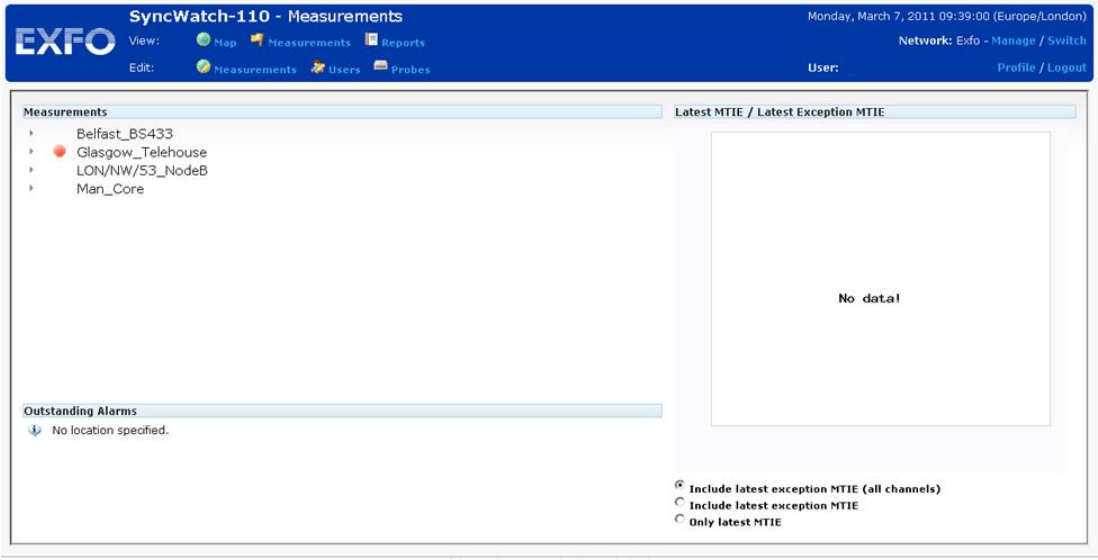
The user will then be presented with a login screen.

Enter a valid email address and password to proceed.



The SyncWatch administrator can supply the IP address/URL of NetSMART and manage user accounts.

After login the following Measurements screen will appear showing a list of all the current measurement profiles on NetSMART:



If the user has access to more than one network, the following 'Networks' screen will appear:

Click on the required network from the list to navigate to the Measurements screen.

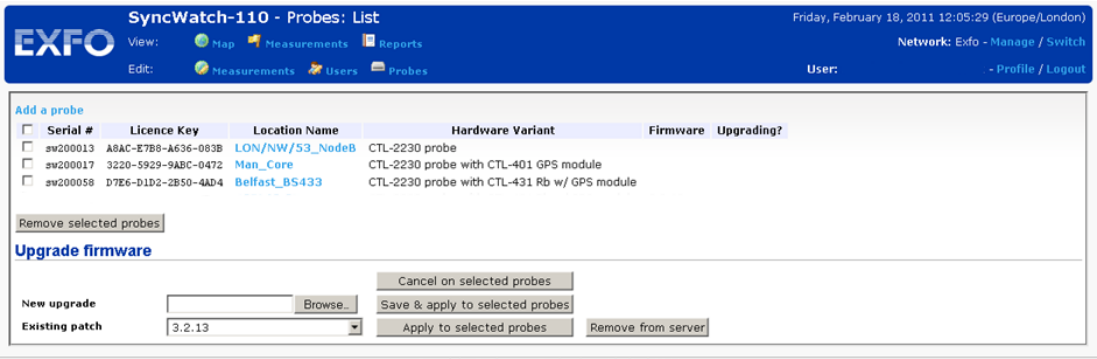
Probes

It is assumed that the probe has already been configured to operate in Managed mode as described in section 7.

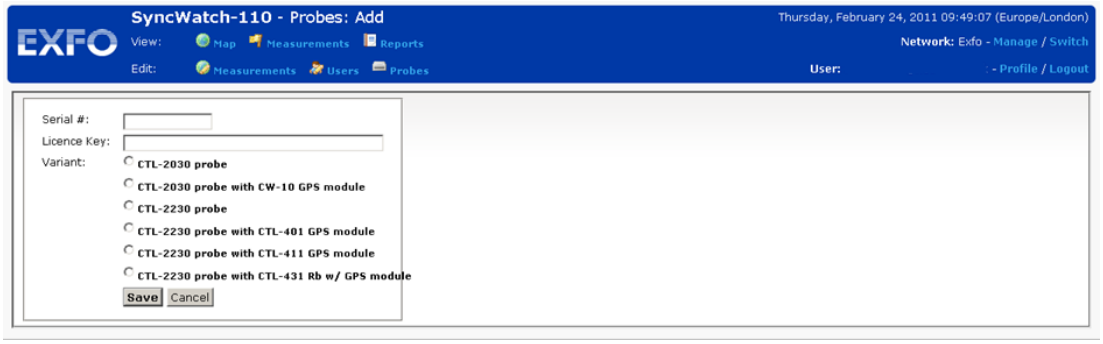
Add a probe

Click on the **Probes** button located on the top navigation bar.

The following screen will appear showing a list of all the probes currently on NetSMART:



Click on the **Add a probe** link on the top left corner and the following screen will appear:



Enter the *serial number*, *license key* and *hardware variant* of the probe and then click the **Save** button.

Details of the newly added probe can be seen on the list.

Serial number, license key and hardware variant information can be obtained from your SyncWatch distributor. The serial number is also printed on the probe starting with swXXXXXX, where X is a decimal digit. The hardware variant information can also be obtained from the Hardware Configuration menu as described in section 7).

Remove a probe

1. Click on the **Probe** button located on the top navigation bar.
2. From the probes list use the checkbox to select the probe(s) to be removed.
3. Click the Remove selected probes button.

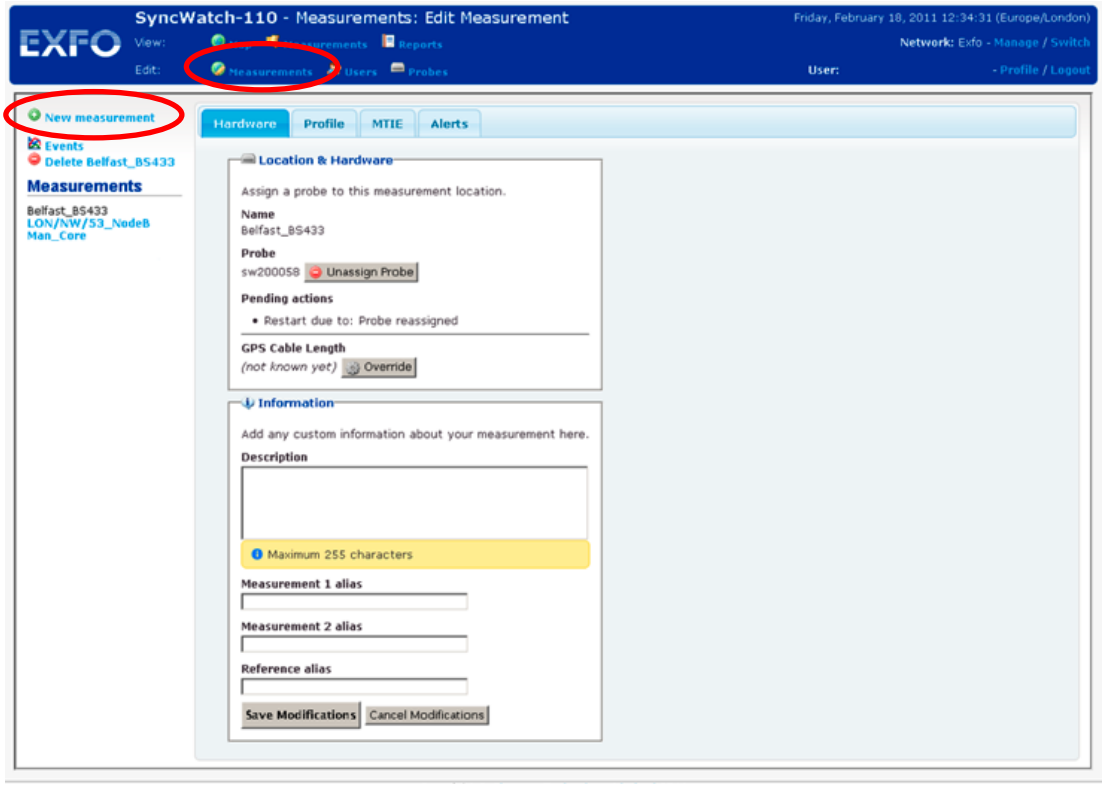
Measurement profiles

The term *Measurement* refers to a configuration profile that can be allocated to a SyncWatch probe.

Configure a measurement profile

Click on the **Edit: Measurements** button on the navigation bar.

The following screen will appear:



Click on the **New measurement** link in the top left corner.

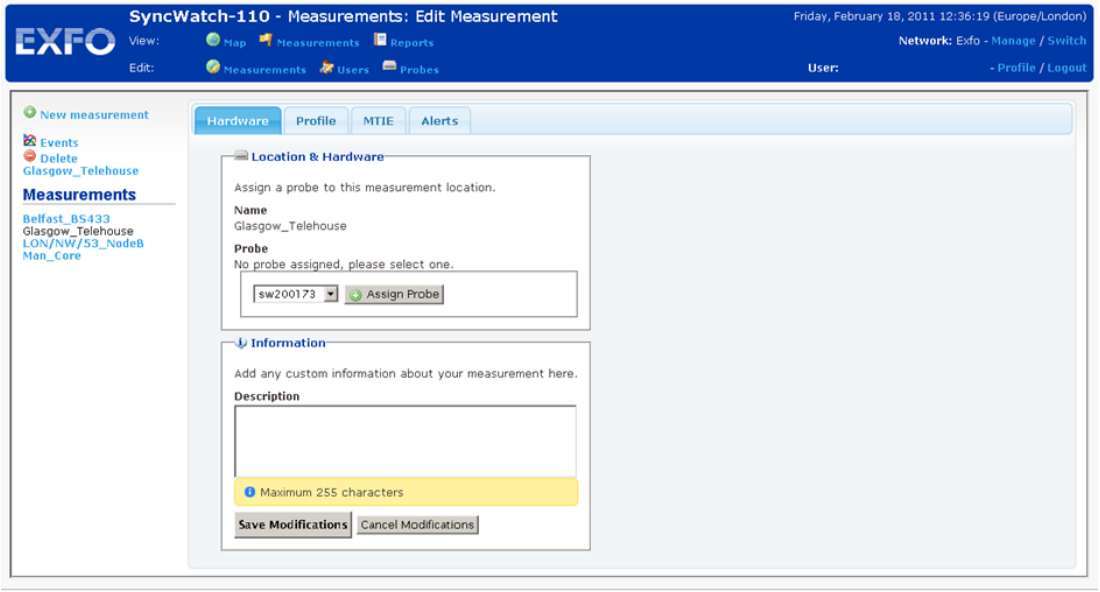
The following screen will appear:

Enter the name of the new measurement profile and click the **Add** button.

The newly added measurement profile can now be seen in the left-hand list.

Click on this measurement profile.

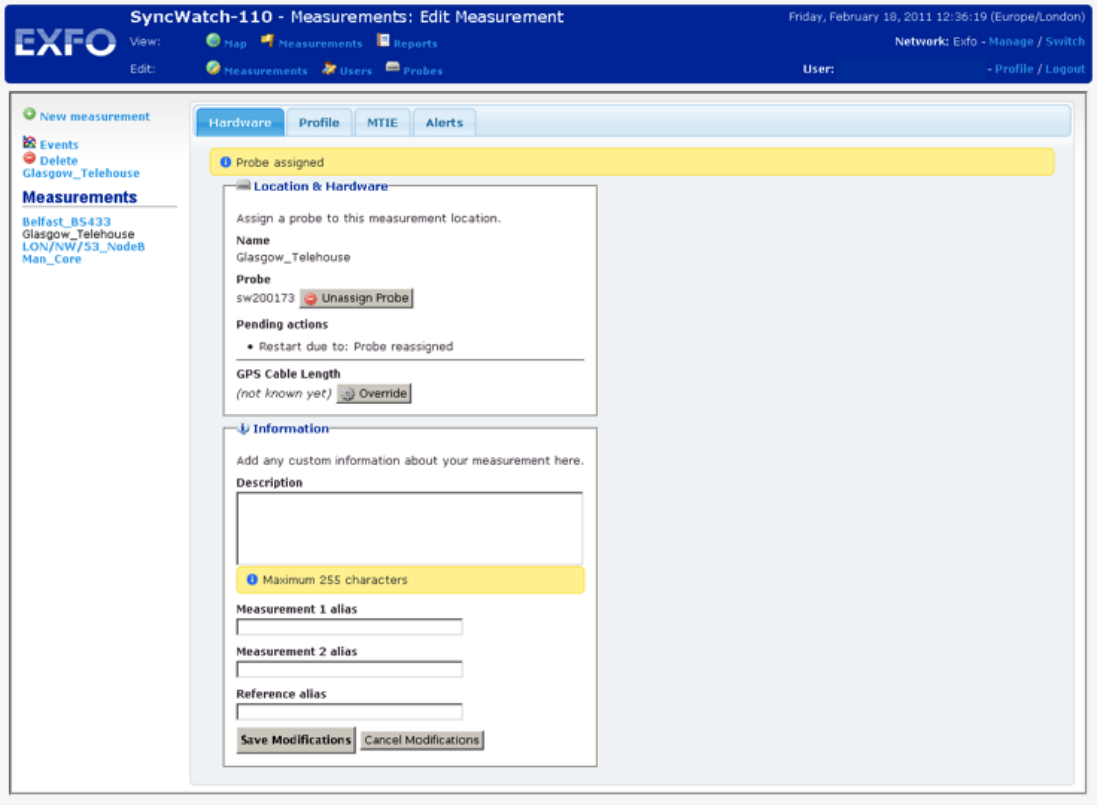
The following screen will appear:



Use the drop down menu to select the required probe from the available list.

