GE
Grid Solutions

MultiSync 100

1588 GPS Clock

Instruction Manual

Revision: 1.0x
Manual P/N: 1601-0300-A3
Manual Order Code: GEK-119628B

WORLDWIDE 10 YEAR WARRANTY

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REGISTERED ISO 9001 GE MULTILIN

GE Multilin MultiSync 100 GPS Clock Instruction Manual for version 1.0x.

Part number: 1601-0300-A3 (July 2017)

General safety precautions

Before attempting to install or use the device, review all safety indicators in this document to help prevent injury, equipment damage, or downtime.

⚠CAUTION

Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.

Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.

If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in Impaired operation and injury.

Caution: Hazardous voltages can cause shock, burns or death.

Installation/service personnel must be familiar with general device test practices, electrical awareness and safety precautions must be followed.

Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.

Failure to shut equipment off prior to removing the power connections could expose you to dangerous voltages causing injury or death.

All recommended equipment that should be grounded and must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.

In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.

Utrustning som är kopplad till skyddsjord via jordat vägguttag och/eller via annan utrustning och samtidigt är kopplad till kabel-TV nät kan i vissa fall medföra risk för brand. För att undvika detta skall vid anslutning av utrustningen till kabel-TV nät galvanisk isolator finnas mellan utrustningen och kabel-TV nätet.

This product cannot be disposed of as unsorted municipal waste in the European Union. For proper recycling return this product to your supplier or a designated collection point. For more information go to www.recyclethis.info.

Safety words and definitions

The following safety and equipment symbols are used in this document.

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Indicates practices not related to personal injury.

For further assistance

For product support, contact the information and call center as follows:

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Markham, Ontario
Canada L6C 0M1

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MultiSync 100 GPS Clock

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MultiSync 100 GPS Clock

Chapter 1: Product description

This chapter outlines the product, order codes, and specifications.

Product description

The MultiSync 100 GPS Clock provides sub-microsecond accuracy for synchronizing intelligent electronic devices, and is available with 1588 timing. Configuration options include adjustable hold-over times in cases of poor GPS coverage, and compensation for installation parameters such as antenna cable length.

Features

Features of the MultiSync 100 include:

- Multiple Time Synchronization signals, including:
  - DC IRIG-B (Unmodulated, DC Level Shift, with support for C37.118 year extensions)
  - User defined pulses
  - Modified Manchester
  - NTP/ SNTP (IEC 61850)
  - IEEE 1588-2011, including the C37.238 Power Profile
  - DCF-77
- SNMP v1, v2c & v3 support for network
- Isolated power supply
- High power line drivers
- Low noise due to balanced pair distribution
- UTC time and Local Standard Time (LST), with user-defined Daylight Savings Time (DST) options
- Remote configuration
- Password protection and user authentication

Order codes

This section lists the order codes for the MultiSync 100.

NOTE

Order codes are subject to change without notice. See the ordering page at store.gegridsolutions.com for the latest options.

Table 1: Order codes

MultiSync100 – P	MultiSync GPS Clock with 1588 timing

Specifications

Specifications are subject to change without notice.

Accuracy

Timing accuracy: ..... <= 100 ns to UTC
Drift: ..... <= 100 µs over 5 hours (7 ppb)

Electrical

POWER SUPPLY
Nominal DC Voltage: ..... 48 to 250 VDC
Minimum DC Voltage: ..... 36 V
Maximum DC Voltage: ..... 300 V
Power drain: ..... 5 W max

ISOLATION
Power to antenna: ..... 3.75 kV
Power to I/O: ..... 3.75 kV

INPUTS
RJ45 UTP connector: ..... 10/100 Mbps
USB2.0: ..... Type B

OUTPUTS
Sync indication output: ..... 200 V, 150 mA (max)
2 x TTL outputs: ..... Time codes or pulses or user defined
Electrical specification: TTL/CMOS compatible
0-5 V, 150 mA sink/source
Timing accuracy: ≤100 ns to UTC

Output options

TTL
Programmable pulses: ..... From 1000 per second to 1 per day with programmable offset & duration
DCF-77: ..... DC level shift
Local or universal time
IRIG-B: ..... DC level shift or Modified Manchester
C37.118 extension
C37.118.1 extensions, firmware version 3.07r and newer
AFNOR NF S87-500 extensions
Local or universal time

Networking

GENERAL
DHCP: ..... Auto-configuration with fallback to ARP tested link-local address
VLAN: ..... packet tagging

PTP (IEEE 1588 V2)
General: ..... One-step or two-step operation
End-to-end or peer-to-peer delay calculations
Layer 2 (Ethernet) or Layer 3 (UDP) transport
Slave only mode
Default Profile support

G8265.1-2010 Telecom Profile

Power Profile support: C37.238

TLV support: C37.238 offset from TAI time base used by PTP

Alternate Time Offset TLV support: with automatic or manual offset

SNMP MIB support: C37.238

Telecom Profile Support: G8265.1-2010; Can translate Telecom Profile to C37.238

NTP

General: Stratum-1 NTP & SNTP time server
Multicast & Broadcast server capability
Optional MD5 authentication

SNMP

General: V1, V2C, and V3 support, independently enabled
Configurable V1 and V2C community names and security groups
Fully configurable via SNMP
V3 User-based Security Module (USM) support
USM MIB support

USM authentication methods: MD5, SHA

USM privacy methods: DES, AES

NOTIFICATIONS

General: SNMP trap generation V1, V2C, and V3
SNMPv3 traps authenticated and privatized via USM
Syslog (RFC-3164 and 5424 verities)

Environmental specifications

OPERATING ENVIRONMENT

Ambient Temperature: -40° to 140 °F (-40° to 60 °C) for UL 60950 and Component Parts
-40° to 195 °F (-40° to 85 °C) for IEC 60068 Type Test short term rating

Storage Temperature: -40° to 185 °F (-40° to 85 °C)

Ambient Relative Humidity: 5% to 95% (non-condensing)

Altitude: Up to 6560 feet (2000 m)

Pollution Degree: 2

Conformal Coating (humidity protection) optional: Request quote

OTHER ENVIRONMENTAL

Humidity (non-condensing): to 95%

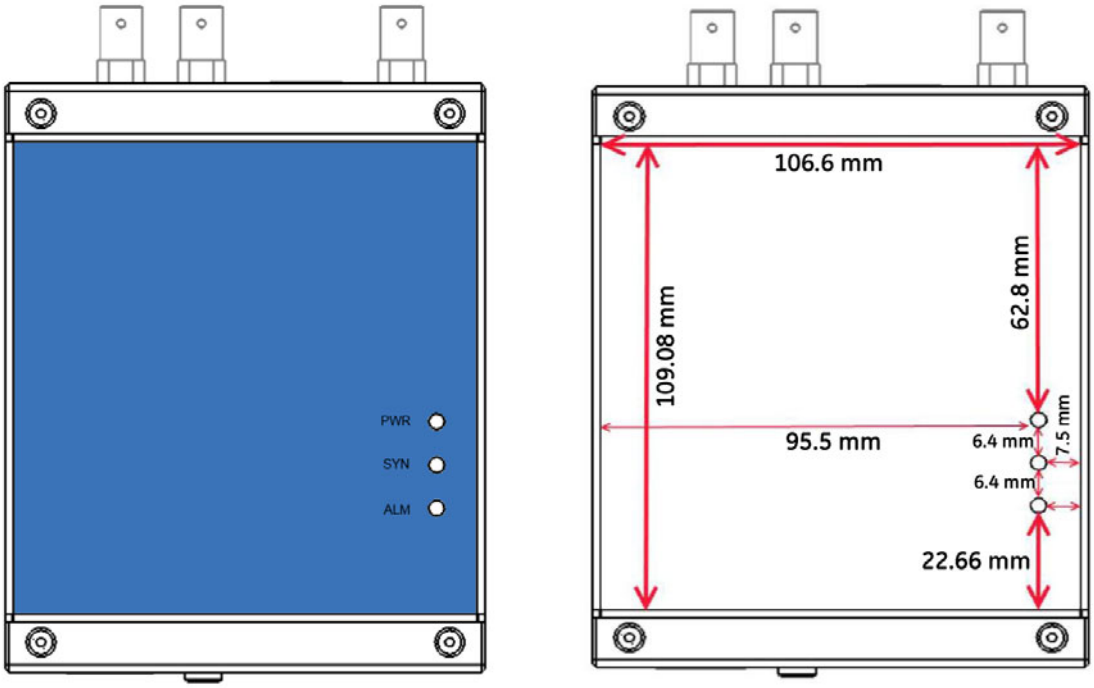
Mechanical specifications

MECHANICAL PROPERTIES

Dimensions (H × W × D): 45 × 110 × 155 mm

Weight: 0.42 kg

Installation: Metal DIN rail-mountable case with IP30 (Ingress Protection rating)



GPS Receiver

L1, C/A CODE, 14 CHANNEL, PARALLEL-TRACKING RECEIVER

Frequency: ..... 1575.42 MHz (L1)
Pulse accuracy: ..... 50 ns
Sensitivity: ..... Acquisition - 142 dBm
Tracking - 160 dBm

Antenna requirements

ANTENNA PORT SPECIFICATIONS

Voltage: ..... 5 VDC
Current: ..... 100 mA (max)
Input impedance: ..... 50 Ω
Total gain: ..... The total combined gain of the antenna system (antenna, cable, and connectors) should fall in the range of 10 to 35 dB, the optimum being 22 dB.

Testing and certification

APPROVALS AND CERTIFICATION

Compliance	Applicable council directive	According to
North America	cULus	UL60950-1 C22.2 No. 60950-1 CB Report including all country deviations
ISO	Manufactured under a registered quality program	ISO 9001:2008

IEC 61850-3 EMI TYPE TESTS

Test	Description		Test Levels	Severity Levels
IEC 61000-4-2	ESD	Enclosure Contact	+/- 8 kV	4
		Enclosure Air	+/- 15 kV	4
IEC 61000-4-3	Radiated RFI	Enclosure Ports	20 V/m	
IEC 61000-4-4	Burst	D.C. Power port	+/-4 kV	4
IEC 61000-4-5	Surge	Signal Ports	+/- 4kV line to earth, +/- 2kV line to line	4
		D.C. Power Ports	+/- 2kV line to earth, +/- 1kV line to line	3
IEC 61000-4-6	Induced RFI	Signal Ports	10 V	3
		D.C Power ports	10 V	3
		Earth Ground Ports	10 V	3
IEC 61000-4-8	Magnetic Field	Enclosure Ports	40 A/m continuous, 1000A/m for 1s	
IEC 61000-4-29 IEC 61000-4-11	Voltage Dips and Interrupts	D.C. Power ports	30% for 0.1s, 60% for 0.1s, 100% for 0.05s	
IEC 61000-4-12	Damped Oscillatory	Signal Ports D.C. Power ports	2.5kV common, 1kV diff, mode @1MHz	3
IEC 61000-4-16	Mains Frequency Voltage	Signal Ports D.C. Power ports	30V Continuous, 300V for 1s	4
IEC 61000-4-17	Ripple on D.C. Power Supply	D.C. Power ports	10%	3
IEC 60255-5	Dielectric Strength	Signal Ports	2 kVAC (fail-safe relay output)	
		D.C. Power ports	2 kVAC	
IEC 60255-5	H.V. Impulse	Signal Ports	5 kV (fail-safe relay output)	

IEEE 1613 (37.90.X) EMI IMMUNITY TYPE TESTS

Test	Description		Test Levels
IEEE 37.90.3	ESD	Enclosure Contact	+/-2 kV, +/-4 kV, +/- 8 kV
		Enclosure Air	+/-4 kV, +/-8 kV, +/- 15 kV
IEEE 37.90.2	Radiated RFI	Enclosure Ports	35 V/m
IEEE 37.90.1	Fast Transient	Signal Ports	+/-4 kV @2.5kHz
		D.C. Power Ports	+/-4 kV
IEEE 37.90.1	Oscillatory	Signal Ports	2.5kV common mode @1MHz
		D.C Power ports	2.5 kV common, 1 kV diff. mode @1MHz
IEEE 37.90	H.V. Impulse	Signal Ports	5 kV (fail-safe relay output)
		D.C. Power ports	5 kV
IEEE 37.90	Dielectric Strength	Signal Ports	2 kVAC
		D.C. Power ports	2 kVAC

ENVIRONMENTAL TYPE TESTS

Test	Description		Test Levels
IEC 60068-2-1	Cold Temperature	Test Ad	-40°C, 16 hours
IEC 60068-2-2	Dry Heat	Test Bd	+85°C, 16 hours

Test	Description		Test Levels
IEC 60068-2-30	Humidity (Damp Heat, Cyclic)	Test Db	95% (non-condensing), 55°C, 6 cycles
IEC 60255-21-1	Vibration		2 g at 10-150 Hz
IEC 60255-21-2	Shock		30 g @ 11 mS

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Chapter 2: Theory of operation

GPS/GNSS and precise time synchronization

GNSS (Global Navigation Satellite Systems) is a general term referring to the satellite navigation systems available in different parts of the world. GPS (Global Positioning System) refers specifically to the system created and maintained by the United States government. GLONASS (Global Navigation Satellite System) refers to the satellite service created and operated by the Russian government. Both the GPS and GLONASS satellite systems have global coverage. Additional satellite systems are under development by China and the European Union to address concerns of potential denial of service or monitoring by the governments operating the satellites. As the first fully global system and most commonly used system in North America, GPS is also a general term for global positioning systems, regardless of the satellites in use. Unless otherwise specified, this manual uses GPS in the general sense.

A GPS satellite-based navigation system is used as the master time source for clock timing signals published by the MultiSync 100 GPS Clock. Each satellite contains an atomic clock, and each satellite publishes a navigation message, including the clock time, at six second intervals via a spread spectrum carrier. The atomic clocks in GPS satellites are monitored by ground control systems to ensure accuracy, and the location of a GPS receiver on the ground is essentially determined by measuring the time delay between time signals from multiple satellites.

Since precise time synchronization is required for determining the location of a GPS receiver, GPS can also be used for precise time synchronization around the Earth. To understand how GPS can be used for precise time synchronization, some definitions are necessary.

- **Time** - the marking of an event with respect to a reference origin. GPS time signals, based on the atomic clock in GPS satellites, are the reference origin.
- **Time interval** - a measurement of duration between events.
- **Coordinated Universal Time (UTC)** - a time system adopted in 1972. UTC is based on the weighted combination of atomic clocks located around the world. UTC occasionally changes by the addition of leap seconds.
- **International Atomic Time (TAI)** - the time system used as the basis for UTC, TAI was synchronized with UTC at the beginning of 1958. The difference between TAI and UTC

includes an initial difference of 10 seconds from 1972 and the accumulated leap seconds since that date. TAI does not accumulate leap seconds.

- **Frequency** - the measure of the number of events that occur within a time interval, such as the number of oscillations of a voltage waveform within one second

Power system applications require precise time synchronization for sequences of event logs, fault recordings, and wide area protection systems based on synchrophasors. Precise time requires precise time intervals, as measured by the time between periodic pulse edges or waveform zero-crossings. The relationship between these marks and a reference time is a measure of the phase of the signal. One application requirement for precise time synchronization is the definition of the required phase stability for time intervals specific to the application.

The most restrictive accuracy in power systems is that of synchrophasors, as the IEC 61850 Standard implies a required accuracy of 1 microsecond. GPS clock receivers are capable of time tagging events to the 100-nanosecond level and maintaining that accuracy over periods ranging from seconds to years. Typical small pulse-to-pulse jitter (phase noise) on the order of one nanosecond will not impact accuracy, but it is required that the time intervals maintain long-term phase stability. GPS is capable of global time and frequency dissemination 24 hours a day, with timing accuracies in the 100-nanosecond range. This level of accuracy explains why GPS has become the typical time synchronization method for commercial applications.

GPS time is not identical to UTC (or civil) time, but is related to UTC time. One major difference is that GPS time is a continuous time usually measured in weeks and seconds from the GPS time zero point of midnight, January 6, 1980. The other difference is leap seconds. UTC time is an atomic time, is the basis for civil time, and aims to keep the difference between UTC time and the earth's rotational speed to less than 0.90 seconds. As the earth's rotation slows down, it becomes necessary to correct UTC time by adding a leap second. GPS time is not adjusted by leap seconds, and as of 2015, GPS time is 17 seconds ahead of UTC time. Beyond the integer number of leap seconds, GPS time is tightly controlled to within one microsecond of UTC, with the difference reported in the GPS navigation message to a precision of 90 nanoseconds.

A GPS receiver gains GPS time by locking on to the spread spectrum carrier and decoding the 50-Hz datastream containing the navigation message. The total signal path transmission delay computation begins with the range from the satellite to the receiver. One can convert the range to a time delay using the speed of light. This delay is then corrected for the ionospheric delay (using a model provided in the navigation message), for the effect of transmission in a rotating inertial reference system, and for hardware delays in cables and receiver circuitry. The difference between the computed and measured millisecond time marks gives the relationship between the receiver clock and GPS time.