Click the **Assign Probe** button.

The following screen will appear:

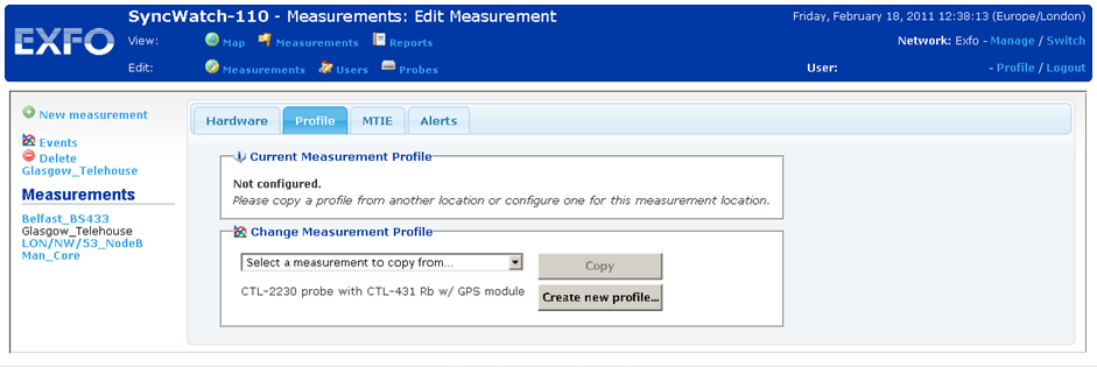


The GPS cable delay can be entered in nanoseconds to compensate for timing delays through the GPS cable.

The Information dialogue box can be used to add any custom free-text information about the measurement profile. This is a useful place to detail the equipment connected to the external interfaces.

Click on the **Profile** tab.

The following screen will appear:



The **Profile** tab shows the current settings of the measurement and reference inputs. A new profile can be created manually or copied from an existing profile.

Copying an existing measurement profile

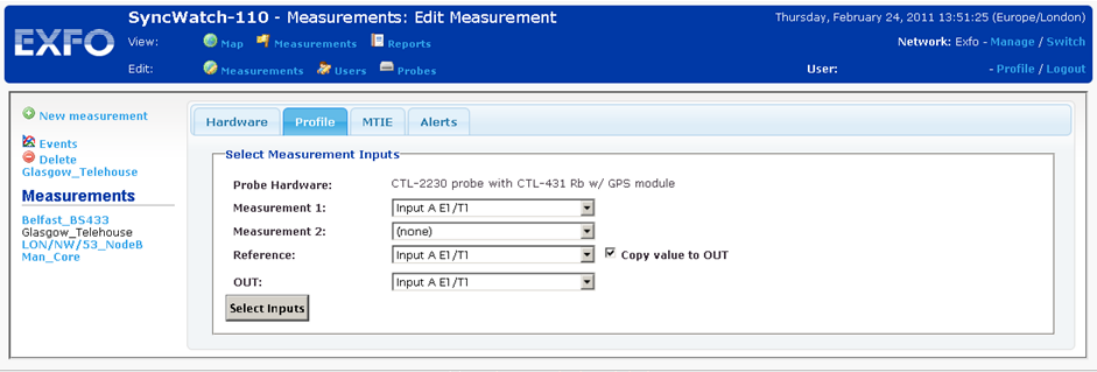
To copy an existing profile, use the drop-down menu to select an existing Measurement profile on the server.

Click the **Copy** button.

Manual configuration of a measurement profile

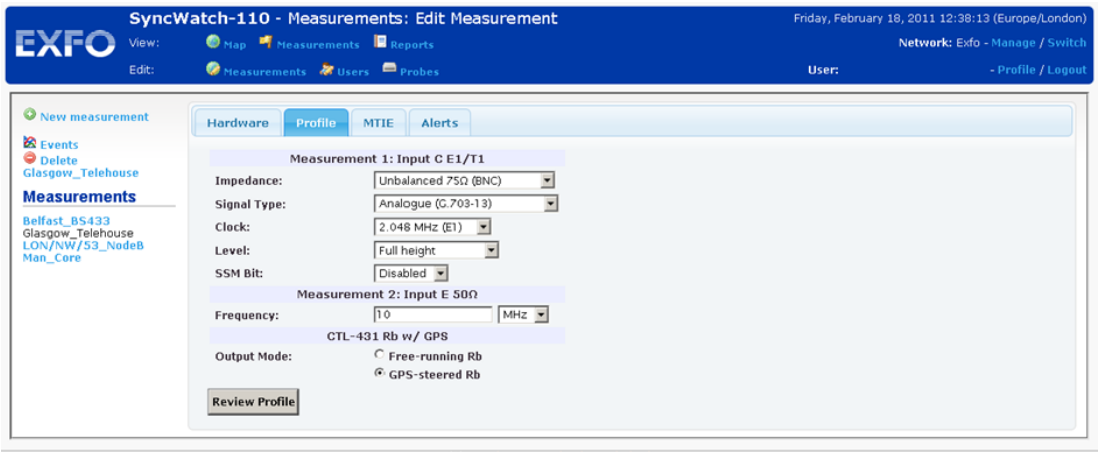
To manually create a new Measurement profile click on the **Create new profile** button.

The following screen will appear:



Use the drop-down menus to select the required measurement and reference inputs and then click on the **Select Inputs** button.

The following screen will appear:



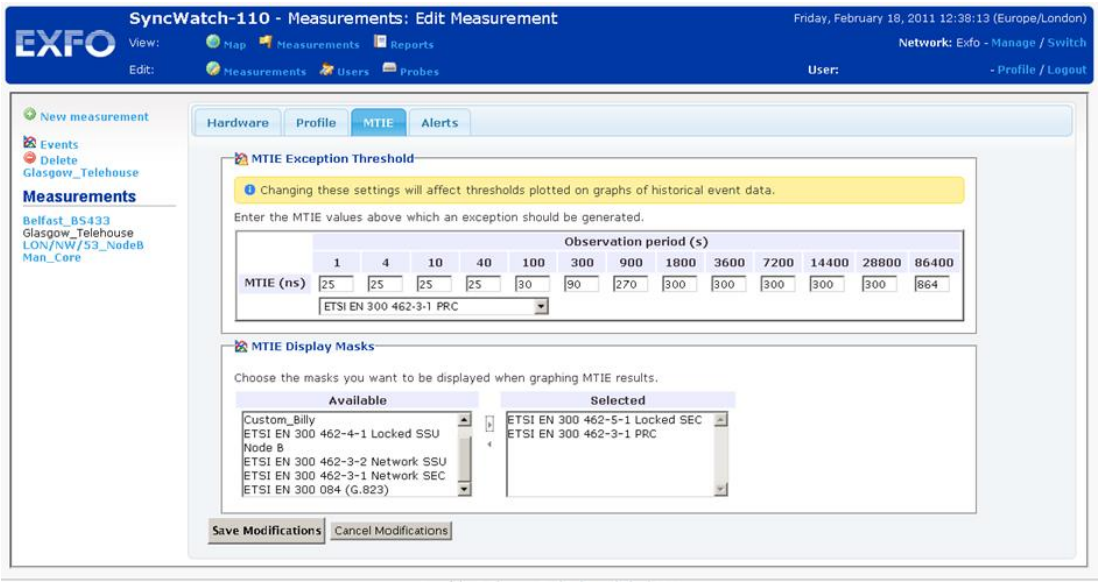
Further details of each input must be entered on this screen. The options available will be dependent on the input type chosen.

Click on the **Review Profile** button to view the profile settings.

Click on the **Submit Changes** button to execute these setting.

The current version of the SyncWatch probe does not support the SSM Bits feature on the E1/T1 inputs.

Click on the **MTIE** tab, the following screen will appear:



MTIE exception threshold

MTIE Exception Threshold is the limit above which a probe will generate an MTIE exception (alarm event) if the measured MTIE exceeds any point of the mask. Lower thresholds will usually result in more regular exceptions.

The threshold values may be entered manually or by using a drop-down box to copy a predefined or industry standard MTIE mask.

Click the **Save Modifications** button to execute this setting.

A valid MTIE mask must always increase numerically for increasing observation intervals; the mask input fields make sure that the mask entered is valid by cascading through all following/preceding fields if a value you enter renders the mask invalid.

MTIE display masks

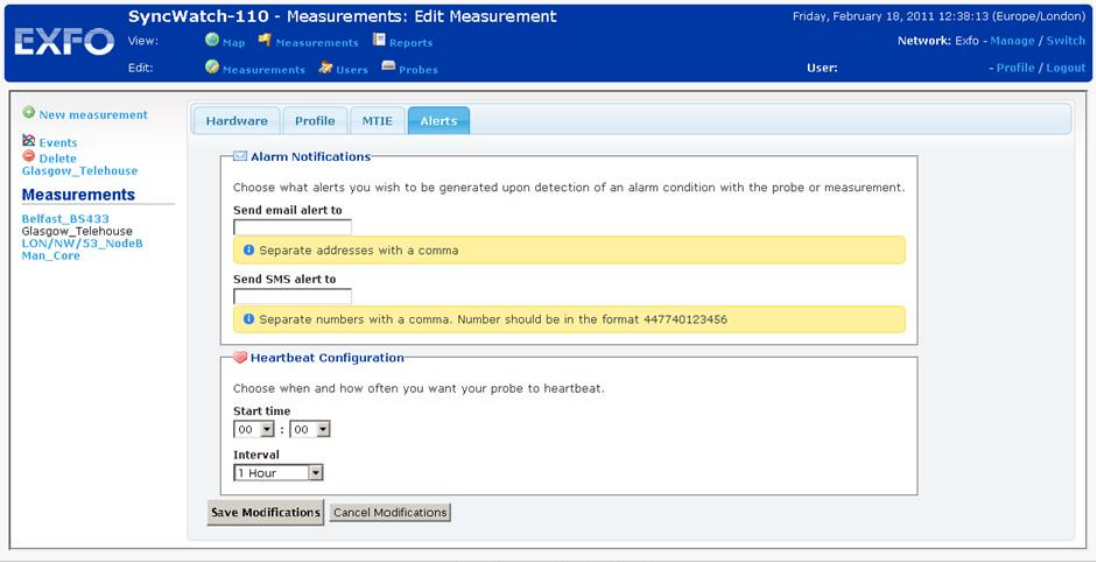
MTIE masks can be selected for display on all MTIE graphs. How to view the MTIE graphs is discussed later in this section. The left box displays the available masks that are not currently selected; the right box displays those that are selected for display.

Select the mask with the mouse and click the move left ◂ or move right ▸ icon or double-click on it. (Multiple masks can be selected by clicking on each mask while holding the shift key).

Click the **Save Modifications** button to execute these setting.

Click on the **Alerts** tab.

The following screen will appear:



Alarm notification

NetSMART can send email and SMS alerts every time an alarm event is generated by the SyncWatch probe. Enter email addresses and phone numbers to be alerted in the relevant boxes. Multiple email addresses must be separated by commas. Multiple phone numbers must be separated by commas.

Phone numbers must be formatted similar to the international call format, in the following format:

(country code)(network prefix)(number).

There must be no leading zeros or plus sign (+), and there must be no spaces in the number. For example, the UK number (+44) 0848 9123 456 must be entered as ‘448489123456’.

Heartbeat configuration

Specifies the time and interval at which Heartbeats are to be generated by the probe.

The probes communicate to the server when there has been an exception or fault, and at a regular interval dictated by the **Heartbeat** interval settings. The **Heartbeat** enables any communications problems or probe failure to be detected quickly, and also provides regular MTIE data for viewing.

The **Start time** is the time the Heartbeat cycle starts. It is recommended that probes are given staggered start times to prevent all locations from generating Heartbeats simultaneously. The **Start time** is based on the server time without the application of a network's UTC offset.

All configuration changes made to the SyncWatch probe will only be executed after the next Heartbeat, this includes firmware upgrades, input configuration, change of Heartbeat interval, request for TIE phase data etc.

Delete a measurement profile

Click on the **Edit: Measurement** button on the navigation bar. From the left-hand column click the Measurement profile to be deleted. Click on the Delete link in the top left corner.

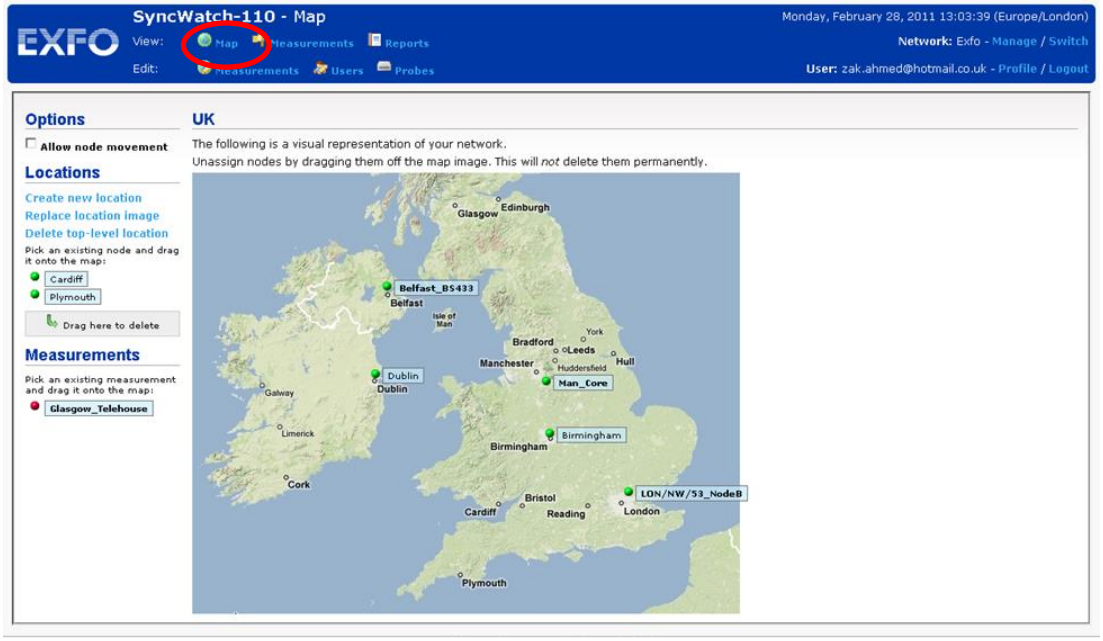
Deleting Measurements will also delete all the historic event data.

Location maps

The position of each SyncWatch probe can be viewed on a Location map. Sub-level maps can be created within a map.

To view a map:

Click on the **Map** button located on the navigation bar.



The example above shows a map with probes and Location icons on it. Each Location icon indicates the presence of a sub-level map. The left-hand column shows a list of all the available Locations and probes that can be placed on to the map. Details of how to create and manage Location are described later in this section.

The way to differentiate between a probe and a Location icon is that a probe icon has bold text and a Location icon has un-bolded text e.g. *Birmingham* is a Location and *Belfast_BS433* is a probe.

The colored circle against each probe indicates the alarm status of that probe and clicking on the colored circle will display the events screen of that probe.

The colored circle against each Location indicates the worst-case alarm status of the probes within the sub-level map and clicking on the colored circle will display the sub-level map.

More information on how to view alarm events is detailed later in this section.

Create a location map

Click on the **Map** button located on the navigation bar. (If there isn't already a map created then there will be a prompt to create a 'top-level' map).

Enter the name of the map and click the **Browse** button to select a suitable .gif or .jpeg file.

Click the **Create** button to load this map.

To create a new Location map, click on the **Create new location** link in the left-hand column.

Enter the name of the Location and click the **Browse** button to select a suitable .gif or .jpeg file.

Click the **Create** button to load this map. (This new Location will be added to the left-hand list).

To place this Location icon on to a map tick the **Allow node movement** checkbox.

Navigate to the required map, this might be the top-level map or a sub-level map, and then drag and drop the Location icon to the required position on the map.

Replace a location map

Click on the **Map** button located on the navigation bar.

Navigate to the map to be replaced and click on the **Replace location image** link in the left-hand column and then click the **Browse** button to select a suitable .gif or .jpeg file.

Click the **Upload** button to load new map image.

Delete a location map

Click on the **Map** button located on the navigation bar.

If the Location icon is in the left-hand list, drag and drop this location icon into the **Drag here to delete** box in the left-hand column and click the **OK** button to confirm.

If the location icon is positioned on a map, navigate to that map.

Tick the **Allow node movement** checkbox in the left-hand column.

Drag and drop the location icon anywhere outside the map, click the **OK** button to confirm and it will appear in the left-hand list.

Drag and drop this Location icon into the **Drag here to delete** box in the left-hand column and click the **OK** button to confirm.

Move probe

Click on the **Map** button located on the navigation bar.

Navigate to the map showing the probe to be moved.

Tick the **Allow node movement** checkbox.

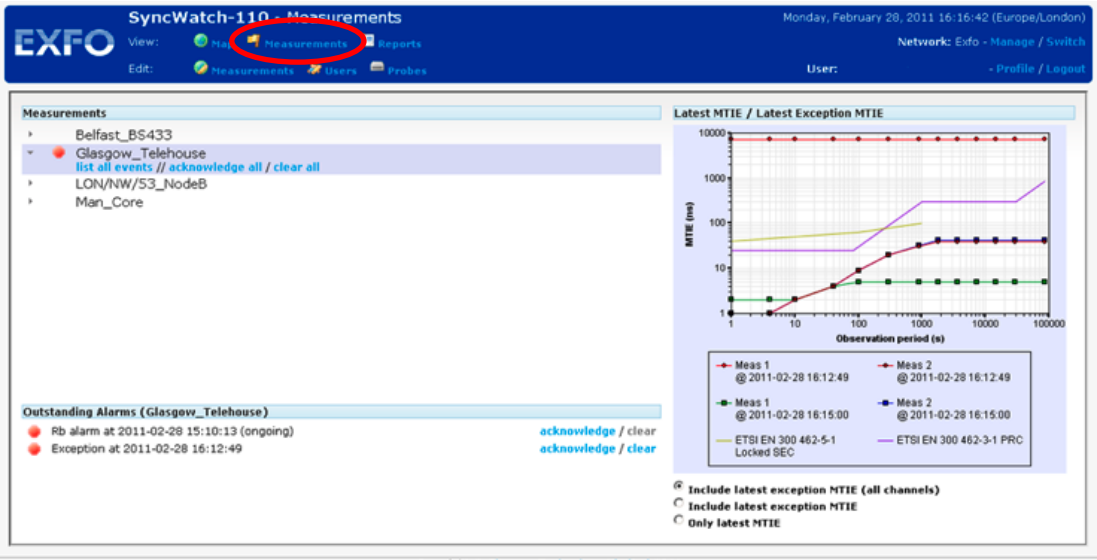
Drag and drop the probe anywhere on the map or between the map and the left-hand column. Any probe listed in the left-hand column, can be dragged and dropped on to the map.

Measurements plots

View MTIE plots

Click on the **View: Measurement** button located on the top navigation bar.

The following 'Measurements' screen will appear:



This screen shows a list of all the Measurement profiles on NetSMART.

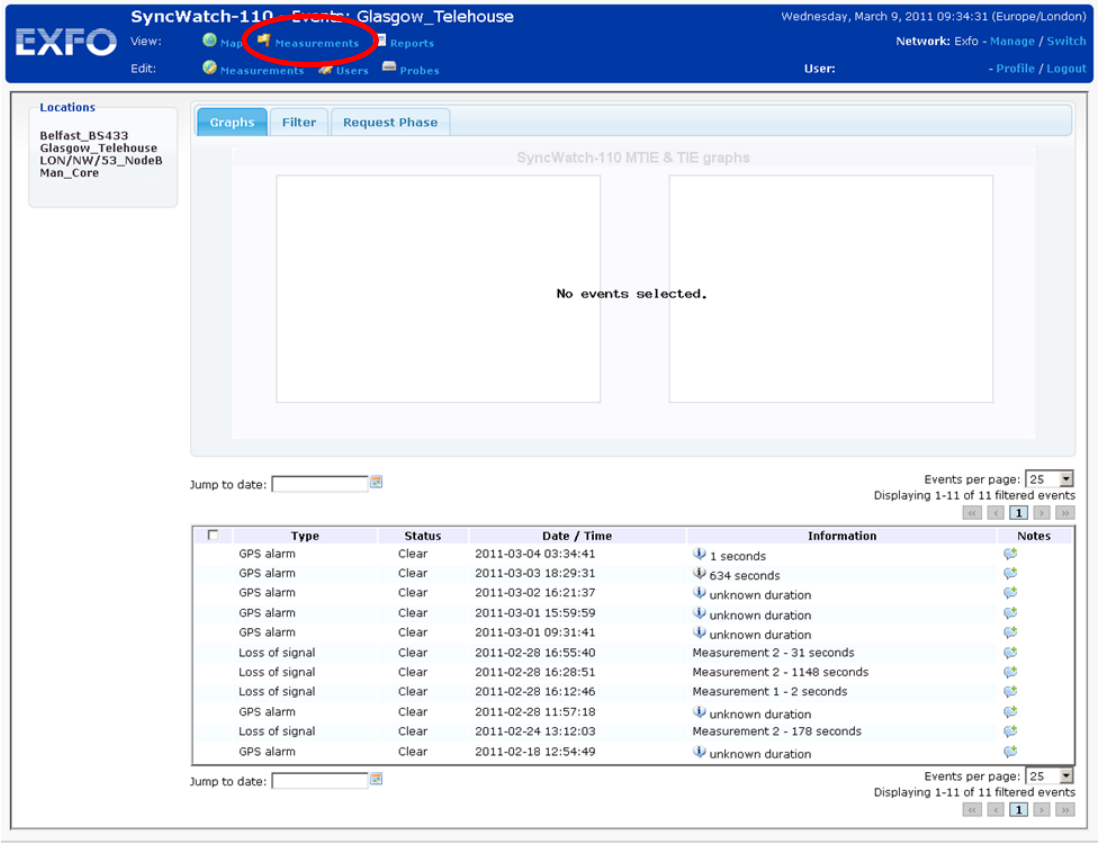
Click on the required **Measurement profile** to view the latest 24 hour MTIE plot at the last probe Heartbeat. Use the checkbox to view this MTIE plot with or without with the MTIE value recorded at the last exception.

After an exception the MTIE plot will reset to 0s phase, this is so that any following exception within 24 hours with a smaller MTIE value can still be viewed or else it would be superseded by the previous larger MTIE exception value.

View historical MTIE plots

Click on the **View: Measurement** button located on the top navigation bar. Select the required **Measurement profile** from the list and then click the **List all events** link below it.

The following 'Events' screen will appear:



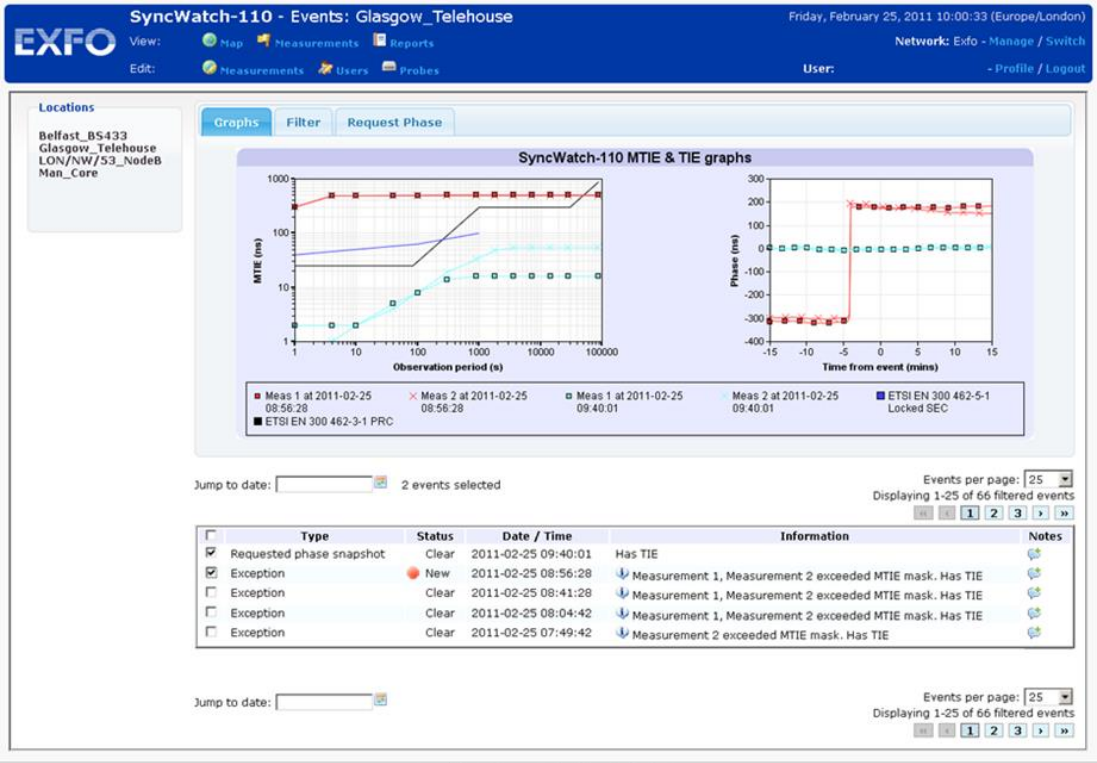
This screen shows a list of all the alarm events and Heartbeats.

Tick a **Heartbeat** checkbox to view the last 24 hour MTIE plot at that time.

If there is an exception, tick the **Exception event** checkbox to view the last 24 hour MTIE and TIE plot at that time.

To view multiple MTIE plots simultaneously:

Select multiple **Heartbeat** and **Exception** checkboxes as shown below:

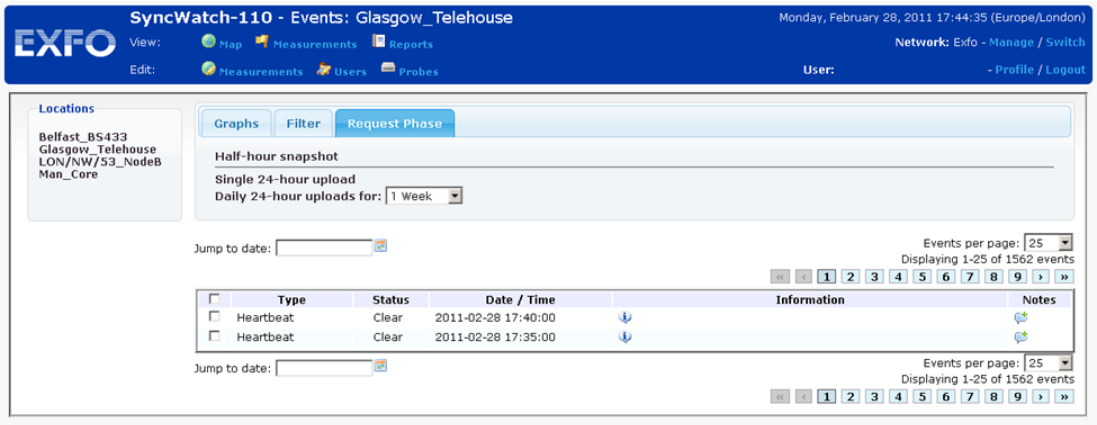


View TIE plots

Tick the checkbox of any **Exception event** to view 24 hour TIE plots. The TIE plot will be based on the time the exception was generated.

Click on the **Request Phase** tab on the Events screen to manually request TIE data.