Once the relationship between the receiver clock and GPS time is established, time signals can be produced by the receiver. Synchronization between receivers at different locations can be established and maintained using GPS time. If time signals are required to maintain synchronization with UTC, the UTC correction in the navigation message can be applied, and time signals, such as one-pulse-per-second (1PPS) signals of IRIG-B or IEEE 1588 signals, can be set and maintained to UTC.

The accuracy of GPS time signals is related to the ability of the receiver to accurately track the received navigation code. Accuracies in the 100-nanosecond range are possible with undegraded GPS signals and correct receiver position.

The IRIG-B time code standard

IRIG-B is one of several time code formats defined under the IRIG Standard. The IRIG-B time code standard was developed by the U.S. Army through the Inter-Range Instrumentation Group (IRIG). IRIG-B defines a frame time of 1000 milliseconds, a frame rate of 1 Hz or 1 pulse per second (PPS), a bit time (or pulse time) of 10 milliseconds, and 100 bits per frame (or 100 PPS).

IRIG-B is an analog signal: analog pulses (or bits) represent time in fractions of seconds from midnight, and days from January 1st. The length of the pulse, as a percentage of the pulse time of 10 milliseconds, determines if the bit is a logical 0, a logical 1, or a position identifier. As the bit rate implies, the IRIG-B time code format publishes 100 bits per second in a specific order to represent the time, the date, time changes, and the time quality. The presence of 2 consecutive position identifiers signifies the start of a time frame. The first identifier alerts that the next rising edge is the frame marker. As IRIG-B has a 1000 millisecond frame interval, this rising edge marker is the "1 PPS" time synchronization commonly referred to.

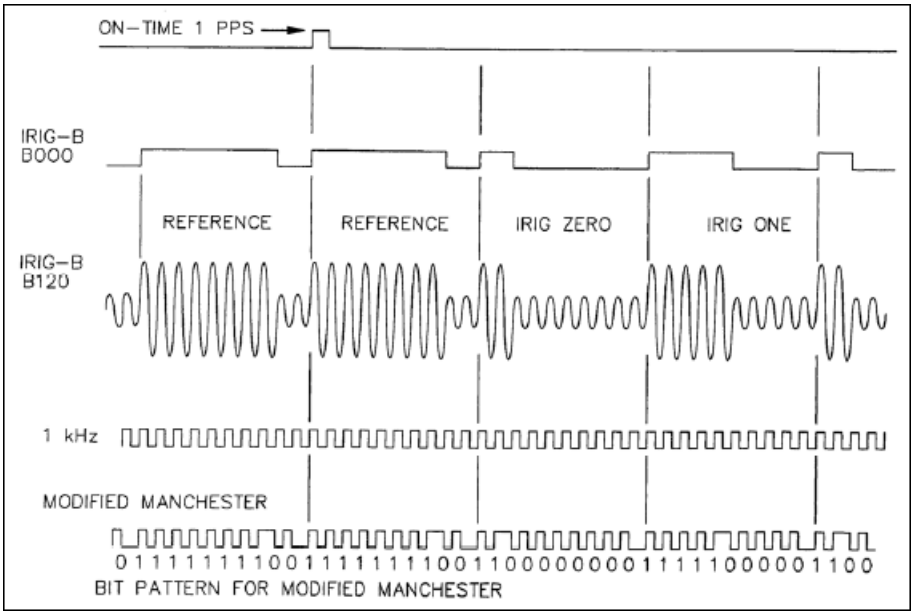
A significant part of the 100 bits in an IRIG-B frame are Binary Coded Data (BCD) that defines the actual time. The BCD time-of-year (BCDTOY) indicates seconds, minutes, and hours from midnight, recycling daily, and days from January 1st, recycling yearly. The BCD year code (BCDYEAR) counts years and cycles to the next year on January 1st. There is also an optional Straight Binary Seconds (SBS) code that counts seconds from midnight, recycling daily.

There are three methods of communicating analog pulses in the IRIG Standard:

- **Modulated** (amplitude-modulated, sine wave carrier) - the method supported in older IEDs
- **Unmodulated** (DC level shift, no carrier signal) - the most commonly supported method for new IEDs
- **Modified Manchester** (amplitude-modulated, square wave carrier) - a version not described in this manual.

The figure shows the pulses for the three methods. The top row (IRIG-B B000) is unmodulated, the middle row (IRIG-B B120) is modulated, and the bottom row is Modified Manchester.

Figure 1: Methods of communicating analog pulses, IRIG Standard 200-04



Modulated IRIG-B

A modulated IRIG-B clock continuously produces a sine wave signal with the amplitude of the signal modulated to indicate the value of a specific bit. The length of the modulation determines a logical 0, logical 1, or position identifier. Modulated, or amplitude-modulated (AM) IRIG-B is the original method for distributing IRIG-B time codes. New IEDs generally don't support amplitude-modulated time codes, as other methods of producing IRIG-B signals are more accurate. The advantage to AM is that there can be longer cable runs between the clock and subscribing IEDs than with other methods. AM implementations generally use coaxial or shielded twisted pair cables and BNC connectors.

Unmodulated IRIG-B

Unmodulated IRIG-B is also known as DC Level Shift (DCLS). An IRIG-B clock using DCLS only produces an output to produce a pulse, and the pulse is a constant magnitude. The length of the output determines a logical 0, logical 1, or position identifier. The output value is normally 5V for on, and 0V for off. Newer IEDs typically use DCLS due to accuracy. However, the distance to IEDs is limited to around 100m. DCLS typically uses TTL outputs over shielded, twisted pair cable and BNC connectors.

C37.118 extensions

The original IRIG Standard did not provide year information, or BCDYEAR, in the time code: only time and day from the start of the year. Lack of year data was a limitation for some applications, especially in regards to synchrophasors. The C37.118-2005 IEEE Standard for Synchrophasors for Power Systems includes definitions to include year data in the IRIG-B time code. The extensions add calendar year, leap second, daylight savings time, local time offset, and time quality to the IRIG-B signal. Individual devices may or may not support the C37.118 extensions.

The IRIG-B Standard was revised in 2004 to include year data. The 200-04 Standard allows IRIG-B to publish BCDYEAR, as described. The C37.118-2005 Standard has been replaced by C37.118.1-2011 IEEE Standard for Synchrophasors for Power Systems. C37.118.1 adds Continuous Time Quality (CTQ) bits to the IRIG-B signal. Any MultiSync 100 model with firmware version 3.07r or later supports C37.118.1.

Defining IRIG-B time codes

The IRIG Standard further defines the Time Code Designation to completely describe the published time code signal.

Table 2–1: IRIG signal identification numbers (3 digits)

Format	**A**			IRIG-A Format
	B			IRIG-B Format
	D			IRIG-D Format
	E			IRIG-E Format
	G			IRIG-G Format
	H			IRIG-H Format
1st Digit - Modulation		**0**		Unmodulated - DC Level Shift, pulse-width coded
		1		Amplitude modulated, sine wave carrier
		2		Manchester modified
2nd Digit - Carrier Frequency / Resolution			**0**	No carrier (DCLS)
			1	100 Hz / 10 ms resolution
			2	1 kHz / 1 ms resolution
			3	10 kHz / 100 µs resolution
			4	100 kHz / 10 µs resolution
3rd Digit - Coded Expressions				**0** BCD_{TOY}, CF, SBS
				1 BCD_{TOY}, CF
				2 BCD_{TOY}
				3 BCD_{TOY}, SBS
				4 BCD_{TOY}, BCD_{YEAR}, CF, SBS
				5 BCD_{TOY}, BCD_{YEAR}, CF
				6 BCD_{TOY}, BCD_{YEAR}
				7 BCD_{TOY}, BCD_{YEAR}, SBS

Common time code formats are:

- B00x for DC Level Shift
- B12x for amplitude modulated

With the C37.118 extensions OFF (no BCD_{YEAR}) these time codes are B002 and B122; with the C37.118 extensions ON, these codes are BOO6 and B126. These time codes are defined by the clock settings as well as the ability of IEDs connected to the clock to support these implementations. A limitation of IRIG is that there can be only one time code on any clock connection string.

IRIG-B in the MultiSync 100 1588 GPS Clock

The MultiSync 100 has two TTL (coaxial) output ports, each of which can be configured to provide an IRIG-B time signal, independent of the other port. The MultiSync 100 supports both DC Level Shift and Modified Manchester time codes. The complete time code designations supported are:

- **B002**: DC Level Shift, only BCD_{TOY} in the time code.

  On the GE Configuration tool **I/O** tab:

  - Under **IRIG-B / Pulse Output Port** select **IRIG-B**, and set **Modulation** to **DCLS**.
  - Under **IRIG-B Stream**, set **Extensions** to **None**, and leave **Binary code in seconds** unchecked.
- **B006**: DC Level Shift, BCD_{TOY} and BCD_{YEAR} in the time code.

  On the GE Configuration tool **I/O** tab:

  - Under **IRIG-B / Pulse Output Port** select **IRIG-B**, and set **Modulation** to **DCLS**.

  - Under **IRIG-B Stream**, set **Extensions** to **C37.118**, and leave **Binary code in seconds** unchecked.
- **B007**: DC Level Shift, BCD_{TOY}, BCD_{YEAR}, and SBS in the time code.

  On the GE Configuration tool **I/O** tab:
  - Under **IRIG-B / Pulse Output Port** select **IRIG-B**, and set **Modulation** to **DCLS**.
  - Under **IRIG-B Stream**, set **Extensions** to **C37.118**, and check **Binary code in seconds**.
- **B232**: Modified Manchester, only BCD_{TOY} in the time code.

  On the GE Configuration tool **I/O** tab:
  - Under **IRIG-B / Pulse Output Port** select **IRIG-B**, and set **Modulation** to **Modified Manchester**.
  - Under **IRIG-B Stream**, set **Extensions** to **None**, and leave **Binary code in seconds** unchecked.
- **B236**: Modified Manchester, BCD_{TOY} and BCD_{YEAR} in the time code.

  On the GE Configuration tool **I/O** tab:
  - Under **IRIG-B / Pulse Output Port** select **IRIG-B**, and set **Modulation** to **Modified Manchester**.
  - Under **IRIG-B Stream**, set **Extensions** to **C37.118**, and leave **Binary code in seconds** unchecked.
- **B237**: Modified Manchester, BCD_{TOY}, BCD_{YEAR}, and SBS in the time code.

  On the GE Configuration tool **I/O** tab:
  - Under **IRIG-B / Pulse Output Port** select **IRIG-B**, and set **Modulation** to **Modified Manchester**.
  - Under **IRIG-B Stream**, set **Extensions** to **C37.118**, and check **Binary code in seconds**.

IRIG-B wiring considerations

DC Level Shift IRIG time code in the MultiSync 100 is developed at a level of approximately 5 volts peak. This signal is normally distributed using copper wiring, however, in the case of the MultiSync 100 the TTL outputs are coaxial with BNC connectors. It is usually possible to connect an unmodulated IRIG driver to numerous IEDs using coaxial cable or preferably shielded, twisted pair cable. The general limitation on length between clock and IEDs is 100m, and the number of IEDs is dependent on voltage drop calculations. An accuracy of one millisecond should be possible for any reasonable configuration of coaxial cable and IEDs; better accuracies require a careful design.

Installation of IRIG-B cables must follow best practices for installation of copper cables in noise-inducing environments. Cables should be grounded and ground loops should be avoided, therefore, ground at one point only. This ground point must be at the clock itself if multiple devices will be connected, so it is an industry best practice to ground time-code outputs at the clocks. A termination resistor can be added to the end of the coaxial run to achieve good impedance matching, particularly for short or lightly loaded lines.

Designing an application for IRIG-B requires specific information about the clock output port and device clock input ports, and a known cable resistance. Clock ratings are the output voltage and output current; device ratings are the minimum and maximum voltage rating and the impedance of the clock port. Devices are normally connected in parallel to the clock output port. Solving the resulting equivalent circuit will determine if the clock has enough capacity to drive the connected devices, and if the voltage level at each device is sufficient for operation. The MultiSync 100 clock output ports are rated for 0-5V and 150mA sink/source.

Network Time Protocol / Simple Network Time Protocol

Network Time Protocol (NTP) is a networking protocol for clock synchronization between devices operating over packet-switched, variable-latency data networks, and is intended to synchronize all participating devices to within a few milliseconds of UTC time. NTP can achieve better than one millisecond accuracy in local area networks under ideal conditions.

NTP functionally relies on a statistical average of the calculated round-trip delay and offset between the device to be synchronized and multiple time servers on diverse networks. NTP does not, therefore, directly account for switching time delays, asymmetry in network paths, or reconfiguration of networks. Routine switching, network reconfiguration, and traffic load reduce the accuracy of NTP time synchronization.

The 64-bit timestamps used by NTP consist of a 32-bit part for seconds and a 32-bit part for fractional second, giving a time scale that rolls over every 232 seconds. NTP uses an epoch of January 1, 1900, so the first rollover occurs in 2036. NTP can adjust for leap seconds, but does not transmit information about local time zones or daylight saving time.

SNTP

Simple Network Time Protocol (SNTP) is a less complex implementation of NTP. SNTP disregards drift values and uses simplified system clock adjustment methods. As a result, SNTP achieves only a low quality time synchronization when compared with a full NTP implementation. It is typically used in applications where high accuracy timing is not required.

NTP/SNTP in the MultiSync 100

The MultiSync 100 can act as an NTP or SNTP server, and is intended to be an NTP Stratum-1 time server. The MultiSync 100 synchronizes to GPS to provide accurate timing signals, and NTP time signals are published through the clock Ethernet port.

IEEE 1588 / PTP / C37.238

The IEEE Std. 1588-2008 IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems (commonly referred to as 1588v2 or PTP for Precision Time Protocol) is a message-based protocol that can be implemented across packet based networks including, but not limited to, Ethernet. 1588 accounts for the variable delay to packets from Ethernet switches that inhibits path delay measurements, and allows accuracy down to the nanosecond level at end-device clocks.

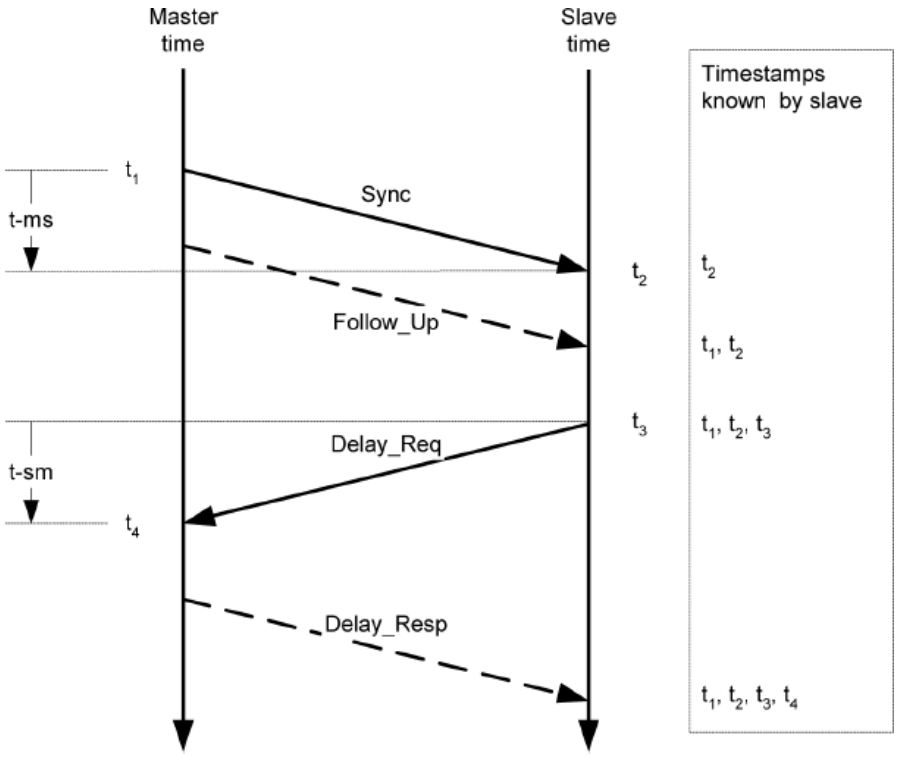
The IEEE 1588 protocol was designed for low cost implementation over Ethernet networks, with plug and play functionality for ease of installation. Synchronization can be achieved with a minimum use of network resources, and can be implemented in systems with minimal computing resources.

Operation of the IEEE 1588 protocol relies on a measurement of the communication path delay between the time source, referred to as a master, and the receiver, referred to as a slave. This process involves a message transaction between the master and slave where the precise moments of transmit and receive are measured - preferably at the hardware level. Messages containing current time information are adjusted to account for the path delay, therefore providing a more accurate representation of the time information conveyed.

Message-based synchronization

1588, or PTP, is based upon the transfer of network datagrams to determine system properties and to convey time information. A delay measurement principle is used to determine path delay, which is then accounted for in the adjustment of local clocks. At start up, a master/slave hierarchy is created using what is called the Best Master Clock (BMC) algorithm to determine which clock has the best source of time. The BMC algorithm is then run continuously to quickly adjust for changes in network configuration. Synchronization is achieved using a series of message transactions between master and slaves. There are five message types - Sync, Delay Request, Follow Up, Delay Response and Management - which are used for all aspects of the protocol. An additional sequence of message transactions takes place to synchronize a pair of clocks.

Figure 2: IEEE 1588 master-Slave offset measurement



The slave clock calculates the link delay (transmission time between the master and slave), the slave clock offset (the time interval by which the slave leads the master), and the drift between the two clocks based on the four timestamps recorded by the slave clock on the receipt and transmission of the 1588 messages.

Best Master Clock algorithm

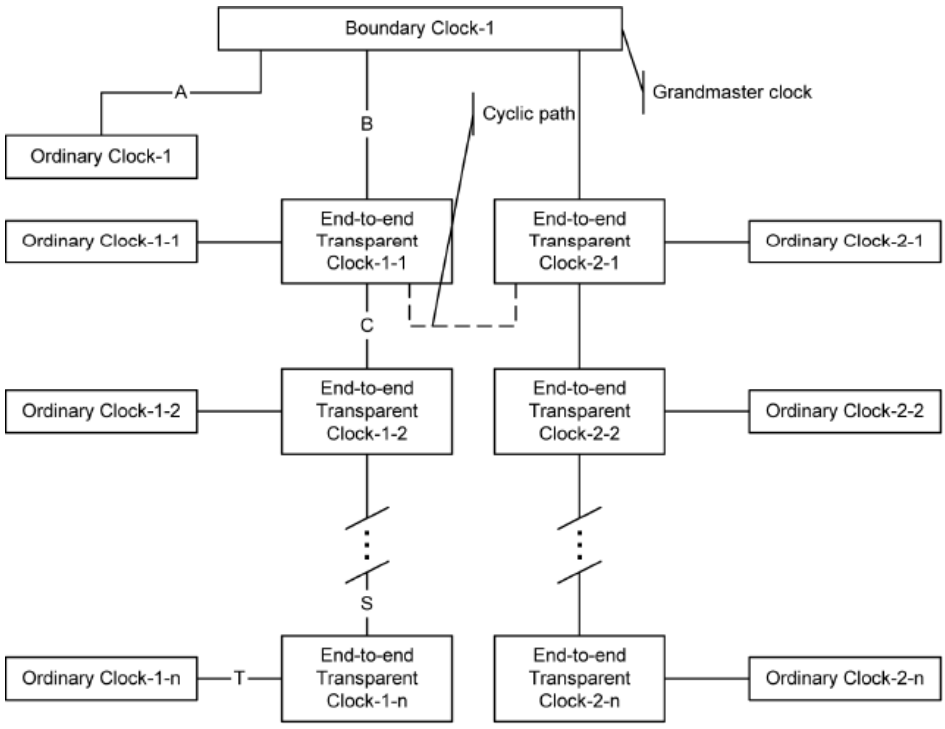
The best master clock (BMC) algorithm is central to the operation of PTP. It specifies the method by which each clock determines the best master clock in its subdomain out of all clocks it can see, including itself. The decision is based upon the stratum (clock quality) number of the local clock (GPS and Atomic clocks are stratum 1), the clock identifier/ accuracy of the clock's time base, the stability of the local oscillator and the closest clock to the grand-master (based on the spanning tree algorithm). The algorithm was designed so that no negotiation has to occur between clocks, while ensuring that configurations with two masters, no masters or an oscillation between masters never occur. BMC allows multiple clocks on the same system, but a device will only synchronize with one master at a time.

Components of a 1588 network

A PTP or 1588 network must account for the time delays caused by packet switching devices. Therefore, all switches must implement clock functions to account for time delays through the switch.

The figure shows a possible PTP synchronization network topology. The grandmaster clock is the primary time source, a boundary clock creates segmented synchronization subdomains, and ordinary clocks synchronize to the boundary clock through end-to-end transparent clocks.

Figure 3: IEEE 1588 synchronisation network



Grandmaster clock

This is the primary reference source within a PTP subdomain, the "ultimate source of time for clock synchronization using the PTP protocol". The Grandmaster clock will generally have a high-precision time source, which can be a GPS reference or an Atomic clock. If synchronization is needed purely within a network and not to any external reference (such as UTC - Coordinated Universal Time), then the grandmaster clock could also free run. It is possible to have multiple Grandmaster-capable clocks on the same system.

Ordinary clock

An ordinary clock is formally defined as a PTP clock with a single PTP port. It operates as a node within a PTP network, and can be selected as a master or slave within a segment according to the BMC algorithm. Ordinary clocks are the most common device within a PTP network. They are generally used as the end nodes within a network as part of the devices needing synchronization. Ordinary clocks can come in various forms and with various interfaces to external devices. At the device end, they're typically a slave clock only.

Boundary clock

Boundary clocks are used within a PTP system to sit in place of standard network switches or routers. Boundary clocks are defined as PTP clocks "with more than a single PTP port, with each port providing access to a separate PTP communication path". The boundary clock acts as an interface between separate PTP domains, intercepting and processing all PTP messages and passing all other network traffic. The BMC algorithm is used by the boundary clock to select the best clock any port can see. The chosen port is set as a slave (to a master or grandmaster clock) and all other ports of the boundary clock are asserted as masters to their domain. Therefore, a boundary clock will carry time through an Ethernet switch, and will continue to carry time if the master clock source is lost.

Transparent clocks

Transparent clocks update a time-interval field within PTP event messages, as introduced in 1588v2. This 64-bit time-interval correction field allows for switch delay compensation to a potential accuracy of less than a picosecond.

There are two types of transparent clocks, end-to-end and peer-to-peer. End-to-end transparent clocks update the time interval field for the delay associated with individual packet transfers, whereas peer-to-peer transparent clocks measure the line delay associated with the ingress transmission path and include this delay in the correction field. Peer-to-peer transparent clocks can allow for faster reconfiguration after network topology changes.

1588-capable Ethernet switches typically support transparent clocks. Some switches also support boundary clocks.

C37.238

C37.238-2011, the IEEE Standard Profile for Use of IEEE 1588 Precision Time Protocol in Power System Applications (known as "C37.238" or the "Power Profile") is a specialized PTP profile for power system applications. This profile is based on the specific substation network architectures, data exchange mechanisms, and performance of time distribution service required for power system applications. The profile is optimized for isolated Ethernet networks and a small number of dedicated grandmaster-capable clocks, typical of the power substation environment.

The Power Profile achieves the above goals by strictly defining some of the aspects of 1588, especially by selecting peer-to-peer measurements and establishing the overall steady-state synchronization requirement of 1 µs worst-case time error over 16 network hops. C37.238 also defines the ability to send time zone related data to slave clocks, specific mappings for IEC 61850 and C37.118.1/.2, strict requirements for Grandmaster clocks, and an IRIG-B replacement mode.

1588 and C37.238 in the MultiSync 100

The MultiSync 100 GPS Clock is intended to operate as a Grandmaster Clock or an Ordinary Clock on 1588 networks. The MultiSync 100 supports both 1588v2 and C37.238. The 1588v2 implementation is configurable for end-to-end and peer-to-peer networks, or to implement the C37.238 Power Profile.

The Multilink ML3000 Ethernet Switch series also supports 1588 when specified with 1588-enabled ports. The ML3000 switches can operate as boundary clocks or as transparent clocks.

The MultiSync 100 GPS Clock can also be used as an interface between 1588 time synchronization networks using the G8265.1-2010 Telecom Profile and the C37.238 Power Profile messages. The MultiSync can accept G8265.1-2010 signals, and ouptut C37.238 signals, to support the application of system-wide grandmaster clocks.

Figure 4: Typical MultiSync 100 GPS Clock application

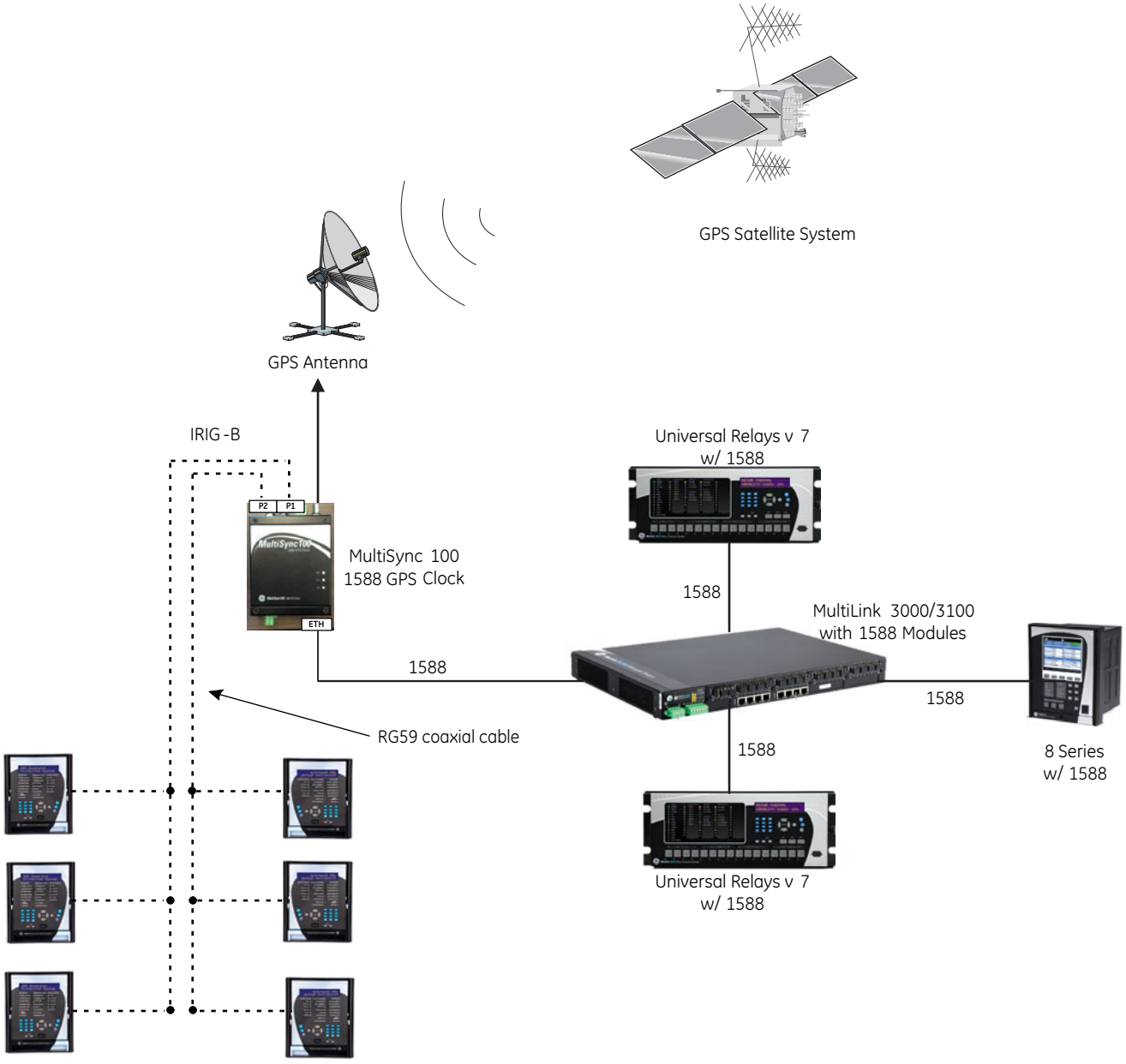
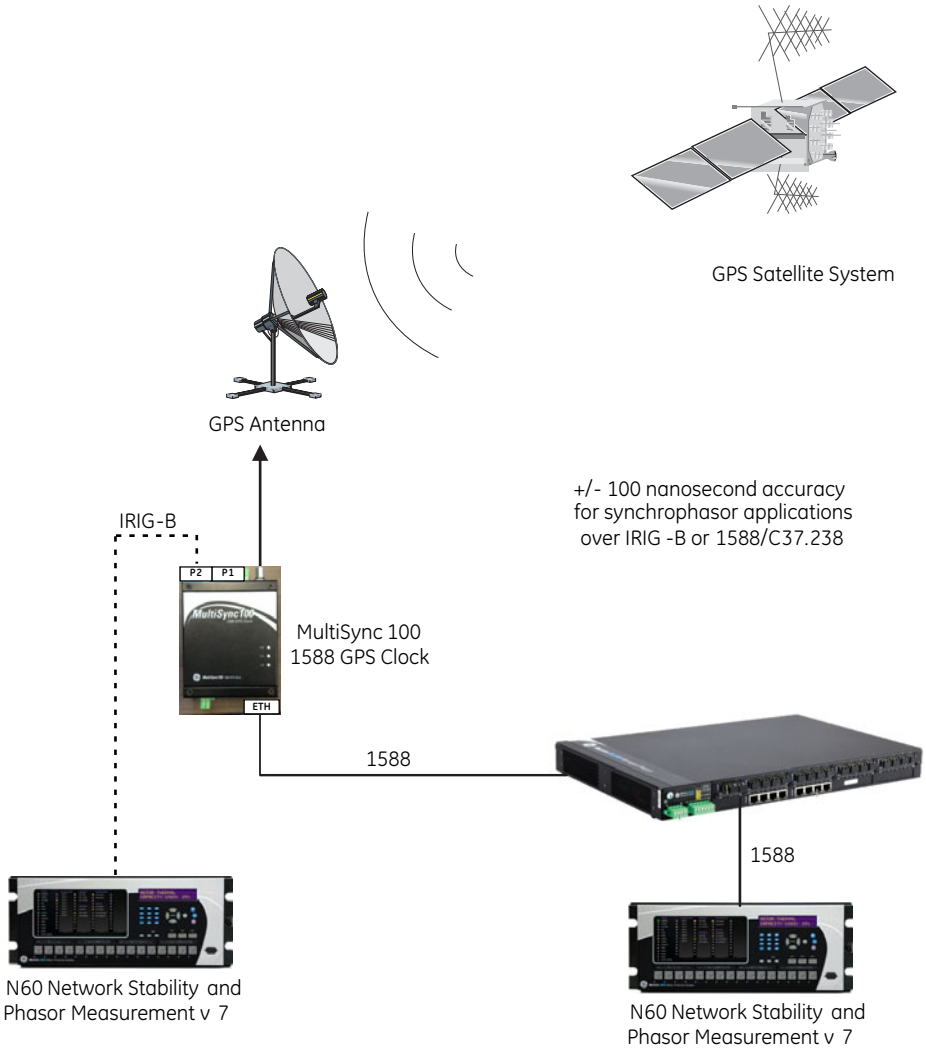


Figure 5: Timing accuracy for Synchrophasors



MultiSync 100 GPS Clock

Chapter 3: Installation

This chapter outlines installation of hardware and software.

Device hardware

Front panel

LED Indicators

The front panel of the MultiSync 100 contains three LEDs:

Label	LED state	Description
PWR	OFF	No power
	ON	Power supplied
SYN	OFF	No power
	ON	In sync
	Slow (2 Hz) flash	Holdover
	Fast (4 Hz) flash	Out of sync
ALM	OFF	No alarms present
	Flashing	Alarm

Refer to the GE Clock Configuration Tool software interface for an indication of which alarms are present.

Bottom panel

Figure 6: Bottom panel

Power supply connector (PWR)

The MultiSync 100 power port is a 2-pin screw lock (5.08 mm pitch). The power supply is an ultrawide range DC power supply capable of operating over 48 V to 250 V DC, drawing a maximum of 5 W.

USB connector (USB)

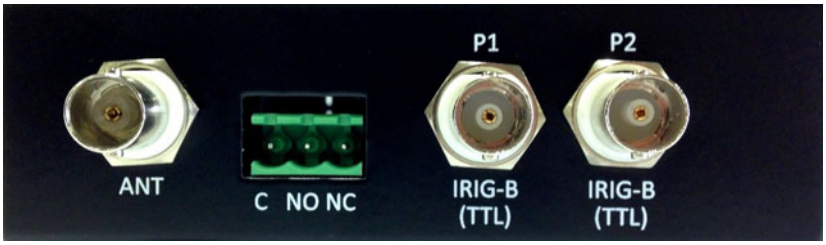
The MultiSync 100 unit is fitted with a USB type B port, which allows configuration of the unit. By disabling Ethernet configuration, only USB configuration is available, increasing the security of the MultiSync 100 unit.

Ethernet port (ETH)

The MultiSync 100 GPS Clock is fitted with an RJ45 Ethernet port, which allows the clock to be configured over a LAN or by direct connection. The MultiSync 100 is available with NTP/SNTP though the Ethernet interface. The Ethernet interface supports 10 and 100 Mbps connectivity.

Top panel

Figure 7: Top panel



Antenna connector (ANT)

The ANT antenna input provides an interface for connecting an external active antenna via low-loss coaxial cable. Cable with 50 Ω impedance is recommended. The MultiSync 100 supplies 5 VDC, 50 mA to power an active antenna. The total combined gain of the antenna system (including the antenna, cable, and connectors) should fall in the range of 10 to 35 dB, with the optimum value being 22 dB.