The following screen will appear:



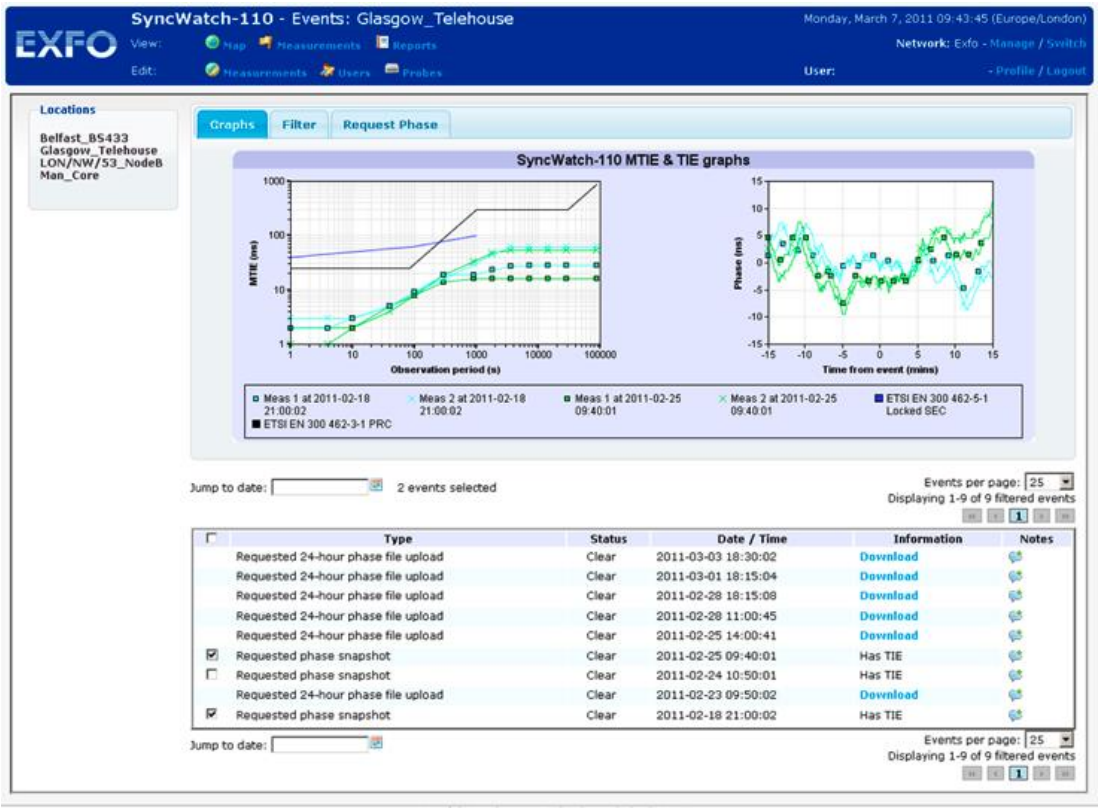
Three options are available:

Half-hour snapshot: Click this link to request 30 mins of TIE data. The data will take 15mins to be generated; this is so that there is 15mins of TIE data before and after the time the data was requested. At the next probe Heartbeat a 'Requested phase snapshot' event will be generated in the events list, tick the checkbox to view this 30mins of TIE data.

Single 24-hour uploads: Click this link to request the last 24 hours of TIE data. This data will be available to download at the next probe Heartbeat. Once this data is available a 'Requested 24-hour phase file upload' event will be generated with a 'Download' link. Save the data file to PC for post processing using the SyncWatch SMART software.

Daily 24-hour uploads: Click this link to request daily 24 hour TIE data for the number of weeks selected. The first 24 hour TIE data will be available to download at the next Heartbeat after which a new 24 hour TIE data will be available to download at the same time every day. A 'Requested 24-hour phase file upload' event with a 'Download' link will be generated when the TIE data becomes available. Save the data file to PC for post processing using the SyncWatch SMART software.

The following screen shows how 'Requested phase snapshot' and 'Requested 24-hour phase file upload' events are listed:

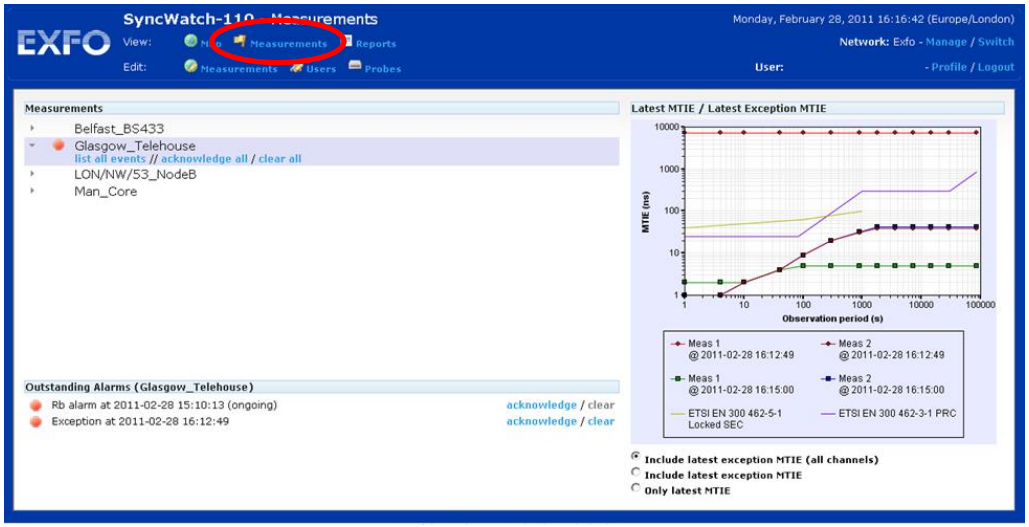


For more information on how to load and analyze TIE data files on SyncWatch SMART see section 9.

Alarm and event

View alarms

To view outstanding alarms on any probe, click on the **View: Measurement** button located on the top navigation bar. The following Measurements screen will appear:



This screen shows a list of all the Measurement profiles on NetSMART.

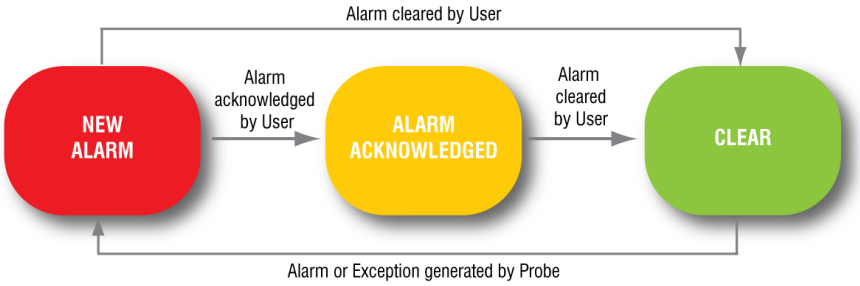
Click on the required **Measurement profile** to view the outstanding alarms. The alarms can be acknowledged or cleared (where user privileges allow) from this screen.

Alarm states:

OK	There are no alarm conditions, or all such alarms have been cleared by the operator.
Acknowledged	All alarms have been acknowledged by the operator but some have not yet been cleared.
New alarm(s)	This is the status given to new alarms and existing alarms.

Current alarms cannot be cleared, they can only be acknowledged.

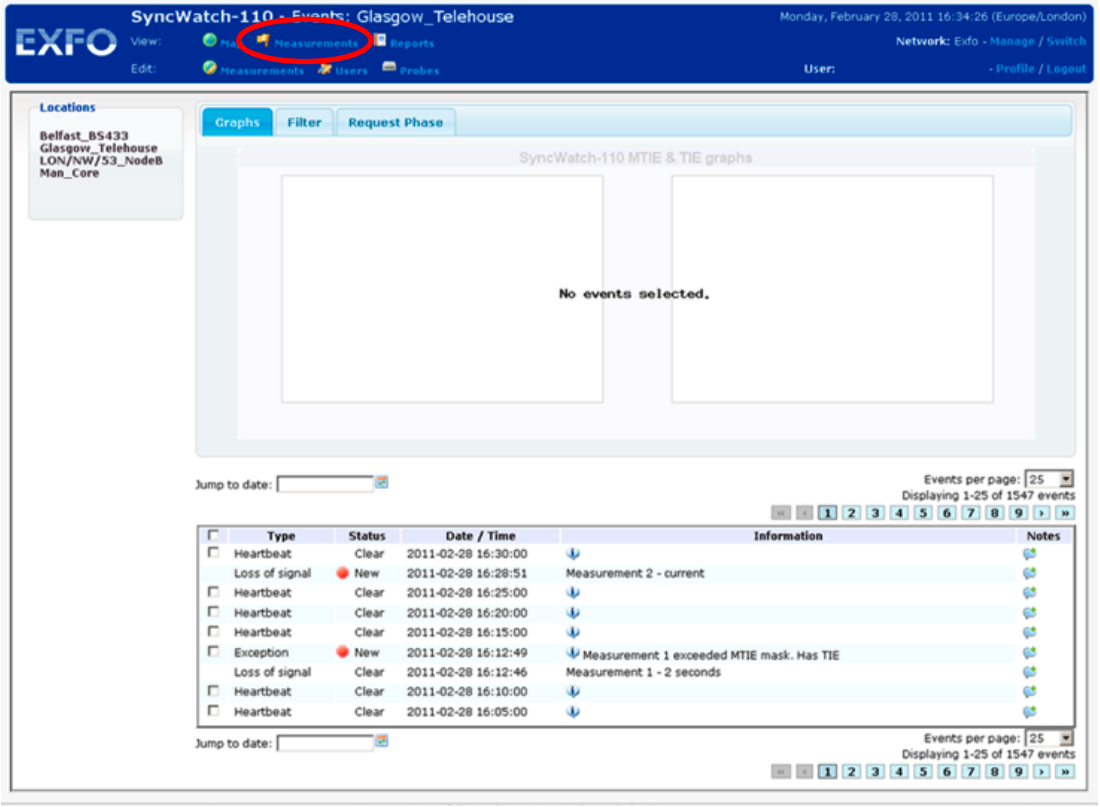
The diagram below shows the relationship between each alarm state:



View historical alarms

1. Click on the **View: Measurement** button located on the top navigation bar.
2. Select the required **Measurement profile** from the list and then click the **List all events** link below it.

The following Events screen will appear:

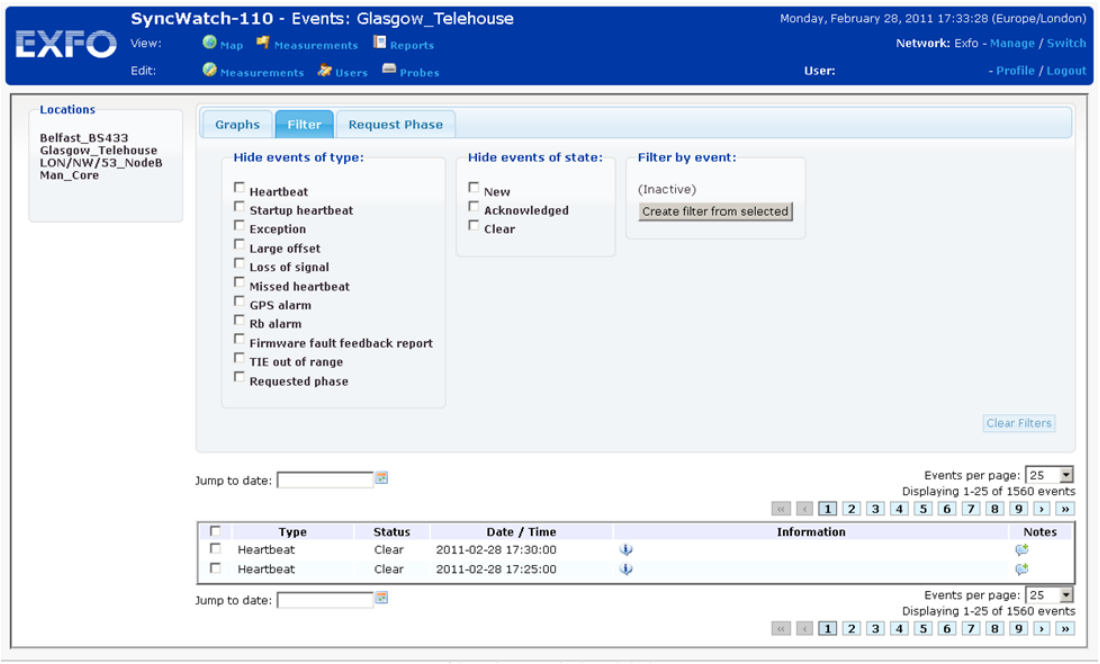


Click the **Notes** icon to manually add notes to each alarm and event.

Filter alarms

Click the **Filter** tab.

The following screen will appear:



Tick the **Alarm** and **Event** types to be hidden from the list.

Alarm and event types

The table below describes all the different types of alarms and events that can be generated by the SyncWatch probe:

Event Type	Description
Heartbeat	Heartbeats are events sent by a probe at regular intervals as configured in the location's personality to inform NetSMART that it is still online and operational.
Startup Heartbeat	A probe sends this event to the network when it is powered up to record the time the measurement started and to retrieve its personality.
Exception	This occurs when the MTIE calculated by a probe exceeds the configured threshold mask. No more exception events can be generated for the 15 minutes following an exception; this is to prevent flooding.
Large offset	A probe generates this event if it detects a large frequency offset (≥ 12.5ppm) between the Measured and the reference signals.
Loss of signal	A probe generates this event if it detects a loss of signal on a used input. If the condition has since been cleared the duration is displayed. Current loss of signal conditions cannot be cleared manually.
Missed Heartbeat	This event is displayed if the probe fails to communicate with the Server.
GPS alarms	A probe generates this event if it detects the GPS Module has lost lock or if it determines that the GPS reference may be unreliable and that any exception may be as a result of this rather than the measured signal. ***Only applicable for SyncWatch probes with GPS options fitted.***
Firmware feedback fault report	This is a diagnostic report, created and then uploaded to the server if probe encounters a system error.
TIE out of range	This event is for 1PPS measurements. 1PPS measurements are not available in this release.
Requested 24-hour phase file upload	This event is generated as a result of the user requesting 24 hours of TIE data.