Alarm connector (N NO NC)

The alarm port is a 3-pin, 5.05 mm connector. The alarm port is a high-voltage port with a normally open (NO) contact and a normally closed (NC) contact. Both contacts are rated at 300 V and 100 mA, AC or DC. The port is galvanically isolated from the internal electronics, and protected by high-voltage, self-resetting fuses and suppressor diodes.

The alarm port is designed to switch a load which will limit the current supplied. The alarm can be triggered from multiple sources, and is programmed using the GE Clock Configuration Tool software.

TTL connectors (P1/P2)

The TTL outputs, labelled P1 and P2, are high-drive ports capable of driving 150 mA at 4.5 V. The outputs can be driven by a user-programmable pulse, IRIG-B, or DCF-77. Each port has its own transient protection. Both ports are galvanically isolated from the internal electronics.

Install hardware

For a sample system configuration, see the Typical MultiSync 100 GPS Clock application figure on page 19.

1. Install the antenna in a location with a clear line of sight to the sky.
2. Connect the antenna to the lightning arrestor.
3. Install the MultiSync 100 in the desired location and connect to the antenna.
4. Connect the MultiSync 100 to the network switch.
5. Connect to power, ensuring the correct DC voltage (36V - 300V) is used.

   If using DHCP, ensure the MultiSync 100 is connected to the network before powering up.
6. Connect the Sync indication relay to the alarm circuit if required

   (C = Common, NO = Normally Open, NC = Normally Closed)
7. Once the MultiSync 100 is installed and configured, connect the clock outputs to your

devices.

- An RG59 cable (or similar with characteristic impedance of >75 Ω) is recommended to connect devices to the P1 and P2 ports.
- A termination resistor of 120 Ω can be added to the end of a TTL run to achieve good impedance matching.

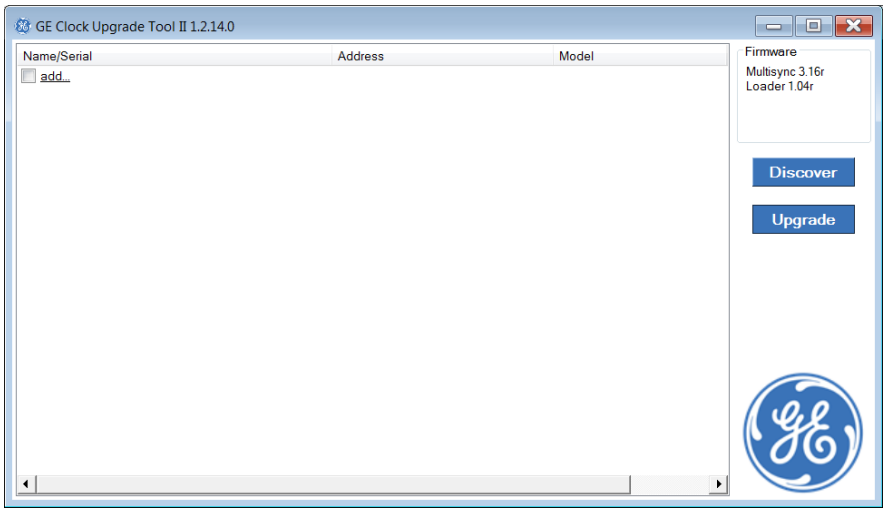
Upgrade firmware

For the latest version of the MultiSync 100 firmware, visit www.gridsolutions.com.

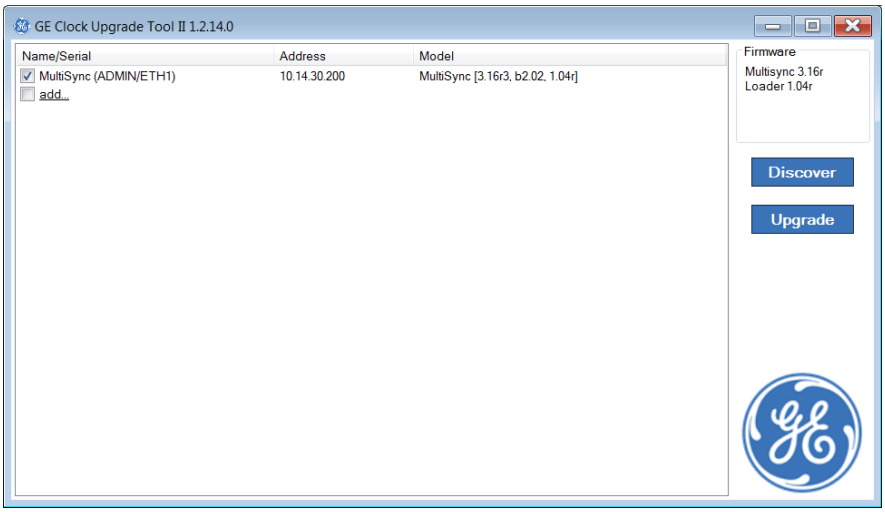
To upgrade the firmware:

1. Download the latest firmware file from www.gridsolutions.com if required.
2. Double-click the firmware executable file.

   The GE Clock Upgrade Tool window opens as shown.



3. Click **Discover** to locate a connected clock.
4. Click the checkbox beside the clock name to select the clock to upgrade, and click **Upgrade**.



Install the GE Clock Configuration Tool software

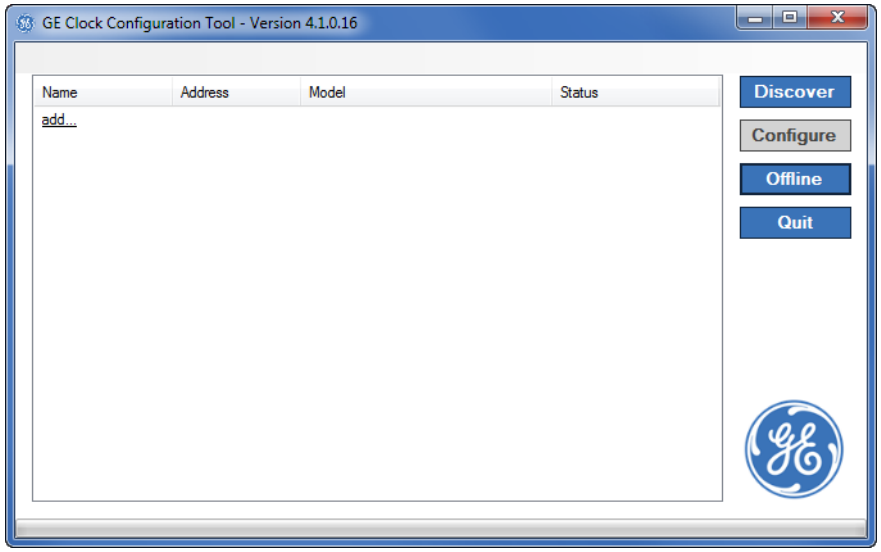
The GE Clock Configuration Tool software is a standalone executable file designed to run on a host computer running Microsoft Windows (XP, Vista, 7, or 8), and Microsoft .NET Framework 4 or later.

For the latest version of the GE Clock Configuration Tool software, visit www.gridsolutions.com.

To install the software:

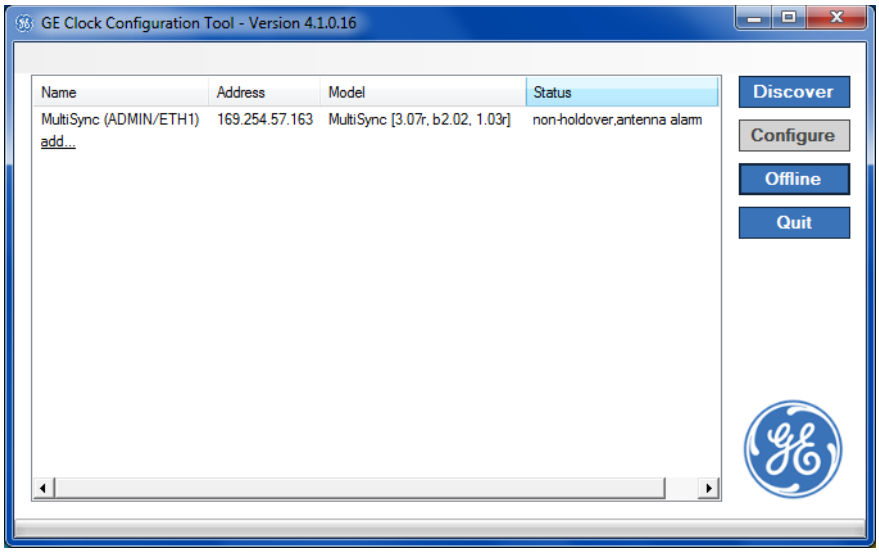
1. Insert the accompanying CD into the CD-ROM drive of any PC connected to the same network as the MultiSync 100.
2. Select the MultiSync GE Clock Configuration Tool from the List of available software.
3. Install the GE Clock Configuration Tool software on the host computer.
4. Ensure the clock is connected either directly to the host computer, or to a network switch located on the same LAN.
5. Run the GE Clock Configuration Tool.

   The Discovery window opens, as shown.



6. Click **Discover** to find the clock on the network.

The GE Clock Configuration Tool sends out a Broadcast message, and any clocks receiving the message respond as shown.



7. Click **Configure** to configure the clock.

   For detailed configuration steps, see Chapter 4 *GE Clock Configuration Tool* on page 31.

Communications settings

The GE Clock Configuration Tool software is designed to communicate with the MultiSync 100 GPS Clock through an Ethernet network or USB.

Ensure the GE Clock Configuration Tool software is not inhibited by:

- Firewall settings
- Anti-virus software
- Other communications software
- Intermediary devices connected between the GE Clock Configuration Tool software and MultiSync 100 GPS Clock

The GE Clock Configuration Tool software uses a combination of UDP Unicast and Broadcast packets for communication. It has been designed to minimize network traffic to reduce network bandwidth requirements. UDP Broadcast packets are user initiated using the Discover button in the GE Clock Configuration Tool software. If a network configuration problem exists (such as incorrect settings) then Broadcast packets may continue until the issue is resolved. All other communication is via Unicast. The expected network traffic between the clock and GE Clock Configuration Tool is 4 packets (2 transmit, 2 receive) per second until the connection is closed.

In the event that you do not want Broadcast packets on your network, it is recommended that you configure the Clock for the first time via direct connection, or by determining the initial IP address is of the clock, Once valid network settings have been set, there is no further need for Broadcast communication.

When using an Ethernet connection on a secure network, note that the following UDP ports may be used:

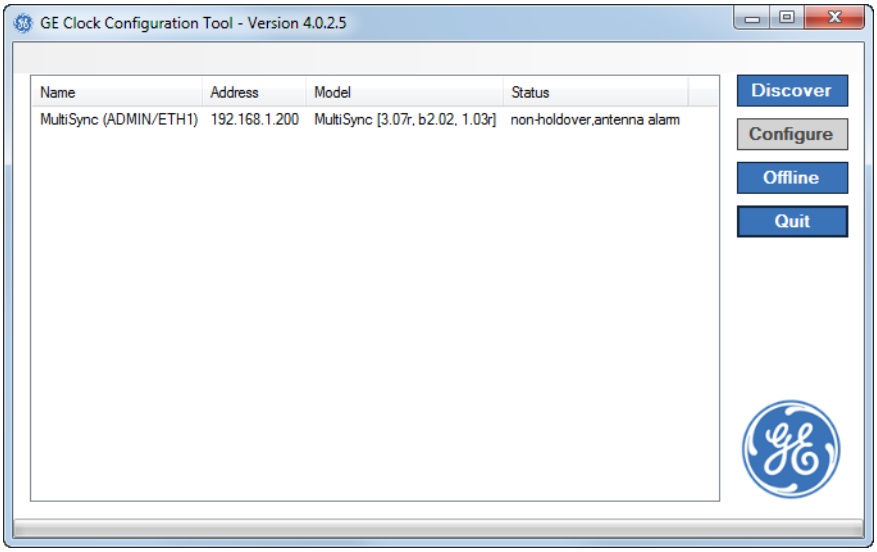
Port	Use
67, 68	DHCP

Port	Use
123	NTP and SNTP
161, 162	SNMP
319, 320	PTP
514	Syslog
9990, 9992, 9997, 9999	Configuration and management

GE Clock Configuration Tool quick configuration

This procedure applies to an average installation. Additional steps are required for some network configurations. See Chapter 4 for more detailed configuration information.

1. Ensure the clock is connected as described *Install hardware* on page 23.
2. To connect to the MultiSync 100, open the GE Clock Configuration Tool software, and click **Discover**.

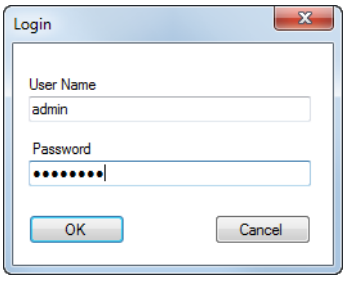


3. Select your MultiSync 100 from the list of available devices, and click **Configure**.

   A password prompt opens. The default login (case sensitive) for the MultiSync 100 GPS Clock is:

   User Name: **admin**

   Password: **Password**



NOTE

If the MultiSync 100 does not appear when you press **Discover** in the GE Clock Configuration Tool, connect the MultiSync 100 directly using an Ethernet cable.

4. Set a new password as prompted, or by clicking the Security icon  at the top of the GE Config window.

   The first time you login, you must change your password.

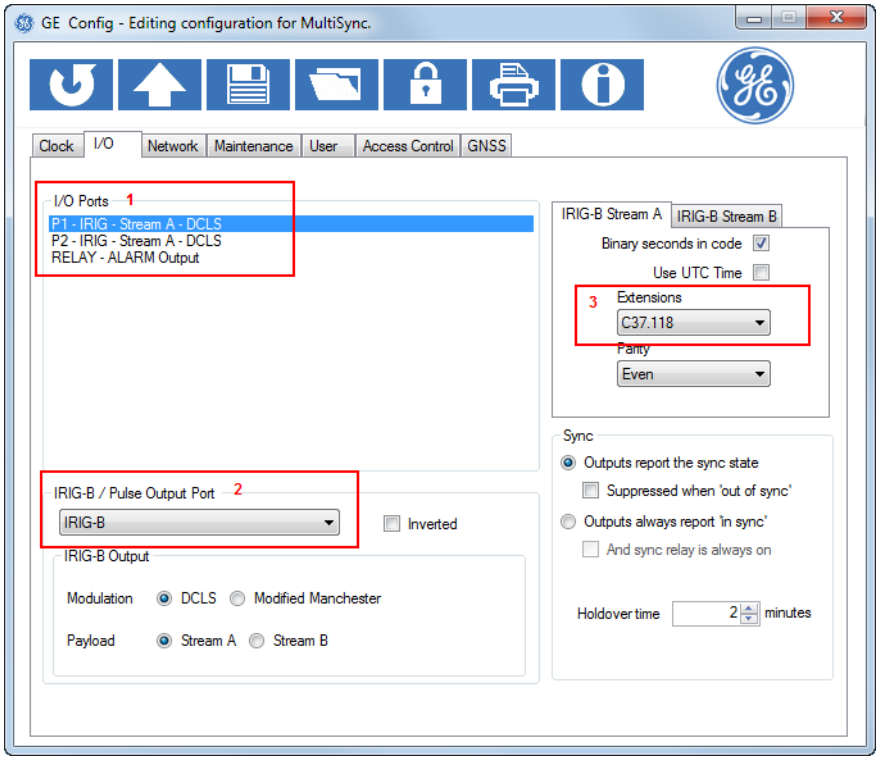
⚠CAUTION

   Ensure that you record your password and store it in a secure manner. If the administrative password is lost, the unit must be returned to the manufacturer for password reset.

   By default, passwords cannot contain the user name, must be at least eight characters long, and must contain at least three of the following character types: uppercase, lowercase, numeric, and control.

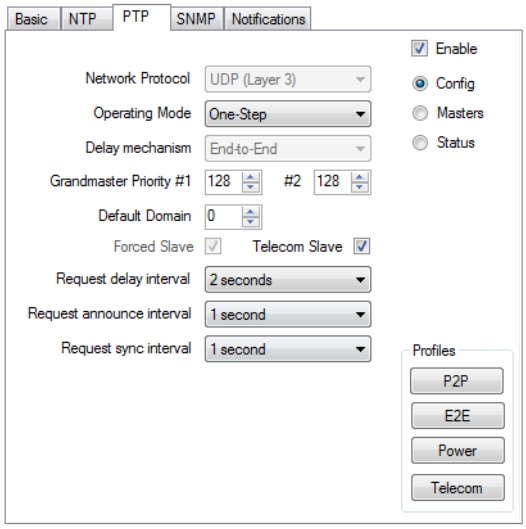
5. On the **GNSS** tab, for an average installation, set the following:
   5.1. **Cable Delay** to 4ns for every meter of antenna cable
   5.2. **Mask Angle** to 5 degrees
6. When using IRIG-B, the best practice is to enable at least one port for IRIG-B time synchronization.

   On the **I/O** tab, for a standard installation, do the following for each port:



   6.1. Select the port from the **I/O Ports** list.
   6.2. Set the **IRIG-B Pulse Output Port** type to IRIG-B.
   6.3. For both IRIG-B Streams A and B, set the **Extensions** to C37.118. to include the year in the IRIG-B data.

7. If using IEEE 1588 / C37.238, click the **PTP** tab and check **Enable** if not already checked. (Additional configuration changes may be required for your network.)



8. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

You are now ready to use the MultiSync 100 GPS Clock.

See Chapter 4 for more detailed configuration information.

MultiSync 100 GPS Clock

Chapter 4: GE Clock Configuration Tool

This chapter explains the GE Clock Configuration Tool software interface.

The MultiSync 100 can be configured by running the GE Clock Configuration Tool software on any PC connected to the same network as the MultiSync 100.

Before starting the GE Clock Configuration Tool software, check that you have the following:

- Administrative rights on your PC.
- UDP exceptions in your firewall for the GE Clock Configuration Tool software, and for ports 9992 and 9999.

NOTE

The time required to acquire GPS/GLONASS satellites and obtain tracking and synchronization for a new clock (given a good view of the sky) is typically within a minute. Reactivating a clock that has been synchronized previously will take longer, but not more than 45 minutes.

Managing configuration files

MultiSync 100 GPS Clock configuration files are stored in .xml format. When saving a file, optional encryption can be applied, requiring a password to reopen the file. Although .xml configuration files can be edited using text editing software, it is recommended that the GE Clock Configuration Tool is used for all changes to configuration files due to the complexity of the settings.

Save clock configuration to a file

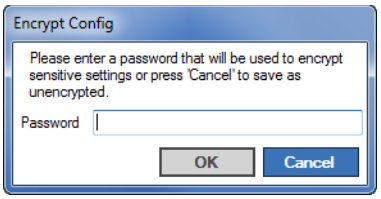
MultiSync 100 GPS Clock configuration files can be saved, with the option of encrypting sensitive settings such that a password is required to load the saved file. Both offline configuration files and active clock configuration files can be saved.

Saved configuration files include the TAI to UTC offset used by the clock, the time at the clock, and the time at the PC. This information is for reference only and is not reloaded with the configuration file.

1. Click the Save icon  at the top of the GE Config window.
2. Browse to select a location and file to overwrite, or enter a new filename for the

current configuration settings.

3. To save the file, do one of the following:
   - Click **Cancel** to save an unencrypted file.
   - Enter a password and click **OK** in order to encrypt any sensitive information within the saved configuration file.



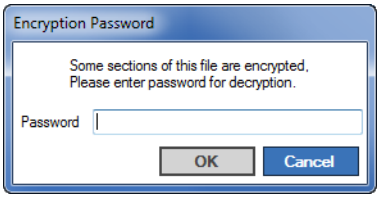
This password is required when the saved file is reloaded.

Load clock configuration from a file

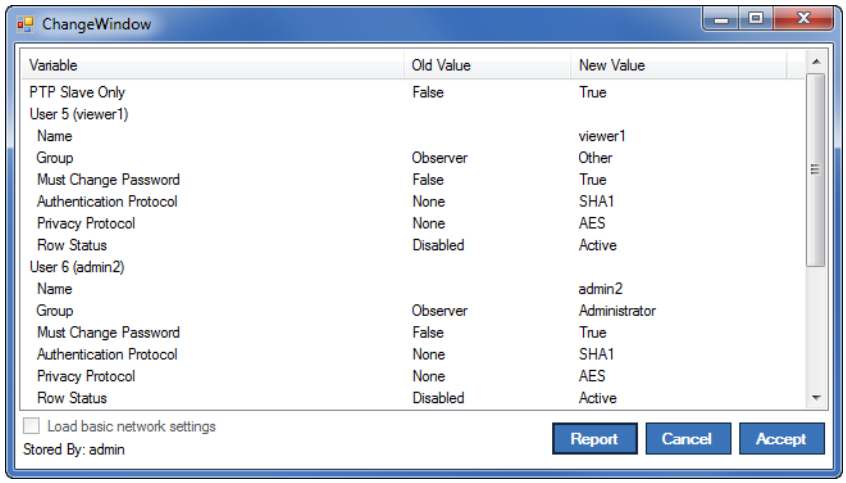
Saved MultiSync 100 GPS Clock configuration files can be loaded to view offline or loaded to an active clock. Configuration files saved with password encryption require the password to load.

When a configuration file is loaded to a clock, the differences between the current configuration and file being loaded are listed for reference.

1. Click the Open icon  at the top of the GE Config window.
2. Browse to the configuration file to open, and click **OK**.
3. Enter the file encryption password if the file was saved with encryption.



A change list opens, listing the differences between the current configuration and the file being loaded.



4. Click **Report** to print a report of all configurations changes, **Accept** to finish loading the file or **Cancel** to return to return to the current configuration.

NOTE

Any changes in the current configuration that have not been saved or loaded to the active clock are not included in the change list.

5. Click the Update icon at the top of the GE Config window to save the configuration loaded from the file to the active clock.

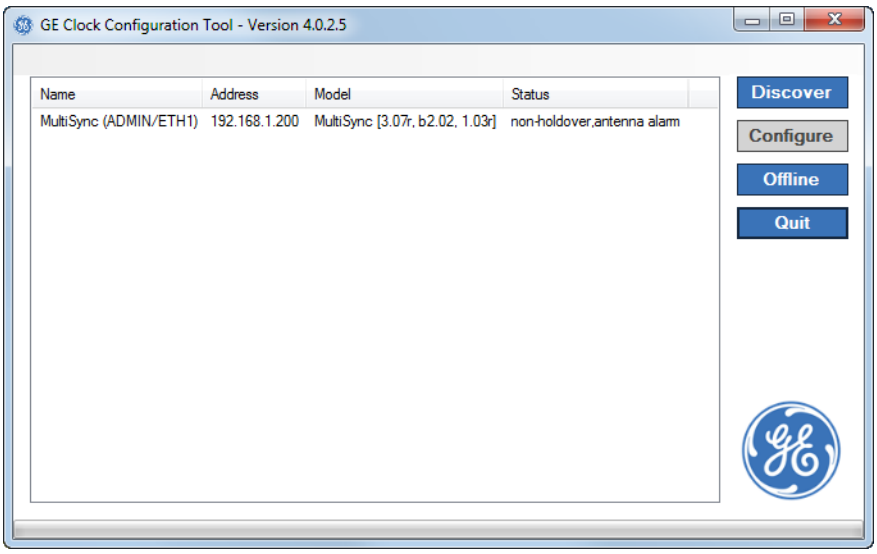
Top menu buttons

	Reload	Reload configuration from the active clock. Any configuration changes made are lost.
	Update	Save configuration to the active clock.
	Save	Save configuration to a file.
	Open	Open a configuration file.
	Security	Change password of current user.
	Print	Print current clock configuration.
	About	Display information about the GE Clock Configuration Tool.

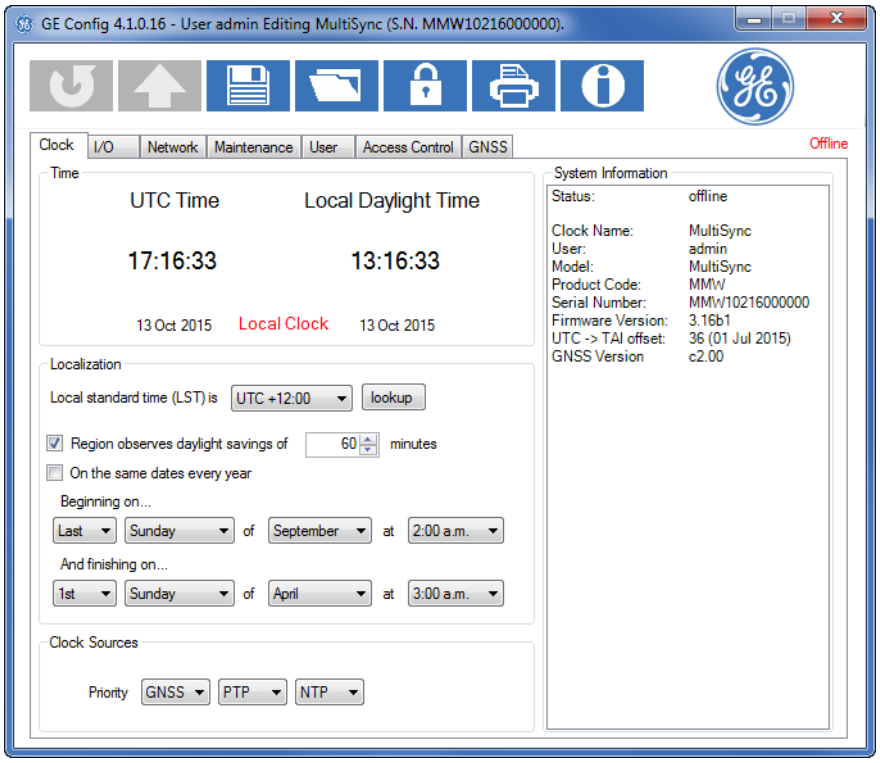
Offline Mode

Use offline mode to create or edit a configuration file without connecting to a clock.

1. Open the GE Clock Configuration Tool software, and click **Offline**.



Notice that in Offline Mode, the GE Clock Configuration Tool software has an "Offline" label in red on the right, the time displayed is for "Local Clock", and the reload and update buttons are not available.



2. Change configuration settings using the GE Clock Configuration Tool interface.

   Individual settings are described in the following sections.

3. Once configuration is complete, click the Save icon  at the top of the GE Config window to save the configuration to a file.

   The saved configuration file can be uploaded to any connected MultiSync 100 GPS Clock.

Configure clock settings

The Clock tab displays the satellite-determined Coordinated Universal Time (UTC), configured Local Daylight Time (LDT), daylights savings settings, clock time source, and general system information.

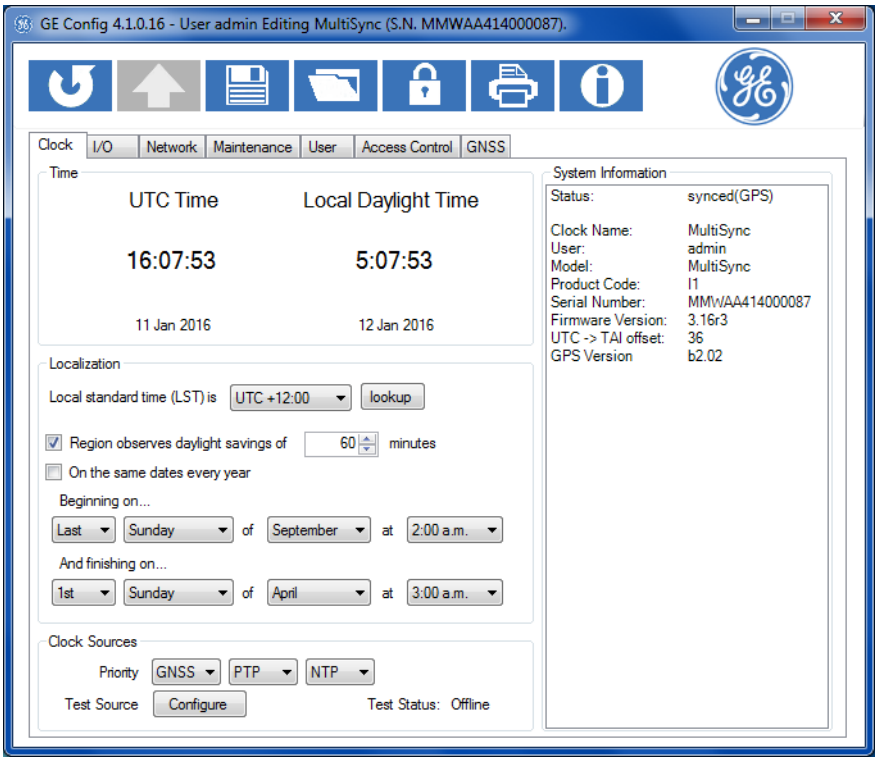
NOTE

The clock displays can be customized by clicking each clock to toggle between analog, 12-hour digital, and 24-hour digital displays.

NOTE

If "Time not available" is displayed in place of the clock displays, the system is either starting up or does not have a sync source.

Use the Clock tab to view system information, set the LDT and regional daylight savings time, and set the clock time source.



View system information

Click the **Clock** tab in the GE Config window.

The System Information area on the right contains the following informational fields:

- **Status**:
  - ***Alarm*** - one or more alarms are active
  - ***Offline*** - the clock is offline
  - ***synced(SOURCE)*** - the clock is online and synced, where the time source is one of GNSS, PTP, NTP, or TEST.
- **Clock Name**: The Clock Designation as entered on the **Maintenance** tab.
- **User**: The current active user
- **Model**: MultiSync
- **Product Code**: product code
- **Serial Number**: clock serial number, or 'Offline'
- **Firmware Version**: firmware version currently running on the clock
- **UTC->TAI offset**: the current number of seconds difference between Coordinated Universal Time (UTC) and International Atomic Time (TAI)
- **GNSS Module Version**: GNSS module version currently running on the clock
- **Alarms**: Any active alarms. Alarm status and settings are located on the I/O tab, and include the following:
  - ***No Power*** - no power source detected.
  - ***Satellites Low*** - the number of satellites being used for time and position calculation is below the threshold set on the GNSS tab.
  - ***No Sync*** - clock is not synchronized with a time source.

- ***Holdover*** - clock is not in sync, and the configured holdover time interval has not yet passed.
- ***Non-holdover*** - clock is not in sync and the configured holdover time interval has expired.
- ***No Antenna*** - The antenna circuit current drain is low (typically under 3 mA). This can be caused by poor connections, the connected antenna having a lower current drain specification, or a component in the antenna system providing power to the antenna so the clock does not see a connected load.
- ***Antenna Short*** - The antenna circuit current drain is high (typically over 100 mA). This can be caused by a short in the antenna circuit, by moisture ingress into the circuit, or by the connected antenna having a higher current drain specification.

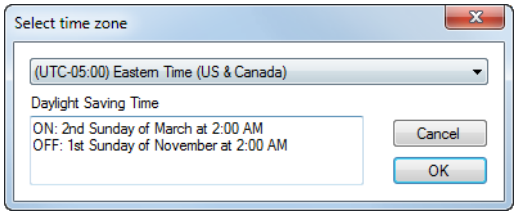
Set Local Standard Time (LST) and daylight savings time

1. Click the **Clock** tab in the GE Config window.
2. In the Localization area, click **lookup**.

NOTE

The lookup feature is derived from the Windows date and time settings on the host PC running the GE Clock Configuration Tool software. Verify these settings are correct before using the lookup feature. Time settings can also be changed individually if needed.

3. In the time zone dialog, select your time zone and region from the drop-down list.



   Time zones containing multiple regions with different daylight savings conventions have more than one entry.
4. Click OK to enter the selected time zone and regional daylight savings settings.

   To enter custom daylight savings settings, change individual settings within the **Localization** area of the **Clock** tab.

NOTE

To disable daylight savings time, ensure that the **Region observes daylight savings** tick box is not selected.

5. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Set clock source priority

The MultiSync 100 GPS Clock has the capability to synchronize to multiple time sources.

1. Click the **Clock** tab in the GE Config window.
2. In the Clock Sources area beside **Priority**, select the highest priority clock source from the left-most drop-down list.

   The remaining Priority fields update automatically, but can also be user-selected.

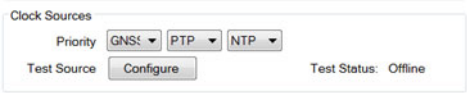
NOTE

Priority is ranked from left (highest) to right (lowest). The default priority setting is GNSS, PTP, NTP.

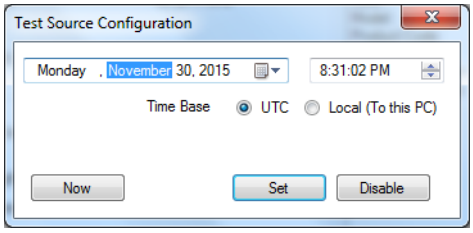
Use test mode

Test mode allows the clock to be set to an arbitrary time for test purposes. Use a test source for pre-commissioning tests or other tests where no other sync source is available. Under normal operating conditions, the test source should never be used. While the clock is in Test mode, all configured outputs will publish time synchronization signals. This includes analog outputs such as IRIG-B, and network messaging such as 1588 and NTP.

1. Click the **Clock** tab in the GE Config window.



2. In the Clock Sources area beside **Test Source**, click **Configure**.
3. Choose from a UTC or Local time base, and adjust the time and date manually, or click **Now** to use the time and date of the host PC.



4. Once you have selected a test time and date for the clock, click **Set**. To cancel any unsaved changes, click **Cancel**.