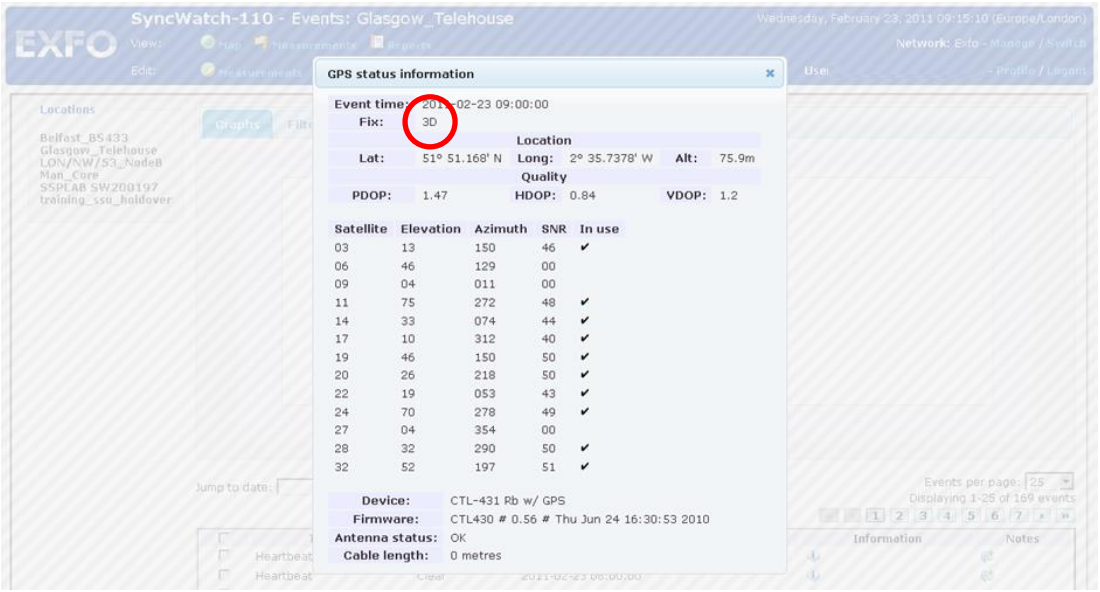
GPS status

To check the GPS status of a SyncWatch probe click on the **View: Measurement** button located on the top navigation bar.

Select the required Measurement profile from the list and then click the **List all events** link below it to navigate to the Events screen.

Click on the blue information icon of any Heartbeat or exception event to view the GPS status at that time.

The following screen will appear:



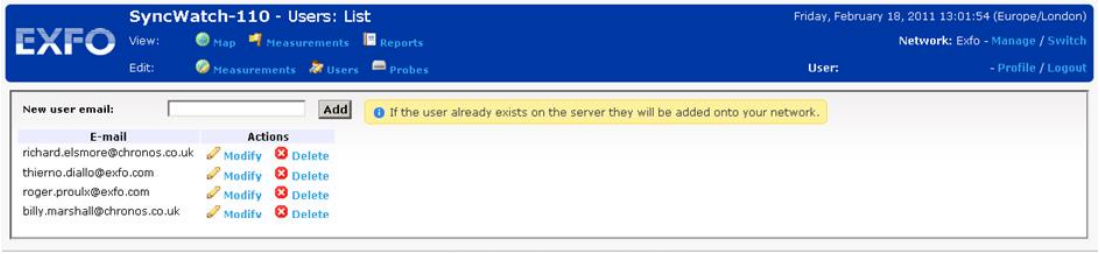
A correct GPS signal will show a '3D' fix value as shown in the red circle above. Any other value indicates a fault condition and a GPS alarm will be generated in the events list and there will also be a red LED on Module Status 3 on the front panel of the SyncWatch probe.

A SyncWatch probe without a GPS module will show a grey information icon in the events list.

User accounts

To manage user accounts click on the **Users** button located on the top navigation bar.

The following 'Users: List' screen will appear:



Create new account

To create a new user account on the server the administrator must enter the user's email address. This is what they will use to login with. It must be unique to the server.

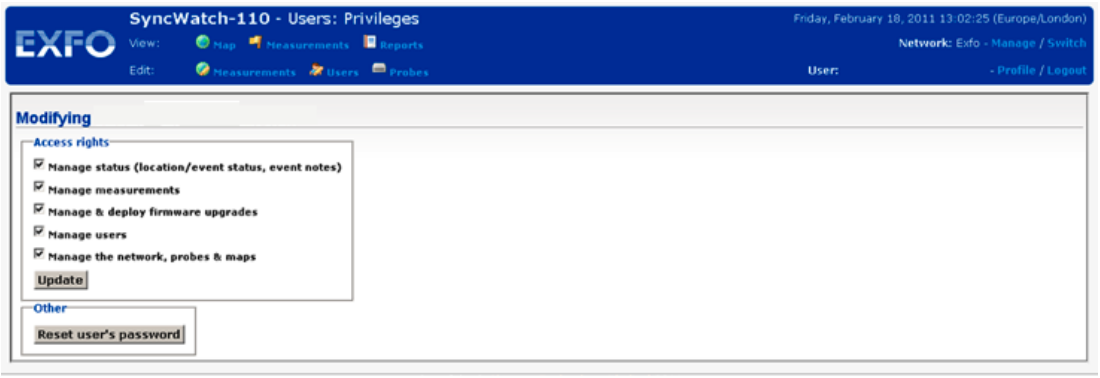
Enter new username in the **New user email** field and then click **Add**.

The user will receive an email with an automatically generated password with which to log into the server. When the user logs in for the first time, they will be prompted to create a new password.

Modify account

Click the **Modify** link next to the user's email address.

The following User: Privilege screen will appear:



This screen shows the current access rights the user has. The access rights can be modified by ticking and un-ticking the necessary privileges.

The table below gives a description of each privilege:

Privilege	Enabled Features
Manage Status	Acknowledge and clear alarms for locations and events Add event notes
Manage Measurements	Add, modify and delete measurements Configure MTIE exception threshold mask and select MTIE display masks Configuration for SMS and Email alerts Heartbeat configuration
Manage and deploy firmware upgrades	Flag probes for firmware upgrade
Manage Users	Add, modify and remove users.
Manage Network, Probes and Maps	Add /remove probes Change the time zone for display of local time Create custom MTIE masks Add map images and locations.

Delete account

To delete an account click on the **Users** button located on the top navigation bar to navigate to the Users: List screen and click the **Delete** link next to the user's email address.

Reset password

Only the administrator can reset the user's password

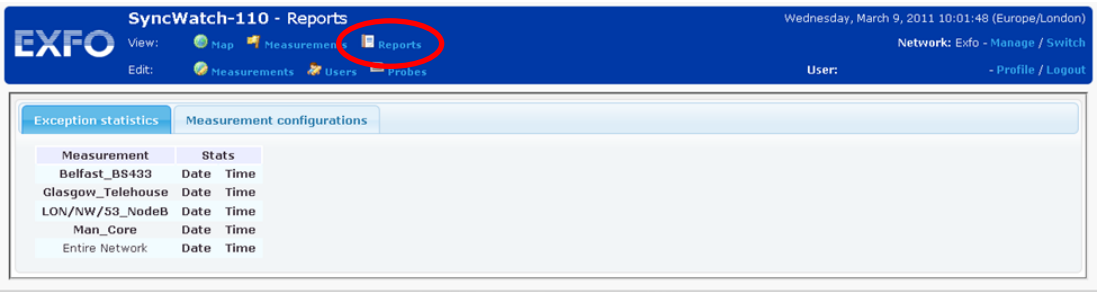
1. To reset a user's password click on the **Users** button located on the top navigation bar to navigate to the 'Users: List' screen.
2. Click the **Modify** link next to the user's email address to navigate to the 'User: Privilege' screen.
3. Click on the 'Reset user's password' button, the user will receive an email with an automatically generated password with which to log into the server. When the user logs in for the first time, they will be prompted to create a new password.

Measurement performance statistics

To view performance statistics for a Measurement:

Click on **Reports** button located on the top navigation bar.

The following 'Reports' screen will appear:

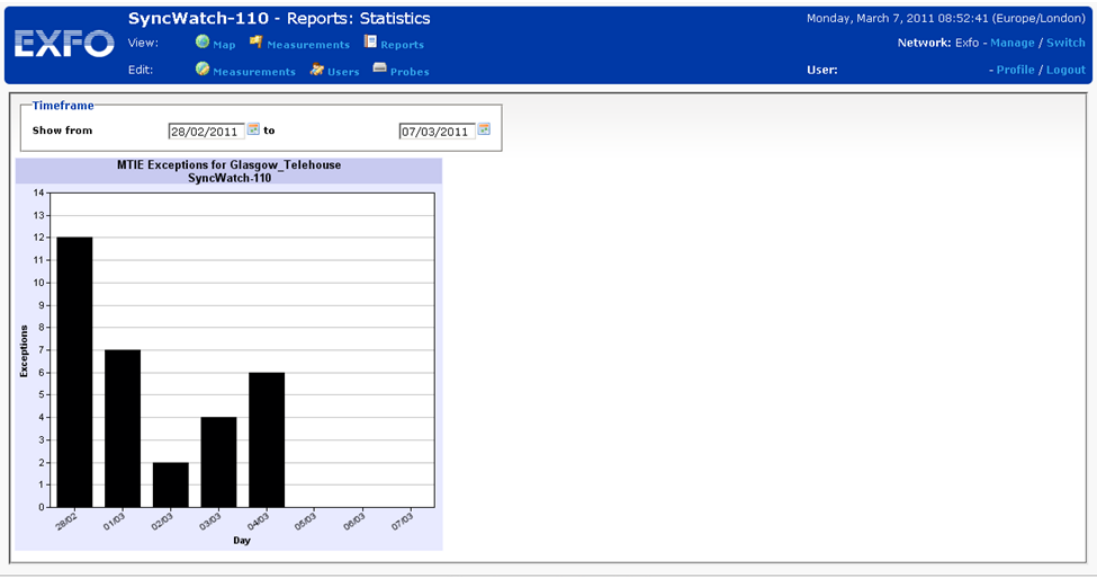


This screen shows a list of all the Measurement profiles. The performance statistics can be viewed individually for each Measurement or for the entire network.

By date

1. To view the performance statistics on a daily basis, click the **Date** link against the required Measurement or the Entire Network.

The following screen will appear:



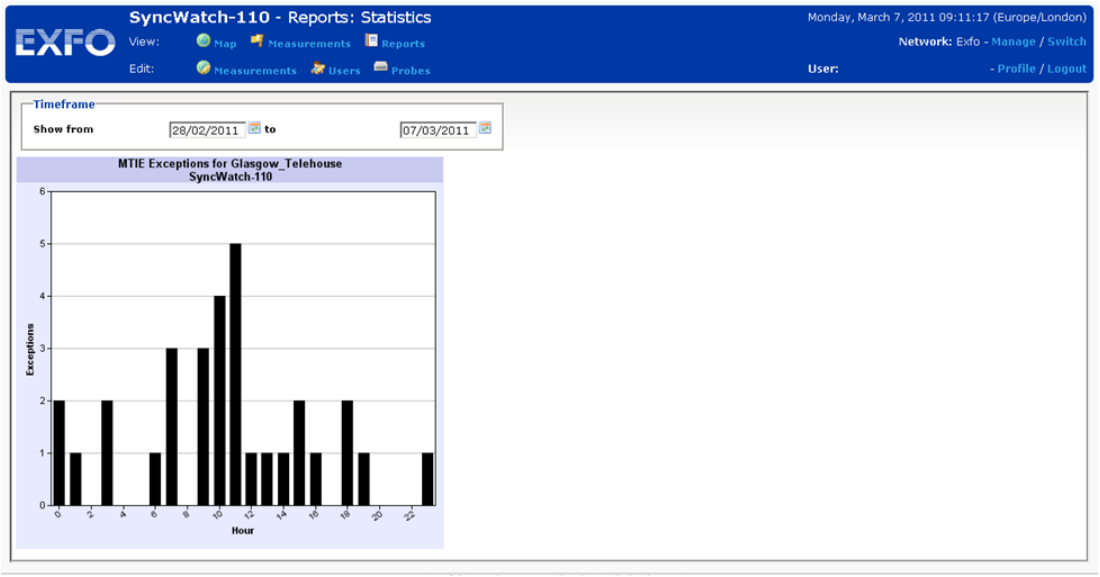
2. Choose the required **Start and End dates** using the calendar icons. The performance statistics graphs show the total number of exceptions on a daily basis.

By time

To view the performance statistics based on each hour of the day:

Click the **Time** link against the required Measurement or the Entire Network.

The following screen will appear:



Choose the required start and end dates using the 'calendar' icons. The performance statistics graph shows the total number of exceptions for each hour of the day. The horizontal axis shows each hour of the day e.g. 18 indicates 6:00pm - 6:59pm.

In the example graph above there were a total of five exceptions recorded between 11:00am – 11:59am from 28/02/2011 to 7/03/2011.

This type of graph can be used to highlight any events that occur regularly at a certain time of day, which may highlight problems caused by congestion on a packet network at certain peak times or by some regular maintenance activity.

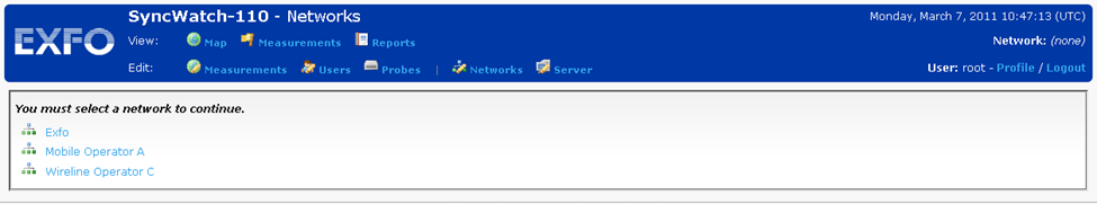
Networks

Multiple networks can be created on NetSMART. Each network will manage its own set of SyncWatch probes.