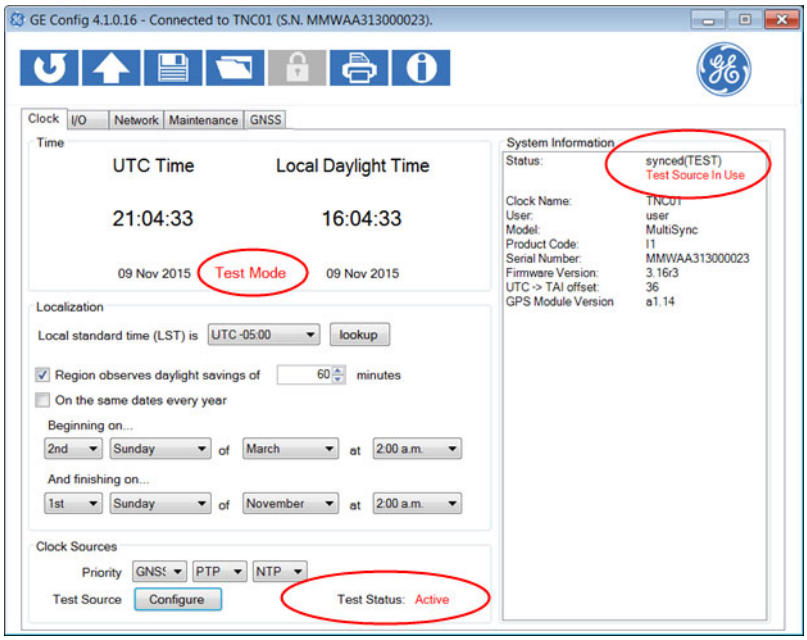
NOTE

Test mode settings take effect immediately when you click **Set**. Test mode and test source settings are not part of the settings file, and do not need to be uploaded.

Once a test source is configured, the clock enters test mode as is indicated in the following places on the **Clock** tab:

- Clock Sources area, Test Status field is “Active”.
- System Information area, Status field is “synced (TEST) Test Source In Use”.

– Time area, “Test Mode” appears beside the date.



In addition, the GE Clock Configuration Tool lists a status of “Synced (TEST)” for the clock if you click **Discover**.

5. Once testing is complete, disable test mode by restarting the clock, or click **Configure** beside **Test Source**, and then click **Disable**.

   Once test mode is disabled, the Test Status field on the **Clock** tab indicates “Offline”.

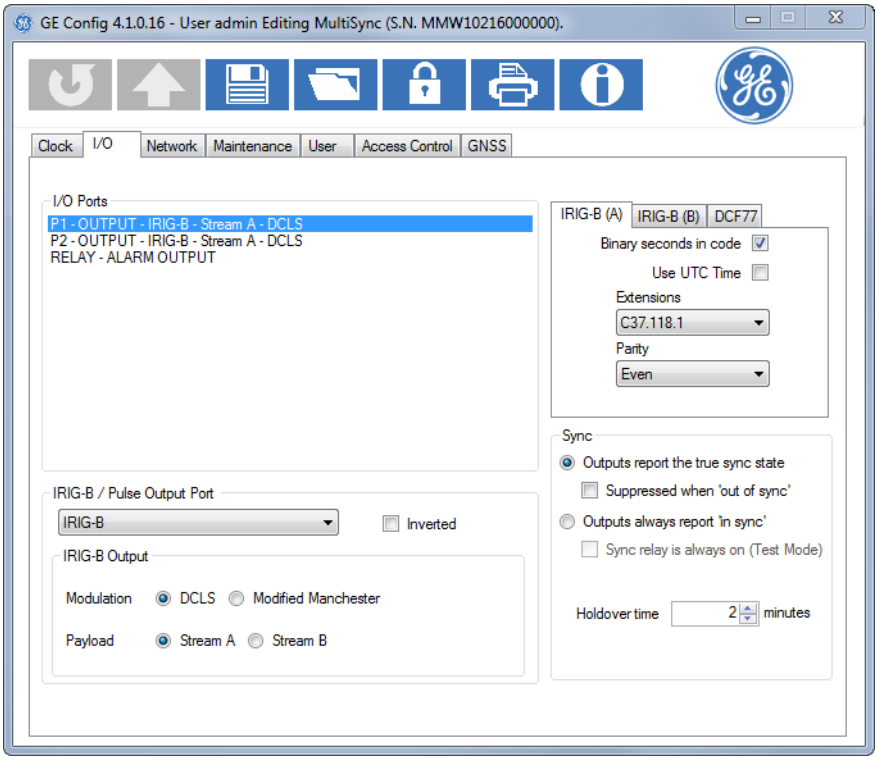
NOTE

If the clock is left in test mode, the test source is automatically deactivated after one week. Test mode settings are designed for short term test purposes, not long term use.

Configure I/O settings

The **I/O** tab displays the configured output pulse and output port settings, as well as the current status of all available relay alarms.

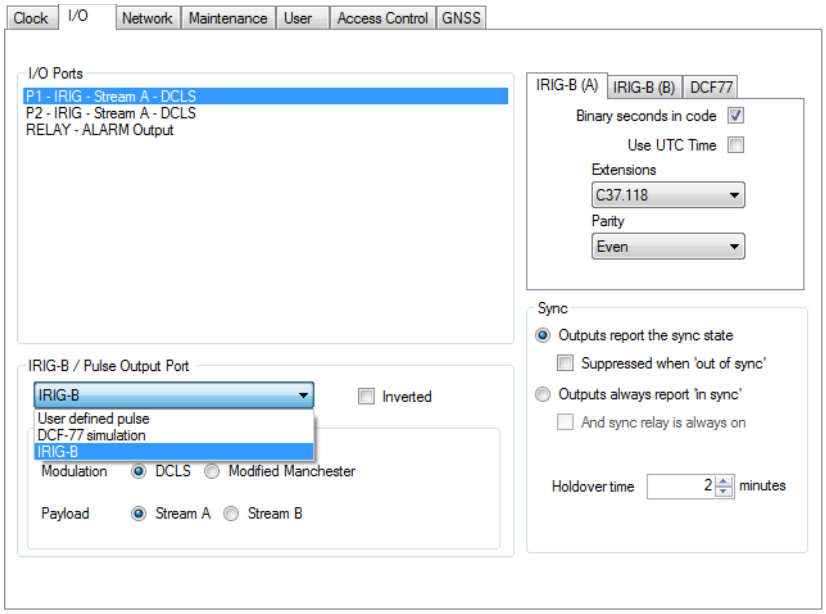
Use the **I/O** tab to set output pulses and output formats, and to enable relay alarms.



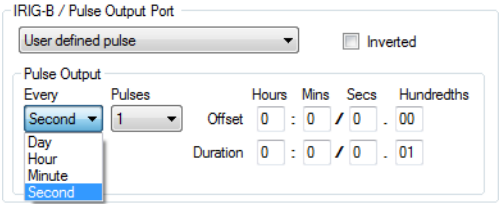
Configure output port settings

1. Click the **I/O** tab in the GE Config window.

2. In the **I/O Ports** area, click to select **P1** (port 1) or **P2** (port 2).



3. In the **IRIG-B / Pulse Output Port** area, select an output time code from the drop-down list:
   - **User defined pulse**: user-configured time code, with output pulses of configurable frequency and duration.
   - **DCF-77 simulation**: time code compliant with the DCF-77 specification.
   - **IRIG-B**: time code compliant with the IRIG-B specification.
4. For a user-defined pulse, configure the following fields:



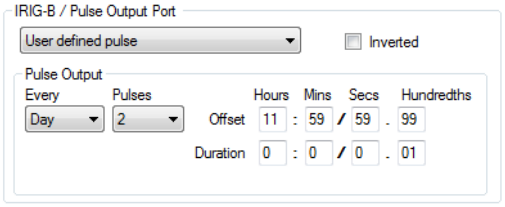
   4.1. **Every** - the period of time within which pulses occur. Select from Day, Hour, Minute, and Second.

   4.2. **Pulses** - the number of pulses within the selected period. Valid values evenly divide the selected period of time as follows:

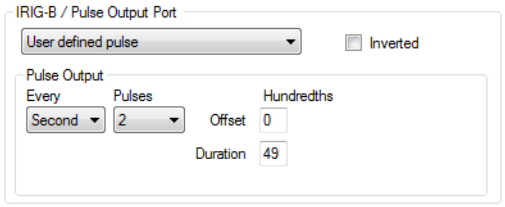
Period	Pulses - valid values
Day	1, 2, 3, 4, 6, 8, 12
Hour	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30
Minute	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30
Second	1, 2, 4, 5, 10, 20, 25, 50, 1000

   4.3. **Offset** - the delay from the start of the period to the start of the first evenly spaced pulse. The offset must be smaller than the time period divided by the number of pulses.

For example, 2 pulses a day must have an offset of less then 12 hours. Valid values in this case range from 0, to 12 hours less 0.01 second.

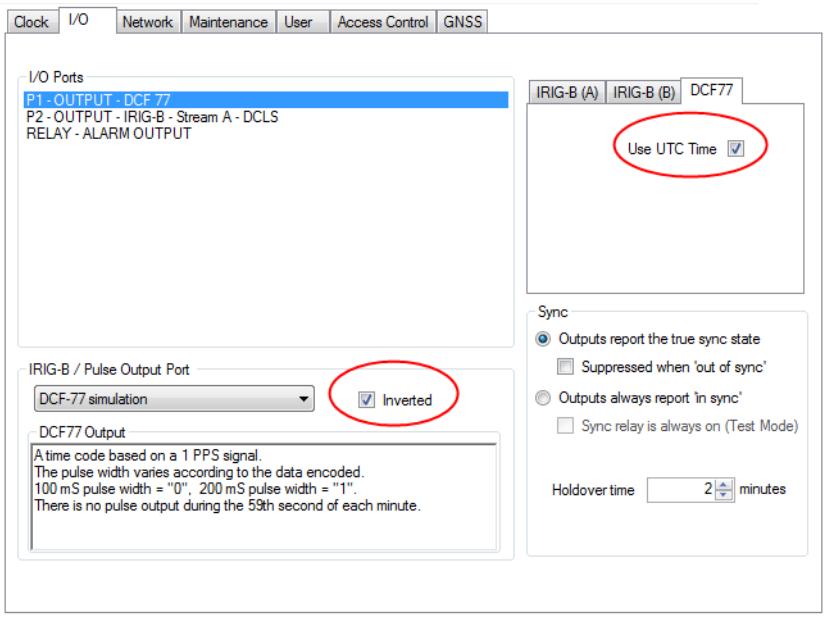


4.4. **Duration** - the length of time the output pulse stays asserted. The duration must be smaller than the time period divided by the number of pulses.
For example, 2 pulses a second must have a duration of less than 50 hundredths of a second. Valid values in this case range from 0 to 0.49 seconds.

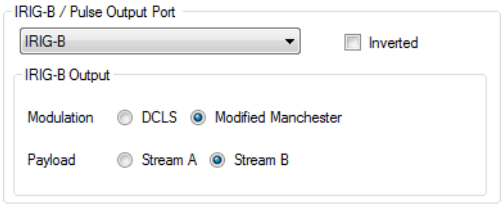


4.5. **Inverted** - reverses the polarity of the output pulses when checked.

5. For a DCF-77 compliant time code, the output signal has the following characteristics and configurable options:
   - A time code based on a 1 PPS signal.
   - The pulse width varies according to the data encoded.
   - 100 mS pulse width = "0", 200 mS pulse width = "1".
   - There is no pulse output during the 59th second of each minute.
   - **Inverted** - reverses the polarity of the output pulses when checked.
   - **Use UTC Time** - applies UTC, instead of the default Local Standard Time, when checked.



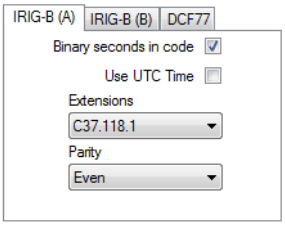
6. For an IRIG-B compliant time code:



6.1. Select the Modulation type:
DCLS - enables an IRIG-B B00X output signal. (Selected by default.)
Modified Manchester - enables an IRIG-B B22x output signal.

6.2. Select the payload, **Stream A** (selected by default) or **Stream B**.
The two different IRIG-B payload streams can be configured independently and used on different output ports as needed. This is useful when two IRIG-B time bases are required (Local Time and UTC Time), or when different IRIG-B extensions are required on each stream.

6.3. Set the extensions and other parameters for each payload:



Binary seconds in code - When checked, all of the outputs programmed for IRIG-B code including the amplitude-modulated output, include the 17-bit Binary Seconds of Day data (formats Bxx0 and Bxx3). When not checked, output formats are Bxx1 and Bxx2. This field is an option specified by IRIG standard 200-04. (Checked by default.)
Use UTC Time - applies UTC instead of Local Standard Time when checked. (Unchecked by default.)
Extensions: Select the extensions to add to the IRIG-B code.
Range: none, C37.118.1, AFNOR S87-500
Default: C37.118.1
none - No extensions to the IRIG-B code will be used.
C37.118.1 - Outputs programmed for IRIG-B code will also output: impending leap second information, local time offset, impending daylight savings change, and time-quality information all in accordance with C37.118.1 specification. In addition, parity checking can be selected. (
AFNOR S87-500 - Outputs programmed for IRIG-B code will also output: day of week, month, and day of month in accordance with the European AFNOR S87-500 specification.

Parity - Enables the selection of even or odd parity checking within the C37.118.1 extensions of the IRIG-B code. If AFNOR S87-500 extensions are configured, the option does not appear.
Range: Even, Odd
Default: Even

NOTE

For more information about IRIG-B settings, refer to *The IRIG-B time code standard* on page 10.

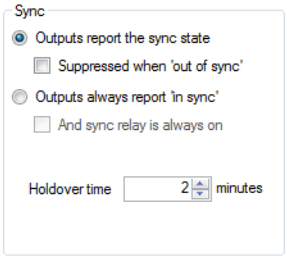
7. Repeat the configuration steps for the second port, if needed.

8. Once configuration is complete, click the Update icon  at the top of the GE Config window to save the configuration to the clock.

Set output sync reporting

Sync reporting settings apply to both ports, and set the behavior of the clock when it loses sync.

1. Click the **I/O** tab in the GE Config window.
2. In the **Sync** area, select from the following options:



   - **Outputs report the true sync state** - this is the default setting, and is recommended in most situations. IRIG-B output signals which include sync status data report the true state of synchronization. (Selected by default.)
   - **Suppressed when "out of sync"** - check this box to suppress the clock output when the clock loses sync. The sync relay operations is unaffected, and continues to indicate the true sync of the clock. Only available with "Outputs report the true sync state" selected. (Unchecked by default.)
   - **Outputs always report 'in sync'** - the clock continues to report time sync signals even when it has lost synchronization. By default the sync relay continues to indicate the true state of the clock. (Not selected by default.)
   - **Sync relay is always on** - the sync relay remains on, indicating the clock is in sync at all times, suppressing the sync relay alarm. Only available with "Outputs always report in sync" selected. (Unchecked by default.)
3. Set the **Holdover time** in minutes.

   Range: 1 to 2400 minutes

   Default: 2 minutes

   The Holdover time sets the period of time that elapses after loss of sync (from GNSS/PTP/NTP) before the MultiSync 100 reports a loss of sync status.

   The holdover feature masks the effect of a momentary loss of sync due to poor satellite coverage, network interruption, etc. The default setting of 2 minutes ensures output remains within 10 microsecond precision. Increasing the Holdover time decreases output precision.

   A holdover period is only be activated if the clock has been in sync for at least two minutes. During the holdover period, a Holdover alarm is triggered and the PTP Quality field degrades appropriately. The alarm relay can be programmed to trigger when either the Holdover alarm or Sync alarm is active (or both).

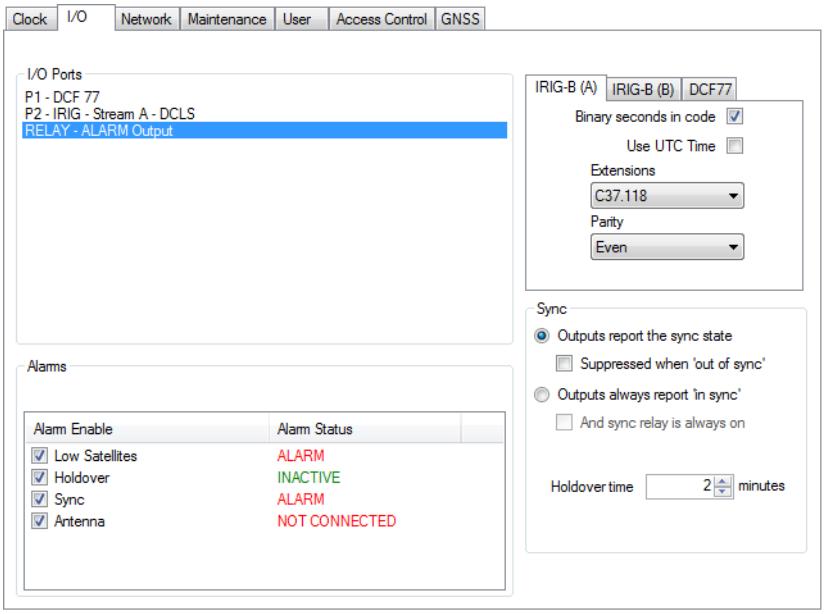
4. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Enable relay alarms

Alarms indicate the status of the MultiSync 100, and indicate a possible loss of accuracy of the time synchronization signal. This configuration step controls the operation of the alarm relay contact. Any enables alarm, when asserted, will energize the relay contact for hardwire signalling to a SCADA or DCS system. The status of enabled alarms is also available through SNMP network monitoring tools.