A probe can only be managed on one network at a time.

Create network

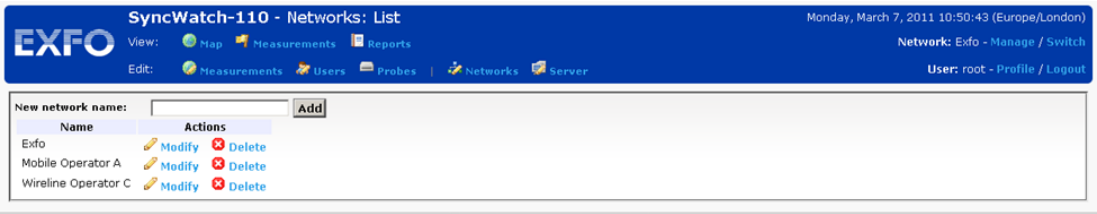
Only the SyncWatch administrator can create Networks on NetSMART. Once logged in as the SyncWatch administrator, the following screen will appear:



If there is only one Network on NetSMART, the Measurement screen will appear instead of the screen above

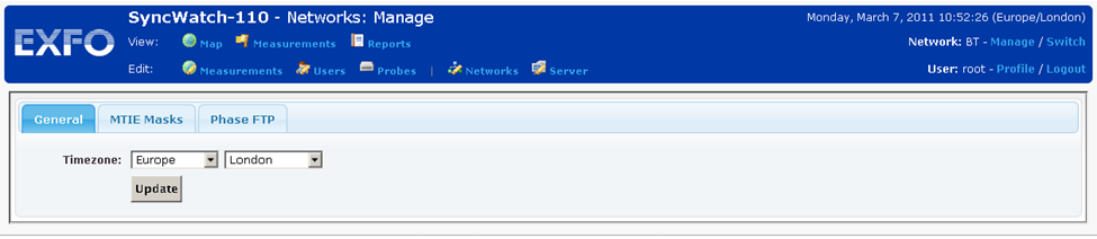
1. Click on the Networks button located on the top navigation bar.

The following 'Networks: List' screen will appear showing a list of all the existing Networks:



2. Type the name of the new network into the 'New network name' field and then click the **Add** button.

The following screen will appear:



3. Fill in the necessary details as described below.

Switch network

A user with access to multiple networks can switch between networks in the following way:

1. Click on the **Switch** link located on the right-hand side of the top navigation bar.

A screen showing a list of all the Networks will appear.

2. Click on the required Network.

Modify network

1. To modify the parameters of a Network, select the required network as described above.
2. Click on the **Manage** link located on the right-hand side of the top navigation bar.

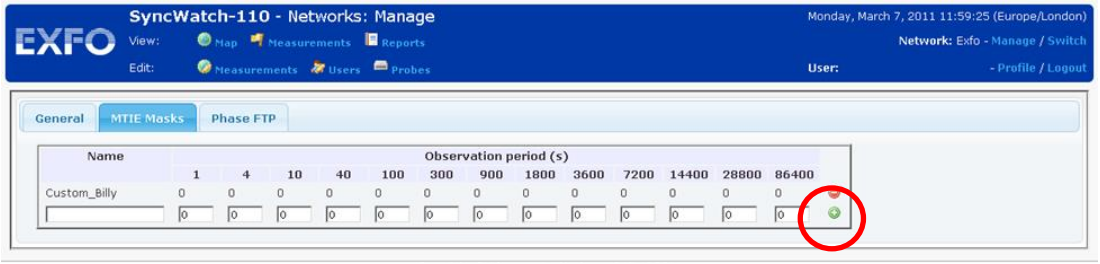
The following screen will appear:

General

In the **'General'** tab use the drop-down menu to change the time zone settings for the network.

MTIE mask

In the **'MTIE Mask'** tab the following screen show a list of all the existing custom MTIE masks; these masks are available for use as MTIE exception threshold masks and displaying on MTIE graphs.



Add a new mask

1. Type a name between 1 and 64 characters in the left-hand box. Mask names must be unique within a network.
2. Enter the mask values for the given observation periods.
3. Click the green **Add** icon circled in the diagram above.

A valid MTIE mask must always increase numerically for increasing observation intervals; the mask input fields make sure that the mask entered is valid by cascading through all following/preceding fields if a value you enter renders the mask invalid.

Remove an existing mask

1. Click the red **Remove** icon at the end of the corresponding row.
2. Click **OK** button to confirm.

It is not possible to edit an existing mask. This can be achieved by adding a new mask then removing the old mask.

Phase FTP

This feature is not supported.

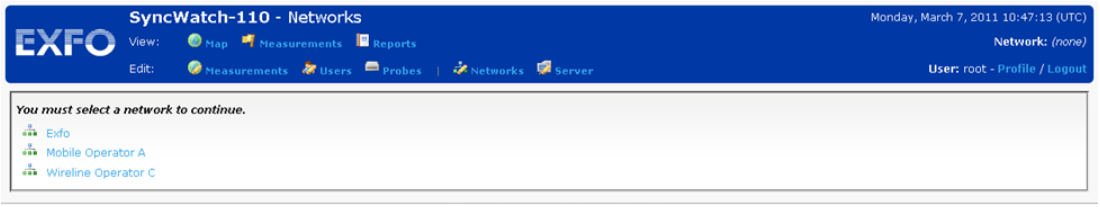
Delete network

Only the SyncWatch administrator can delete a Network.

1. To delete a Network, click on the **Networks** button located on the top navigation bar to navigate to the 'Networks: List' screen.
2. Click on the **Delete** link next to the Network to be deleted.
3. Change the required parameters as described earlier in this section.

SNMP - optional

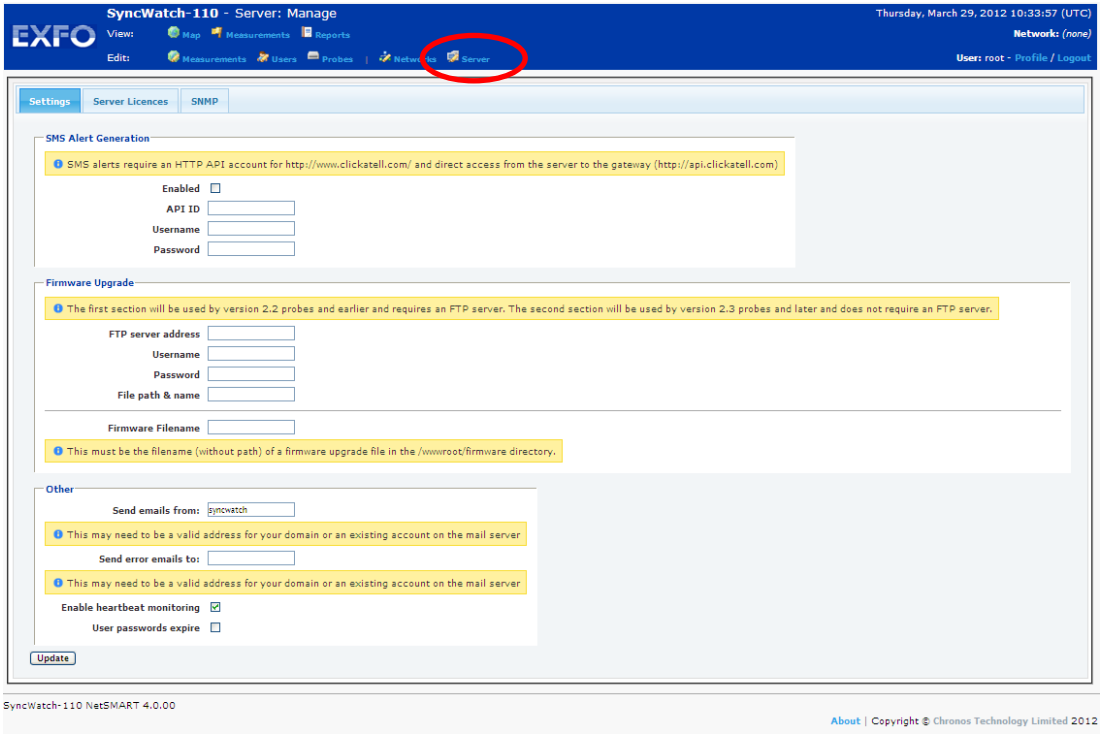
Only the SyncWatch administrator has access to the server setting required to configure the Northbound SNMP. Once logged in as the SyncWatch administrator, the following screen will appear:



If there is only one Network on NetSMART, the Measurement screen will appear instead of the screen above

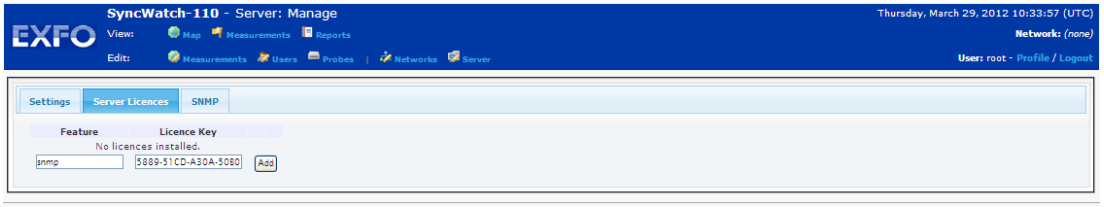
1. Click on the **Server** button located on the top navigation bar.

The following 'Server: Manage' screen will appear:



2. Click on the Server Licenses tab located under the top navigation bar.

The following ‘Server: Manage’ screen will appear:



3. Enter ‘snmp’ into the Feature text box.
4. Enter the SNMP License key into the text box.
5. After clicking on the Add button the license key should be displayed as valid.
6. Click on the Server button located on the top navigation bar to refresh screen settings.

Configure northbound SNMP

MIB file

In order to receive the SNMP v2c notifications (traps) sent out by NetSMART, the SyncWatch MIB must be loaded into the receiving Network Management System. This task should be carried out by the appropriate personnel.

The following table gives details as to the location of the MIB in the SyncWatch installation.

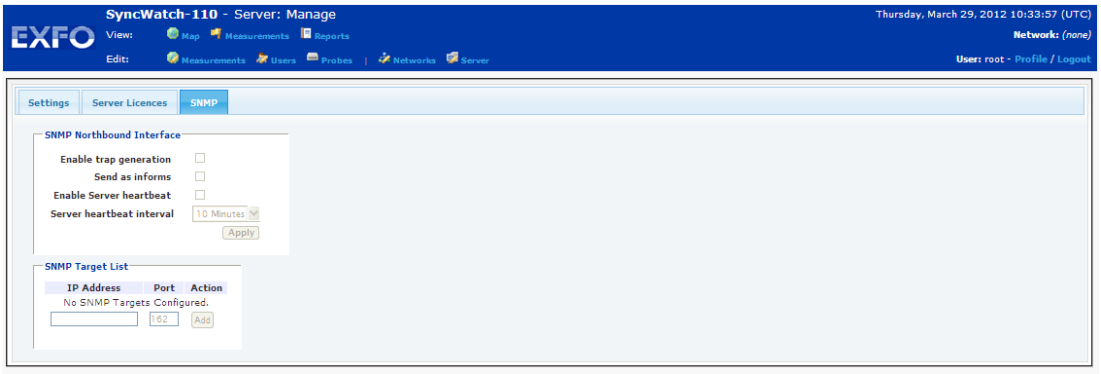
MIB File Details
XXXXXXX-SYNCWATCH-MIB.txt
<*install drive*>:\SyncWatch\snmp\share\mibs

Traps

Further details about the SNMP traps sent by NetSMART and the varbinds that they contain can be found in the MIB file located on the server *c:\SyncWatch-110\snmp\share\mibs*

Server configuration

SNMP Northbound Interface settings need to be configured on the 'Server: Manage' screen.



In the **SNMP** tab, configure the following:

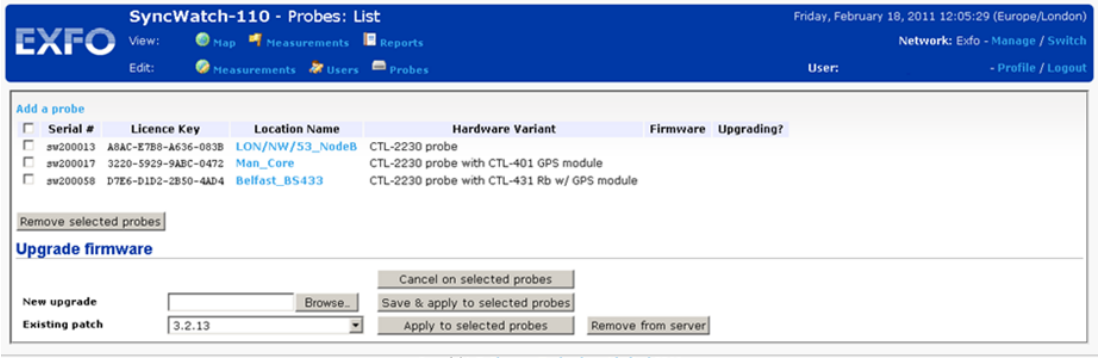
1. Tick the Enabled trap generation checkbox. When enabled, the Server generates a SNMP trap for each one of the probe generated events and forwards them to all configured SNMP targets.
2. Ticking the Send as informs checkbox will enable acknowledged event notifications. Do not tick the checkbox if notification only SNMP traps are required.
3. Tick the Enable Server heartbeat checkbox. When enabled, the Server will generate and forward heartbeat traps to all configured SNMP targets.
4. Select the Server heartbeat Interval using the drop-down selection box (default value is 10 minutes).
5. Select Apply to save the SNMP Northbound interface settings.
6. Complete the SNMP target address: text entry (no default value).

7. Enter the SNMP target port: text entry (default value is 162 - standard SNMP trap receiving port).
8. Select Add to save the configuration to the SNMP Target List.
9. Repeat steps 6, 7 and 8 to add multiple SNMP targets.

Firmware upgrade

1. Click on the **Probes** button, located on the top navigation bar.

The following screen will appear showing a list of all the probes currently on NetSMART:



2. Tick the probed to be upgraded. Either load a new firmware file by clicking the **Browse** button or select an existing firmware file from the drop-down menu.
3. Click the **Save & apply to selected probes** button, the firmware upgrade will start at the next Heartbeat.

11. Maintenance

Probe firmware upgrade

USB mode

The probe firmware can be upgraded via a USB stick. Follow the procedures below:

1. Name the required firmware as *syncwatch-usb-upgrade.bin* and save it in the root directory of the USB stick.
2. Insert USB stick into the probe.
3. During the upgrade process the front-panel input status LEDs will flash from side to side.
4. When the firmware upgrade is successfully completed the LEDs will repeatedly flash green.
5. Remove the USB stick and the LEDs will stop flashing.
6. The front-panel input status LEDs will then all turn red as the probe reboots – this will take around 2 minutes to complete.

Standalone mode

Currently not supported on SyncWatch SMART. The firmware can be upgraded via a USB stick as described above. Contact SyncWatch support if further assistance is required.

Managed mode

See 'Firmware upgrade' in section 10.

The probe can not be upgrade via a USB stick if the probe is in Standalone or Managed mode. Change the probe mode to USB, complete the upgrade and change back to the required mode.

Calibration of rubidium module

The Rubidium oscillator, on board the CTL431 and CTL435 GPS modules, in free-run mode can offer a highly stable long term measurement reference without the need for an external timing source. The Rubidium oscillator in free-run will drift between 4-5uS per day.

The Rubidium is calibrated by the manufacturer prior to shipment to the customer and calibration certificates are supplied in the probe packaging. Whilst in GPS referenced mode the Rubidium is automatically calibrated to GPS. If the product is used for long periods in free-run mode the user may wish to calibrate the Rubidium to ensure it is performing to its highest standard of quality.

Calibration procedure (via GPS)

1. Connect a SyncWatch GPS antenna to the GNSS port using the procedure described in section 6.
2. Start a measurement on the probe by following the steps applicable to the probe's mode of operation. If the GPS signal is valid and calibration is taking place, the Status LED on the probe for module 3 will light green.

Once calibration is taking place, the GPS signal must be connected for at least 20 minutes to ensure complete calibration.

Probe fuse replacement

Warning: Fuse replacement requires the case to be opened by competent personnel. This must only be done with the power disconnected.

The SyncWatch probe contains two fuses. If either of these fuses is suspected of being blown, the SyncWatch probe should be disconnected from its -48V supply. The applied voltage should be measured to check that it is within the -40. to -72V dc specification.

To confirm that fuses are blown, they should be removed and checked. The fuses are located inside the probe and the screws on the bottom of the probe and those on the top of the front panel need to be removed before the fuses can be accessed.

The fuses are located near the power connector. If a blown fuse is found it should be replaced with an identical new fuse 1A A/S fuse DC rated and UL approved.

To replace a fuse the probe's lid must be removed. This requires removing the rack ears (if fitted) and the 2 screws on each side, removing the 11 screws on the underside of the probe lid and the 5 screws on the top-side of the probe lid.

Recycling and disposal (Applies to European Union Only)

For complete recycling/disposal information as per European Directive WEEE 2012/19/UE, visit the EXFO Web site at **www.exfo.com/recycle**.

12. Troubleshooting

SMART: Connection times out - Changing the system clock whilst connected to a SyncWatch probe will force the connection to drop.

SMART: Initialization Error - If an initialization error appears referring to ‘delay adjustment values’, delete the file "%UserProfile%\My Documents\SyncWatchSMART\sys\settings.ini" and restart SMART.

SMART: Download Diagnostics - To aid systems diagnostics by the SyncWatch support team, download the data file from the Probe Info menu and send to SyncWatch support for analysis.

SMART: Application Error - Application will fail to initialize without Microsoft.NET Framework 3.5 or later installed on the PC.

GPS: The GPS receiver within the SyncWatch probe is designed with high signal sensitivity to ensure that the receiver can maintain the highest quality of timing performance under less than ideal antenna locations.

GPS: The use of GPS re-radiating equipment to provide GPS signals to the SyncWatch probe is NOT recommended unless the re-radiating environment is fully isolated from all other GPS signals. This is because the SyncWatch GPS receiver may be able to pick up low level external GPS signals at the same time as the re-radiated GPS signals and cause degradation in timing performance.

GPS: If an external GPS antenna is used with the SyncWatch probe in the vicinity of internally located GPS re-radiating equipment, then every effort must be made to avoid the re-radiating signals reaching the external antenna. The re-radiating equipment must comply with ETSI EN 302 645 V1.1.1 (2010-03).

13. Advanced results analysis

Measurement results files generated by the SyncWatch probe during any mode of operation can be analyzed using the SyncWatch SMART software. Further in-depth analysis of these results files can be done using the Time Monitor Analyzer software.

Key features of the Time Monitor Analyzer:

- Extensive analysis on collected data
- Flexible analysis of full or partial data-sets
- Packet Timing Analysis (NTP, IEEE 1588 PTP, QoE)
- ITU-T, ETSI, ANSI and Telcordia compliant masks
- Runs on Windows® 95, 98, Me, NT, 2000, XP, Vista, Windows® 7.

For further information regarding Time Monitor Analyzer please contact your SyncWatch distributor.

14. Specifications

Probe measurement inputs

- General purpose frequency inputs: (justify to the left, do same for others).
  - Frequencies between 64 KHz and 200 MHz in 8 KHz steps.
  - 1, 5 or 10 MHz.
  - 1 PPS TTL into 100 KΩ.
- Four configurable E1 inputs:
  - 2.048 MHz: G.703-13 compliant.
  - 2.048 Mbps: G.703-9 compliant.
  - 2 inputs at 75 Ω on BNC connector.
  - 2 inputs at 120 Ω on RJ48 connector.
  - Line code: HDB3.
- Two configurable T1 inputs:
  - 1.544 Mbps: G.703-5 compliant.
  - 2 inputs at 100 Ω on RJ48 connector.
  - Line code: B8ZS.
- Synchronous Ethernet 100 M Base-T on RJ45 connector. Synchronous Ethernet 1000 M Base-T on RJ45 connector and SFP (optional).
- IEEE 1588v2 PTP on RJ45 and SFP connectors (optional).

Probe GPS input (optional)

- Standard L1 GPS.
- 5 V @ max 25mA antenna current.
- SMA connector, female.

Enhanced Rubidium GPS receiver (optional)

- Independent PRC quality reference (exceeds G.811 MTIE performance).
- Provides Rubidium holdover in the event of GPS signal outage.

Rubidium GPS receiver (optional)

- Independent PRC quality reference (exceeds G.811 MTIE performance).
- Provides Rubidium holdover in the event of GPS signal outage.

OCXO GPS receiver (optional)

- Independent PRC quality reference (meets G.811 MTIE performance).
- Provides no holdover in the event of GPS signal outage.

Probe management interfaces

- 10/100 BaseT on RJ45.
- RS232 on DE9 connector.
- (Optional) GSM/GPRS 850/900/1800/1900 MHz modem.
- USB Maintenance connector for re-flash (return to base).

Probe power supply

- 40 to -72 VDC including all tolerances.
- 40 W Max (with Rb GPS and PTP 1G option).
- 15 W Max (without GPS and PTP option).

Environmental specifications

- Operating temperature: 0 °C to +50 °C.
- Storage temperature: -10 °C to +60 °C.

Physical specifications

- Weight: 1.75 kg.
- 443 mm W X 200 mm D X 44 mm H.

Probe installation options

- 19’ and ETSI rack mountable, 1 RU.

Compliance

- UL.
- CE Mark.
- 6 of 6 RoHS.
- EN 61326; EN301489; EN61010.
- FCC Part 15.

Supported SFPs

- Optical
  - Finisar FTRJ1319P1BTL
  - Finisar FTLF8519P2BNL
  - Avago AFCT-5710PZ

- Electrical
  - Finisar FCMJ-8251-3
  - Avago ACBU-5710-RZ

SyncWatch SMART software

Platform requirements

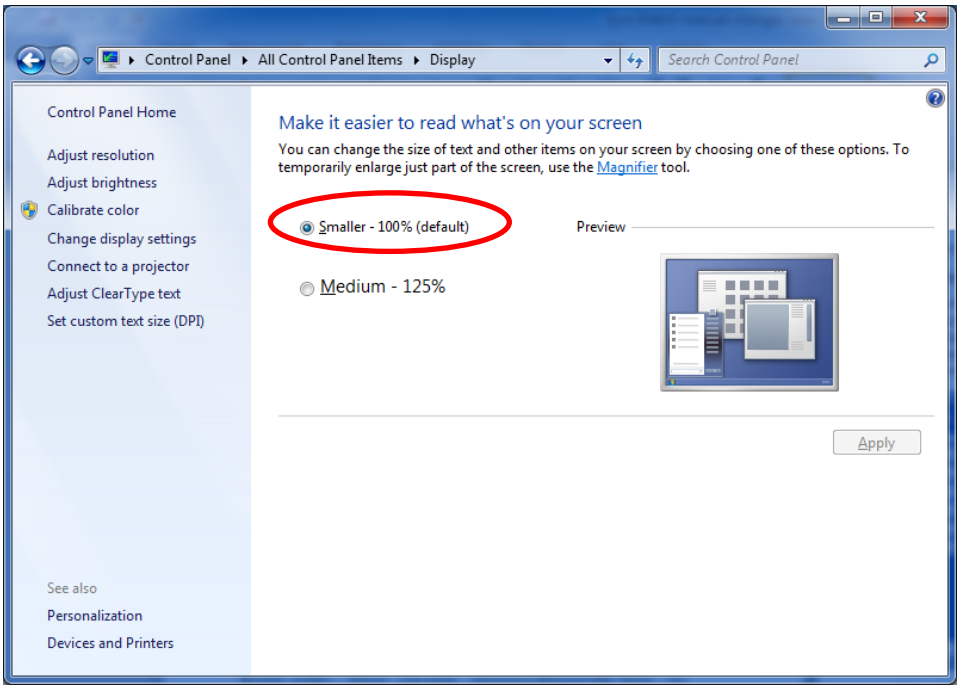
- Operating Systems: Windows Server 2008 R2; Windows XP; Windows 7*.
- Related software: Microsoft.NET Framework 3.5 or later.
- Processor: 1 GHz Pentium processor or equivalent (Minimum); 2 GHz Pentium processor or equivalent. (Recommended).
- RAM: 1 GB (Minimum); 2 GB. (Recommended).
- Hard disk: Up to 10 GB of available space may be required (see note below).
- Display: 800 x 600, 256 colors (Minimum); 1024 x 768 high color, 32-bit. (Recommended).

The data files collected by SyncWatch can be large. Typical file sizes for each measurement are:

- Frequency Measurement; @1 Hz sample rate data file created is 2.7 Mbytes per day
- Packet Measurement: ’32 packets per second, file created is 132 Mbytes per day (sync and delay/request packets).

*Windows 7

For best presentation of the application when using Windows 7 the “Smaller - 100% (default)” option must be selected in Control Panel – Display.



NetSMART software

Platform requirements

- Operating Systems: Windows® 2000 SP4, XP, Vista.
- Related software: Microsoft.NET Framework 3.5.
- Processor: Pentium IV 2.0 GHz or higher.
- RAM: 512 MB or higher.
- Hard disk: 6 GB or higher.
- Display: XGA [1024x768] minimum.

Browser requirements

- Internet Explorer 8.
- Internet Explorer 9 or later.
- Firefox: Version 4 or later.
- Chrome: Version 11 or later.

15. Contacting the Technical Support Group

To obtain after-sales service or technical support for this product, contact EXFO at one of the following numbers. The Technical Support Group is available to take your calls from Monday to Friday, 8:00 a.m. to 7:00 p.m. (Eastern Time in North America).

For detailed information about technical support, visit the EXFO Web site at www.exfo.com.

Technical Support Group	1 866 683-0155 (USA and Canada)
400 Godin Avenue	Tel.: 1 418 683-5498
Quebec (Quebec) G1M 2K2	Fax: 1 418 683-9224
CANADA	support@exfo.com

For detailed information about technical support, and for a list of other worldwide locations, visit the EXFO Web site at www.exfo.com.

If you have comments or suggestions about this user documentation, you can send them to customer.feedback.manual@exfo.com.

To accelerate the process, please have the model and serial number of the probe (see the product identification label on the bottom of the probe), as well as a description of your problem.

Transportation

Maintain a temperature range within specifications when transporting the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in its original packing material when shipping
- Avoid high humidity or large temperature fluctuations
- Keep the unit out of direct sunlight
- Avoid unnecessary shocks and vibrations.

16. Warranty

General information

EXFO Inc. (EXFO) warrants this equipment against defects in material and workmanship for a period of one year or from the date of original shipment. EXFO also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, EXFO will, at its discretion, repair, replace, or issue credit for any defective product, as well as verify and adjust the product free of charge should the equipment need to be repaired or if the original calibration is erroneous. If the equipment is sent back for verification of calibration during the warranty period and found to meet all published specifications, EXFO will charge standard calibration fees.

IMPORTANT

The warranty can become null and void if:

- unit has been tampered with, repaired, or worked upon by unauthorized individuals or non-EXFO personnel
- warranty sticker has been removed
- case screws, other than those specified in this guide, have been removed
- case has been opened, other than as explained in this guide
- unit serial number has been altered, erased, or removed
- unit has been misused, neglected, or damaged by accident

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL EXFO BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Liability

EXFO shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the product is connected or the operation of any system of which the product may be a part.