1. Click the **I/O** tab in the GE Config window.
2. Click to select the **RELAY-ALARM Output** port.

   All available alarms are listed.



3. In the **Alarms** area, check or uncheck boxes to enable or disable specific alarms. All available alarms are enabled by default.
   - **Low Satellites**: Triggers when no satellites have sufficient signal strength to be used for GNSS synchronization.
   - **Holdover**: Triggers when the MultiSync 100 has lost sync with GNSS, PTP, or NTP after being in sync for more than 2 minutes. The Holdover alarm is active for the configured **Holdover time**.
   - **Sync**: Triggers when the MultiSync 100 is not synced with GNSS, PTP, or NTP, and the configured **Holdover time** has expired.
   - **Antenna**: Triggers when either the antenna is not connected, or a short circuit exists on the antenna connection

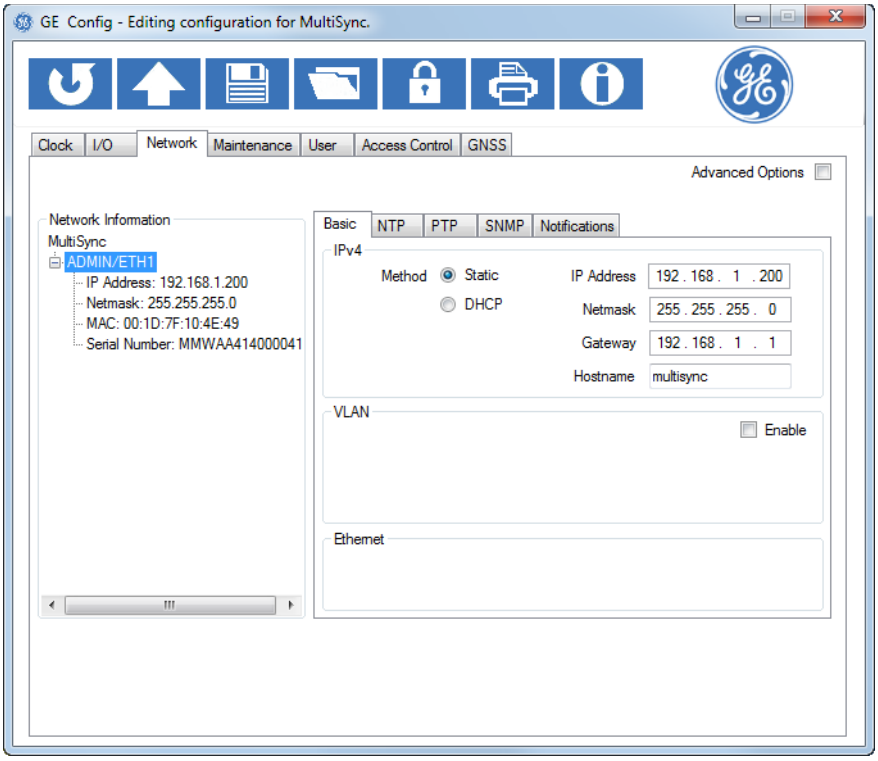
4. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Configure network settings

The **Network** tab displays information about the current network connection in the Network Information area.

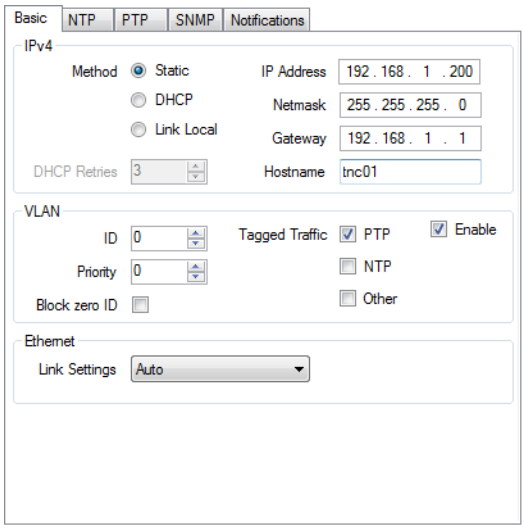
Use the **Network** tab to change network settings as needed for your specific network configuration, and to configure notifications.

Additional options are available if the **Advanced Options** box is checked. These options are indicated with **(adv)** in the manual, and should only be changed by users with an advanced knowledge of IP networks.



Configure Ethernet settings (Network>Basic)

1. Click the **Network** tab in the GE Config window.
2. Click the **Basic** tab.



In the **IPv4** area, select from the following configuration options:

2.1. **Method**: Select the method to use when configuring the Ethernet interface. Once the method is selected, enter the IP Address, etc. as applicable.
Range: Static, DHCP, Link Local
Default: DHCP

Static: Allows you to manually configure Ethernet settings. Set a valid IP Address, Netmask, and Gateway (if applicable, as well as a text Hostname in accordance with IETF RFC 952 guidelines to enable connection via DNS.
DHCP: Enables DHCP for automatic Ethernet settings assigned by the local DHCP server. This is the default clock setting. If the interface is set to DCHP and no DCHP server is running on the network, the interface reverts to a link local address as below.
Link Local (adv): Chooses a random IP Address from the range 169.254.0.0 to 169.254.0.16. Addresses are tested using ARP until a vacant address is identified.
DHCP Retries (adv): If **DHCP** is enabled, you can set the number of times the selected Ethernet port will attempt to obtain network information from a DHCP server before reverting to the link local address.
Range: 1 - 100
Default: 3

3. In the **VLAN** area, select from the following configuration options:

3.1. **Enable**: Enables the Virtual Local Area Network (VLAN). VLAN is disabled by default.

3.2. **ID**: Sets the ID inside the VLAN tags used by the selected packets.
Range: 0 to 4095
Default: 0

3.3. **Priority**: Sets the priority within the VLAN tag.
Range: 0 to 7
Default: 0

3.4. **Block zero ID**: When checked, blocks packets received on the selected interface on VLAN ID 0. Only available when the clock has already been configured with VLAN enabled, and the GE Clock Configuration Tool software is connected to the clock via VLAN.

3.5. **Tagged Traffic**: Configures the VLAN for the selected type of Ethernet packets.
Range: PTP, NTP, Other, PTP + NTP, PTP + Other, NTP + Other, PTP + NTP + Other
Default: PTP

NOTE

It is recommended that only advanced users with a thorough knowledge of VLAN tagging and Ethernet traffic configure 'Other' traffic.

4. In the **Ethernet** area, configure the **Link Settings** (adv): Sets the Ethernet port parameters. When set to Auto, the auto-negotiate function is enabled.
Range: Auto, 10 Mbps half duplex, 10 Mbps full duplex, 100 Mbps half duplex, 100 Mbps full duplex
Default: Auto

Configure NTP settings (Network>NTP)

1. Click the **Network** tab in the GE Config window.
2. Click the **NTP** tab.
Check **Enable** to enable Network Time Protocol (NTP). (Enabled by default)
Select from the following NTP 'Server' settings, with NTP enabled. If Advanced Options is checked, ensure the **Server** radio button selected as shown:

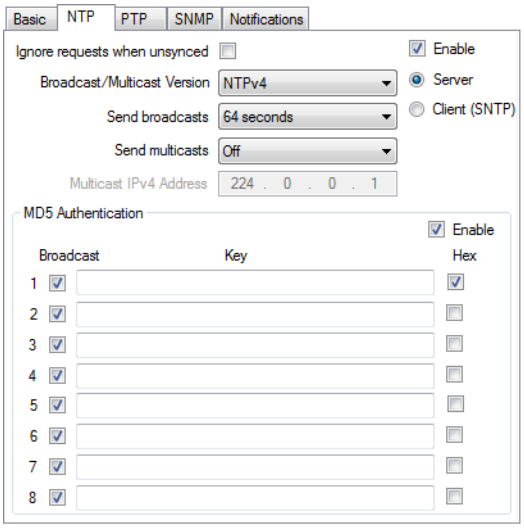
2.1. **Ignore requests when unsynced**: When checked, the clock will not respond to NTP time sync requests unless it is synchronized to an external time source referenced to UTC time. (Unchecked by default.)

2.2. **Broadcast/Multicast Version**: Select the preferred NTP version for Broadcast and Multicast traffic.
Range: NTPv1, NTPv2, NTPv3, NTPv4
Default: NTPv4

2.3. **Send broadcasts**: Set to configure the clock to send NTP Broadcast messages with the frequency specified.
Range: Off, 1/8, 1/4, 1/2, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384 seconds
Default: 64 seconds

Send multicasts: Set to configure the clock to send NTP Multicast messages
Range: Off, 1/8, 1/4, 1/2, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384 seconds
Default: Off

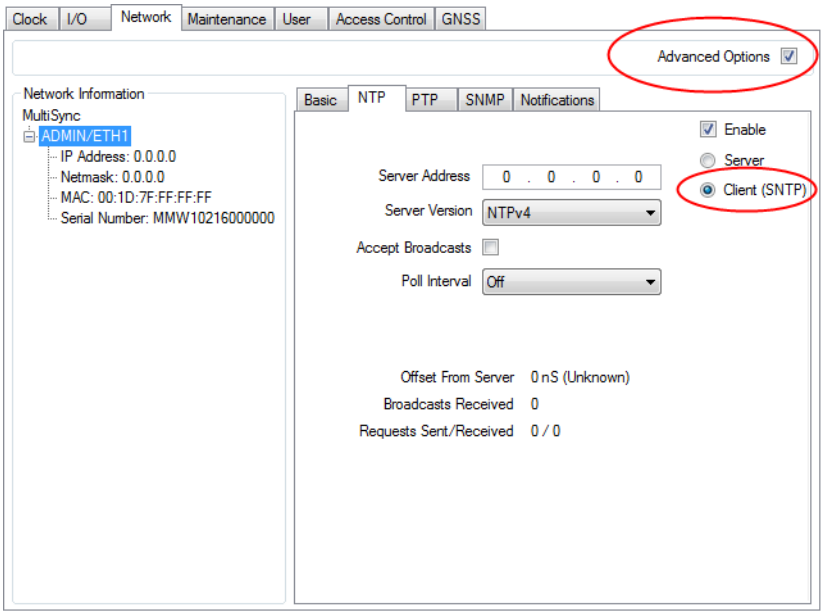
2.4. Optionally, configure MD5 authentication.



2.1. **Enable**: When selected, MD5 authentication is enabled. Incoming messages are checked and outgoing messages are signed with one of the configured keys. (Disabled by default.)

2.2. Configure up to eight MD5 authentication keys as follows:
Broadcast: Check to enable MD5 Authentication in Broadcast packets.
Key: Enter an authentication key up to 16 ASCII characters or hexadecimal values in length.
Hex: Check to convert the corresponding key from ASCII to hexadecimal. Uncheck to convert from hexadecimal to ASCII.

3. To switch from the **Server** to the **Client (SNTP)** view, select both **Advanced Options**, and the **Client (SNTP)** radio button.



The SNTP client function is a test function that allows the clock to synchronize to an NTP/SNTP Master clock. It is recommended that this functionality be restricted to a laboratory or controlled environment on a test basis, as some configurations do not comply with the published RFC. The SNTP Client operation is dependant on the Sync Priorities configured on the Clock tab.

3.1. **Server Address** (adv): Enter the IP address of the NTP/SNTP server.

3.2. **Server Version** (adv): Select the NTP version to use when polling the server.
Range: NTPv1, NTPv2, NTPv3, NTPv4
Default: NTPv4

3.3. **Accept Broadcasts** (adv): Check to sync to incoming NTP broadcasts. (Unchecked by default.)

3.4. **Poll Interval** (adv): Select the frequency of time requests between the Ethernet port and the server. Note that shorter intervals provide higher levels of accuracy, but increase network traffic.
Range: Off, 1/8, 1/4, 1/2, 1, 2, 4, 8, 16, 32, 64 seconds
Default: Off

3.5. **Offset From Server** (adv): Displays the offset between the Ethernet port and the NTP server in ns.

3.6. **Broadcasts Received** (adv): Displays the number of NTP/SNTP broadcasts received.

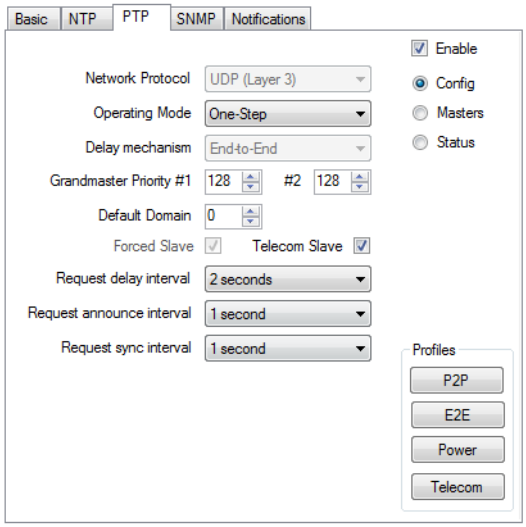
3.7. **Requests Sent/Received** (adv): Displays the number of time requests sent and responses received.

4. Change settings as needed. When finished, click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Configure PTP settings using Profiles (Network>PTP)

The PTP tab settings can be configured using pre-defined profiles.

1. Click the **Network** tab in the GE Config window.
2. Click the **PTP** tab.
   Check **Enable** to enable Precision Time Protocol (PTP).



3. For a quick configuration to match a published profile, click one of the buttons in the **Profiles** area:

P2P: Sets the Default PTP profile with Peer-to-Peer delay discovery.

- Transport: Multicast, UDP, One-Step.
- Delay Mechanism: Peer-to-Peer.
- GM Priority: 1&2, 128, 128.
- Default Domain: 0.

E2E: Sets the Default PTP profile with End-to-End delay discovery.

- Transport: Multicast, UDP, One-Step.
- Delay Mechanism: End-to-End.
- GM Priority: 1&2, 128, 128.
- Default Domain: 0.

Power: Sets the C37.238-2011 Power Profile.

- Transport: Ethernet (layer 2), One-Step.
- Delay Mechanism: Peer-to-Peer.
- GM Priority: 1&2, 128, 128.
- Default Domain: 0.
- TLVs Add: Alternative Time, C37.238-2011.
- TLVs Require: Alternative Time, C37.238-2011.

Telecom: Sets the G8265.1-2010 Telecom Profile.

- Transport: Slave Only, Unicast, UDP, One Step.
- Delay Mechanism: End-to-end.
- GM Priority: 1&2, 128, 128.
- Default Domain: 0.
- This profile configures slaves only; you must set addresses for masters.

4. When finished, click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

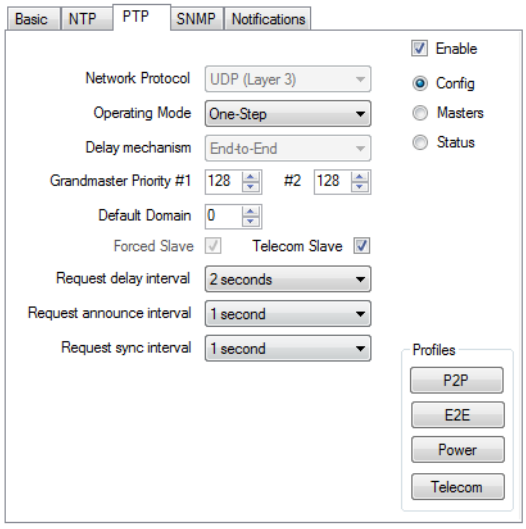
   If additional PTP configuration changes are needed, see the full description of PTP settings in the procedure below.

Configure IEEE 1588 / C37.238 PTP settings (Network>PTP)

The PTP tab settings can be configured individually, or set using pre-defined profiles.

1. Click the **Network** tab in the GE Config window.
2. Click the **PTP** tab.

Check **Enable** to enable Precision Time Protocol (PTP).