EXFO shall not be liable for damages resulting from improper usage or unauthorized modification of the product, its accompanying accessories and software.

Exclusions

EXFO reserves the right to make changes in the design or construction of any of its products at any time without incurring obligation to make any changes whatsoever on units purchased. Accessories, including but not limited to fuses, pilot lamps, batteries and universal interfaces (EUI) used with EXFO products are not covered by this warranty.

This warranty excludes failure resulting from: improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the product or other factors beyond the control of EXFO.

Certification

EXFO certifies that this equipment met its published specifications at the time of shipment from the factory.

Service and repairs

EXFO commits to providing product service and repair for five years following the date of purchase.

To send any equipment for service or repair:

- Call one of EXFO's authorized service centers (see EXFO Service Centers Worldwide on page 163. Support personnel will determine if the equipment requires service, repair, or calibration.
- If equipment must be returned to EXFO or an authorized service center, support personnel will issue a Return Merchandise Authorization (RMA) number and provide an address for return.
- If possible, back up your data before sending the unit for repair.
- Pack the equipment in its original shipping material. Be sure to include a statement or report fully detailing the defect and the conditions under which it was observed.
- Return the equipment, prepaid, to the address given to you by support personnel. Be sure to write the RMA number on the shipping slip. EXFO will refuse and return any package that does not bear an RMA number.

A test setup fee will apply to any returned unit that, after test, is found to meet the applicable specifications.

After repair, the equipment will be returned with a repair report. If the equipment is not under warranty, you will be invoiced for the cost appearing on this report. EXFO will pay return-to-customer shipping costs for equipment under warranty. Shipping insurance is at your expense.

Routine recalibration is not included in any of the warranty plans. Since calibrations/verifications are not covered by the basic or extended warranties, you may elect to purchase FlexCare Calibration/ Verification Packages for a definite period of time. Contact an authorized service center:

EXFO Service Centers worldwide

If your product requires servicing, contact your nearest Authorized Service Center.

EXFO Headquarters Service Center
400 Godin Avenue
Quebec (Quebec) G1M 2K2
CANADA

1 866 683-0155 (USA and Canada)
Tel.: 1 418 683-5498
Fax: 1 418 683-9224
support@exfo.com

EXFO Europe Service Center
Winchester House, School Lane
Chandlers Ford, Hampshire S053 4DG
ENGLAND

Tel.: +44 2380 246800
Fax: +44 2380 246801
support.europe@exfo.com

EXFO Telecom Equipment (Shenzhen) Ltd.
3rd Floor, Building 10,
Yu Sheng Industrial Park (Gu Shu Crossing), No. 467,
National Highway 107,
Xixiang, Bao An District,
Shenzhen, China, 518126

Tel: +86 (755) 2955 3100
Fax: +86 (755) 2955 3101
support.asia@exfo.com

17. Appendix A

1 PPS and TOD Signal Specifications

This appendix provides electrical specifications for 1PPS and TOD input signals.

1PPS+TOD	
Timing relationship between 1 PPS and TOD	Transmission of a TOD message starts 1 ms after the rising edge of 1 PPS signal, and the tramission is completed within 500 ms, as shown in Figure A-1. This TOD message indicates the time of the current 1 PPS rising edge, and is sent at a rate of once per second.
Rise Time -1 PPS Pulse	50 ns
Pulse Width	50 ms < Pulse width < 200 ms
Parameter	**Specification**
TOD frame	TOD messages use whole 8-bit bytes for transmission, with check sum protection. Message type and message ID are used to clarify messages. Follows Big Endian convention when a field is longer than one byte, where bit 0 represents the least significant bit (LSB), and bit 0 of each byte is transmitted first. See Figure A2. See **Table A3** for TOD frame field descriptions.
TOD single parameters	Baud Rate: 9600 Parity Check: None Start Bit: 1 (low level) Stop Bit: 1 (high level) Idle Frame: High level Data Bits: 8
TOD frame	TOD messages use whole 8-bit bytes for transmission, with check sum protection. Message type and message ID are used to clarify messages. Follows Big Endian convention when a field is longer than one byte, where bit 0 represents the least significant bit (LSB), and bit 0 of each byte is transmitted first. See **Figure A2.** See **Table A3** for TOD frame field descriptions.

Table A1 - Signal specifications

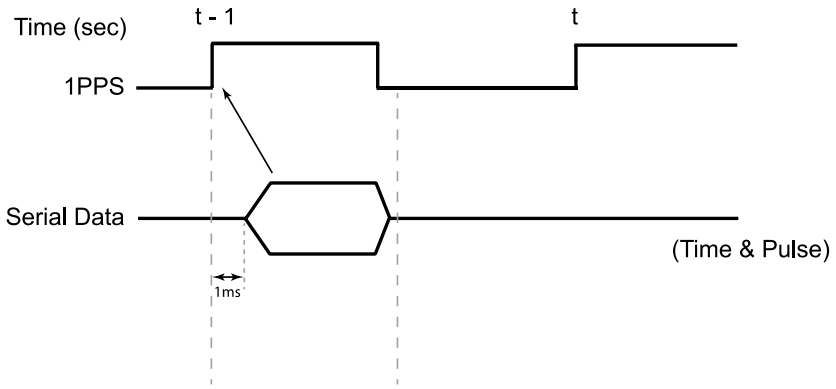


Figure A1 – Timing relationship between 1 PPS & TOD for 1 PPS+TOD signals

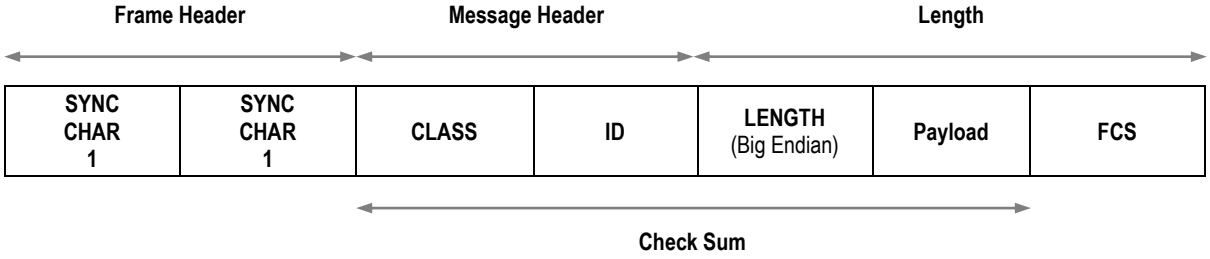


Figure A2 –TOD frame structure for 1 PPS+TOD signals

Field Name	Field Length	Description
Sync Char 1	1 byte	Part of Frame Header 0x43 = ASCII character “C”
Sync Char 2	1 byte	Part of Frame Header 0x4D = ASCII character “M”
Class	1 byte	Basic classification of TOD message
ID	1 byte	Serial number of TOD message
Length	2 bytes	Length of payload only (Does **not** include Frame Header, Message Header, Length Field itself, or FCS)
Payload	16 bytes	Contains the message content Two TOD messages have been defined: Time Information Message (see **Table A3** for payload contents) Time Status Message (see **Table A4** for payload contents) See **Table A5** for TOD message data type definitions
Frame Check Sequence (FCS)	1 byte	Generating polynomial FCS is: $G(x) = \mathbf{x}^8 + \mathbf{x}^5 + \mathbf{x}^4 + 1$ Initial value of FCS is set to 0xFF, and there is no need to negate the input data. Checksum calculation uses right-shift calculation, and there is no need to negate the output frame check data. When the frame check sequence is transmitted, the LSB (bit 0) is transmitted first.

Table A2 - TOD frame field descriptions for 1 PPS+TOD signals

Byte Offset	Data Type	Name	Units	Notes
0	U4	Time of Week (TOW)	seconds	GPS second time of week
4	I4	Reserved	-	Reserved
8	U2	Week number	-	GPS week (GPS time), 16 bits Whole weeks since 1980-01-06
10	I1	LeapS	seconds	Leap Seconds (GPS-UTC)
11	U1	1 PPS Status	-	0x00 = normal 0x01 = Time sync equipment (atomic clock) in holdover mode) 0x02 = do not use 0x03 = Time sync equipment (high-stability crystal clock) in holdover mode) 0x04 = Transport carrier equipment in holdover mode). Other values are reserved
12	U1	TAcc	-	PPS jitter category (0 - 255): 0 = 0 ns 1 = 15 ns 2 = 30 ns 3 = 45 ns . . . . 255 =not defined Note: This value is fixed to 255 for transmission and base station equipment
13	U1	Reserved	-	Reserved
14	U1	Reserved	-	Reserved
15	U1	Reserved	-	Reserved

Table A3 - Time Information Message payload contents for 1 PPS+TOD signals

Byte Offset	Data Type	Name	Units	Notes
0	U1	Clock source type	-	0x00 = Beidou 0x01 = GPS 0x02 = IEEE-1588 0x03 = Other
1	U2	Status of the clock source	-	GPS fix type, range = 0 to 3 0x00 = No fix 0x01 = Dead reckoning only 0x02 = 2D fix 0x03 = 3D fix 0x04 = GPS + dead reckoning combined 0x05 = time-only fix 0x06 - 0xff= reserved
3	U2	Week Number	-	Clock source status alarms: Bit 0: not used Bit 1: Antenna open Bit 2: Antenna shorted Bit 3: Not tracking satellites Bit 4: not used Bit 5: Survey in progress Bit 6: No stored position Bit 7: Leap second pending Bit 8: In test mode Bit 9: Position is questionable Bit 10: not used Bit 11: Almanac not complete Bit 12: PPS was not generated
5	U1	Reserved	-	Reserved
6	U1	Reserved	-	Reserved
7	U1	Reserved	-	Reserved
8	U4	Reserved	-	Reserved
12	U4	Reserved	-	Reserved

Table A4 - Time status message payload contents for 1 PPS+TOD signal

Short	Type	Size (bytes)	Range	Resolution	Comments
U1	Unsigned Char	1	0 to 255	1	
I1	Signed Char	1	-128 to 127	1	2's complement
U2	Unsigned Short	2	0 to 65535	1	
I2	Signed Short	2	-32768 to 32767	1	2's complement
U4	Unsigned Long	4	0 to 4,294,967,295	1	
I4	Signed Long	4	-2,147,483,648 to 2,147,483,647	1	2's complement
R4	IEEE 754 Single Precision	4	-1×2^{127} to 2×2^{127}	Value $\times 2^{-24}$	
R8	IEEE 754 Double Precision	8	-1×2^{1023} to 2×2^{1023}	Value $\times 2^{-53}$	
CH	ASCII / ISO 8859.1 Encoding	1			

Table A5 - TOD message data type definitions for 1 PPS+TOD input

ROHS statement

NOTICE
通告
CHINESE REGULATION ON RESTRICTION OF HAZARDOUS SUBSTANCES
中国关于危害物质限制的规定
NAMES AND CONTENTS OF THE TOXIC OR HAZARDOUS SUBSTANCES OR ELEMENTS CONTAINED IN THIS EXFO PRODUCT
包含在本 **EXFO** 产品中的有毒有害物质或元素的名称和含量

O	Indicates that this toxic or hazardous subs tance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006 表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求以下。
X	Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is abov e the limit requirement in SJ/T11363-2006 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T11363-2006 标准规定的限量要求。

Part Name 部件名称	Toxic or hazardous Substances and Elements 有毒有害物质和元素					
	Lead 铅 (Pb)	Mercury 汞 (Hg)	Cadmium 隔 (Cd)	Hexavalent Chromium 六价铬 (Cr VI)	Polybrominated biphenyls 多溴联苯 (PBB)	Polybrominated diphenyl ethers 多溴二苯醚 (PBDE)
Enclosure 外壳	O	O	O	O	O	O
Electronic and electrical sub-assembly 电子和电子组件	X	O	X	O	X	X
Optical sub-assembly [a] 光学组件 [a]	X	O	O	O	O	O
Mechanical sub-assembly [a] 机械组件 [a]	O	O	O	O	O	O

a. If applicable.
如果适用。

MARKING REQUIREMENTS
标注要求

Product 产品	Environmental protection use period (years) 环境保护使用期限 (年)	Logo 标志
This Exfo product 本 EXFO 产品	10	
Battery [a] 电池 [a]	5	

a. If applicable.
如果适用。

P/N:1067824

www.EXFO.com - info@exfo.com

CORPORATE HEADQUARTERS	400 Godin Avenue	Quebec (Quebec) G1M 2K2 CANADA Tel.: 1 418 683-0211 · Fax: 1 418 683-2170
EXFO AMERICA	3400 Waterview Parkway Suite 100	Richardson, TX 75080 USA Tel.: 1 972-761-9271 · Fax: 1 972-761-9067
EXFO EUROPE	Winchester House, School Lane	Chandlers Ford, Hampshire S053 4DG ENGLAND Tel.: +44 2380 246 800 · Fax: +44 2380 246 801
EXFO ASIA-PACIFIC	62 Ubi Road 1 #09-01/02 Oxley Bizhub 2	SINGAPORE 408734 Tel.: +65 6333 8241 · Fax: +65 6333 8242
EXFO CHINA	Beijing Global Trade Center, Tower C, Room 1207, 36 North Third Ring Road East, Dongcheng District	Beijing 100013 P. R. CHINA Tel.: +86 (10) 5825 7755 · Fax: +86 (10) 5825 7722
EXFO SERVICE ASSURANCE	270 Billerica Road	Chelmsford MA, 01824 USA Tel.: 1 978 367-5600 · Fax: 1 978 367-5700
EXFO FINLAND	Elektroniikkatie 2	FI-90590 Oulu, FINLAND Tel.: +358 (0) 403 010 300 · Fax: +358 (0) 8 564 5203
TOLL-FREE	(USA and Canada)	1 800 663-3936

Printed in Canada (2015-02)

EXPERTISE REACHING OUT