3. For a quick configuration to match a published profile, click one of the buttons in the **Profiles** area, as described in the previous section.
4. Click the **Config** radio button to view and change basic PTP settings.
   - 4.1. **Network Protocol**: The network protocol should be consistent across the entire subnet. UDP is the most common PTP network protocol.
     Range: UDP (Layer 3), ETH (Layer 2)
     Default: ETH (Layer 2)
   - 4.2. **Operating Mode**: A network-wide parameter. If the operating mode is not known, select Two-Step.
     Range: One-Step, Two-Step
     Default: One-Step
     One-Step means the MultiSync 100 places timestamps in the outgoing message as it leaves the clock. Two-Step means a second message carries the timestamp. This setting is a function of network design. 1588 requires that all slave devices support both One-Step and Two-Step operating modes.
   - 4.3. **Delay mechanism**: The delay mechanism should be consistent across the network. The Peer-to-Peer option requires the network to use PTP v2 switches with transparent clocks.
     Range: End-to-End, Peer-to-Peer
     Default: Peer-to-Peer
   - 4.4. **Grandmaster Priority**: Set the priority for automatic selection of master clocks in the PTP network. Lower values indicate higher priority. The first setting (#1) overrides all other selection criteria. The second setting (#2) is used to select between similar clocks.
     Range: 0 - 255, where 0 is the highest priority
     Default: 128, 128
   - 4.5. **Default Domain**: A PTP domain consists of one or more PTP devices communicating with each other. Only devices within each domain can communicate with each other using PTP.
     Range: 0 - 127
     Default: 0
   - 4.6. **Forced Slave**: Check to make the clock a PTP slave. The GNSS time will be ignored, and the unit will never be a master clock. (Unchecked by default.)

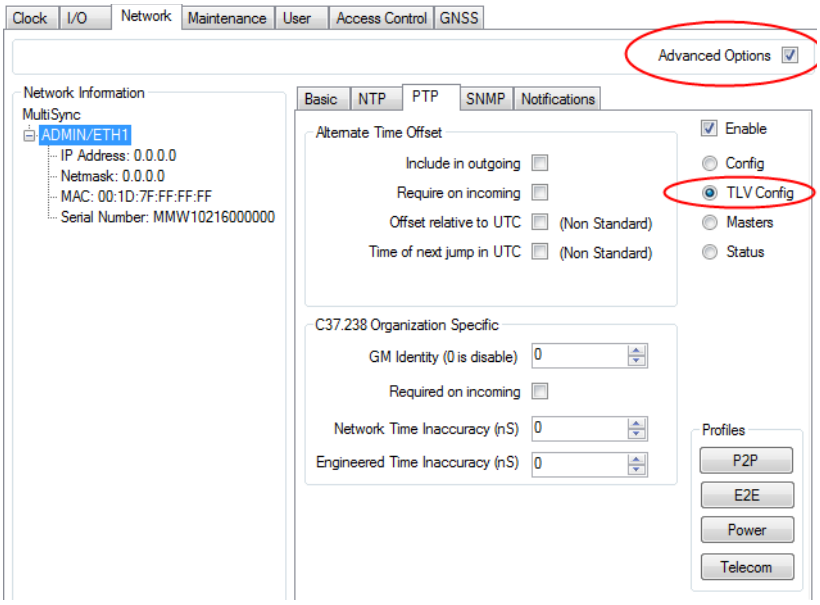
4.7. **Telecom Slave**: Check to make the clock a PTP Telecom slave. The unit will become a unicast slave and will negotiate using unicast to establish sync with one of the master clocks configured in the G8265.1 Telecom Masters settings. When Telecom Slave is checked, an additional **Masters** radio button appears on the right which accesses the G8265.1 Telecom Masters settings. (Unchecked by default.)

4.8. **Request delay interval**: Sets the time interval between successive Delay Request messages being sent to other PTP devices on the network
Range: 1, 2, 4, 8, 16, 32 seconds
Default: 1 second

4.9. **Request announce interval**: Sets the time interval between successive Announce messages from ports acting as a Master. When configured as a Telecom Slave; this field represents the requested rate of announce messages.
Range: 1/8, 1/4, 1/2, 1, 2, 4, 8, 16 seconds
Default: 1 second

4.10. **Request sync interval**: Sets the time interval between successive Sync messages. When configured as a Telecom Slave; this field represents the requested rate of sync messages.
Range: 1/128, 1/64, 1/32, 1/16, 1/8, 1/4, 1/2, 1, 2, 4, 8, 16 seconds
Default: 1 second

5. To access the TLV (type, length, value) view on the **Network>PTP** tab, click **Advanced Options** and then click the **TLV Config** radio button.



5.1. The **Alternate Time Offset** area (adv) includes IEEE 1588-2008 settings. All settings in this area are disabled (unchecked) by default.
Include in outgoing (adv): If checked, the ALTERNATE_TIME_OFFSET_INDICATOR will be added to announce messages.
Require on incoming (adv): If checked, messages not containing the ALTERNATE_TIME_OFFSET_INDICATOR TLV will be ignored.
Offset relative to UTC (adv): If checked, the currentOffset field of the ALTERNATE_TIME_OFFSET_INDICATOR TLV will be used as the offset from Local Time, instead of the TAI.
Time of next jump in UTC (adv): If checked, the timeOfNextJump field of the ALTERNATE_TIME_OFFSET_INDICATOR TLV will be used in reference to UTC, instead of the TAI.

5.2. The **C37.238 Organization Specific** area (adv) includes:

GM Identity (adv): Sets the Grandmaster Identity, which is transmitted in IEEE_C37_238 TLV (2 bytes). If the value is set to less than 3, then the TLV will not append to announce messages.

Range: 0 - 254

Default: 0 (disabled)

Required on incoming (adv): If checked, announce messages which do not contain the C37.238-2011 TLV will be ignored.

Network Time Inaccuracy (adv): sets the networkTimeInaccuracy as defined in C37.238-2011, providing an estimate of the worst-case error in nanoseconds from the Grandmaster. This is the sum of the source clock uncertainty and the uncertainties of all other PTP aware devices (e.g. Transparent clocks) transporting the messages.

Range: 0 - 2147483647 ns

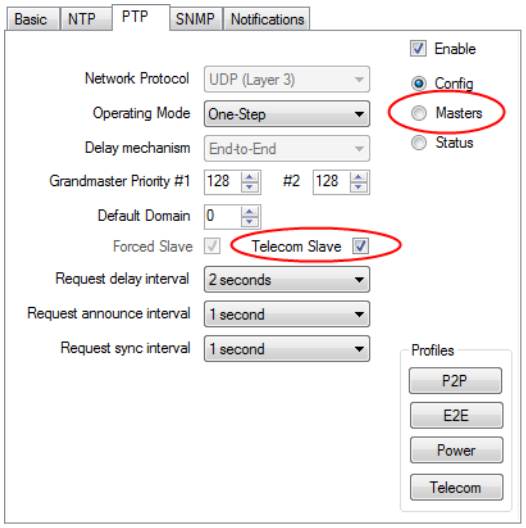
Default: 0

Engineered Time Inaccuracy (adv): sets the Engineered networkTimeInaccuracy defined in C37.238-2011. This value is set at the end device to represent the worst case error in nanoseconds from this device to all preferred grandmasters.

Range: 0 - 2147483647 ns

Default: 0

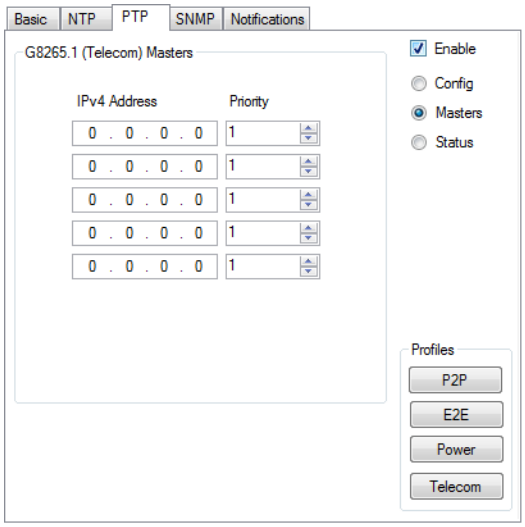
6. To access the **G8265.1 (Telecom) Masters** list, check **Telecom Slave** and then click the **Masters** button.



NOTE

The **Masters** radio button is not present unless **Telecom Slave** is selected.

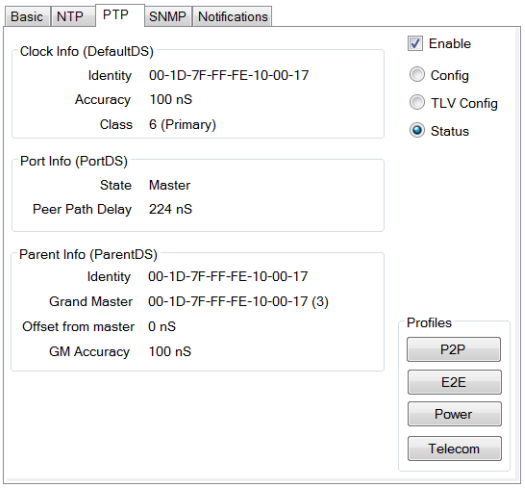
6.1. **IPv4 Address**:



Enter the IP Address of the Telecom Master. Up to five Master Clocks can be configured. The clock will communicate via Unicast messages and sync to the best available master clock.

6.2. **Priority**: Sets the priority of the master clock (lower numbers indicate higher priority). If multiple Masters have the same highest quality level, the Master with the lowest priority is selected. If the quality level and priority are both the same, then the order in the G8265.1 (Telecom) Masters list dictates which Master clock is used.

7. To view clock PTP information, click the **Status** button. This page is for informational purposes only and does not contain any configurable fields.



7.1. **Clock Info (DefaultDS)** area:

Identity: The PTP identity of the clock.

Accuracy: An estimate of the accuracy of the master clock based on the sync source, and the characterization of its internal oscillator as defined under clockAccuracy in IEEE 1588-2008.

Class: The clockClass as defined in IEEE 1588-2008.

7.1. **Port Info (PortDS)** area:

State: The portDS.portState as defined in IEEE 1588-2008.

Peer Path Delay: The calculated latency between this port and the connected network node.

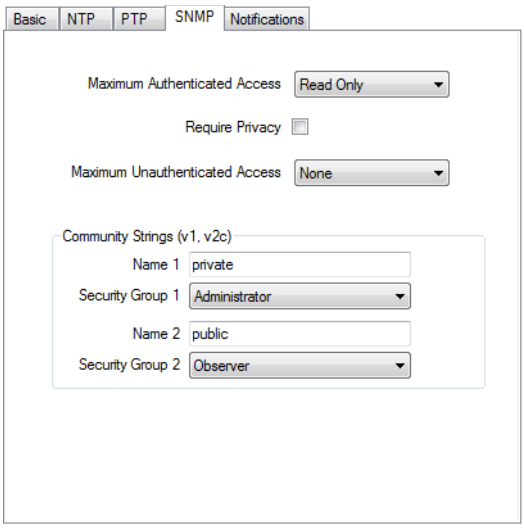
7.1. **Parent Info (ParentDS)** area:
Grandmaster: The PTP identity of the grand master clock.
Offset from Master: the calculated offset from the current master clock.
GM Accuracy: The clockAccuracy, as advertized by the grand master clock.

8. Change settings as needed. When finished, click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Configure SNMP settings (Network>SNMP)

The SNMP tab contains configuration and access settings for the SNMP functionality.

1. Click the **Network** tab in the GE Config window.
2. Click the **SNMP** tab.



2.1. **Maximum Authenticated Access**: Sets the access limits for authenticated clients using SNMP v3 with USM authentication.
Range: None, Read Only, Read/Write
Default: Read Only

2.2. **Require Privacy**: Check this box to require SNMP v3 USM privacy on SNMP requests. (Unchecked by default.)


NOTE

When Require Privacy is enabled, SNMP v1 and SNMP v2c are disabled.

2.1. **Maximum Unauthenticated Access**: Sets the access limits for unauthenticated clients using SNMP v1, SNMP v2c, and SNMP v3 without USM authentication.
Range: None, Read Only, Read/Write
Default: None

2.2. **Community Strings (v1, v2c)** area:
Name 1: Sets the private string access key. The maximum number of characters is 32.
Default setting is “private”.
Security Group 1: Sets the group governing access rights for the private string. Access can be further restricted by the **Maximum Unauthenticated Access** field setting.

Default setting is Administrator.

Name 2: Sets the public string access key. The maximum number of characters is 32.

Default setting is "public".

Security Group 2: Sets the group governing access rights for the public string. Access can be further restricted by the **Maximum Unauthenticated Access** field setting.

Default setting is Observer.

NOTE

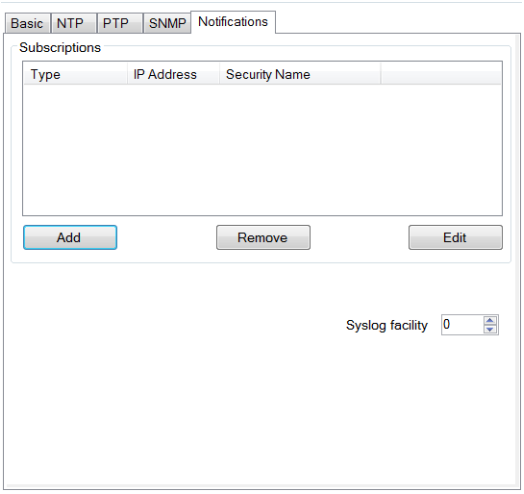
SNMP v1 and v2c use an unencrypted community string as the only authentication method. Packet analyzers (such as Wireshark) can be used to read the community string.

3. Change settings as needed. When finished, click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Set notifications (Network>Notifications)

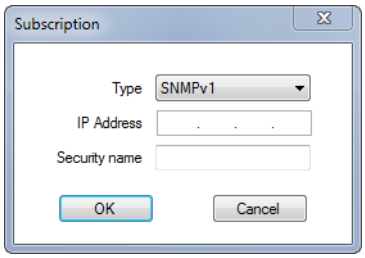
MultiSync 100 clocks have the ability to act as an SNMP Agent or Syslog Originator. Use the Network>Notifications tab to manage this functionality. By default, no notifications are configured.

1. Click the **Network** tab in the GE Config window.
2. Click the **Notifications** tab.



3. To add a subscriber (SNMP Manager or Syslog collector), click the **Add** button in the **Subscriptions** area.

4. Enter the following information:



   4.1. **Type**: Set the Syslog or SNMP type. The Historic entries are meant only for back-compatibility with older GE clocks, and should not be used otherwise.
   Range: SNMPv1, SNMPv2c, SNMPv3, Syslog, Historic SNMPv1, Historic Syslog
   Default: SNMPv1

   4.2. **IP Address**: Enter the IP address of the subscriber.

   4.3. **Security name**: Enter the security key.
   If **Type** is SNMPv2, enter any character combination up to 32 characters long.
   If **Type** is SNMPv3, and a **Username** configured on the **User** tab is entered here, the authentication settings of the user will be applied.

5. Use the following controls to manage subscriptions:

   5.1. **Remove**: Select the subscriber to remove, and click **Remove**.

   5.2. **Edit**: Select the subscriber to edit, and click **Edit**.

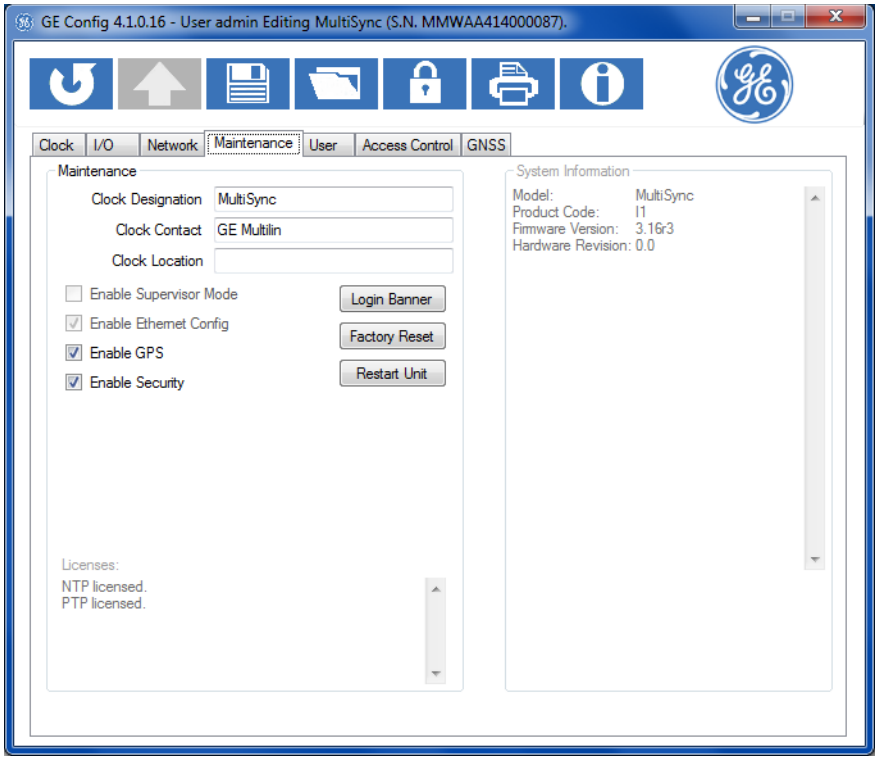
   5.3. **Syslog facility**: Sets the Local Use value, for a Syslog Facility Number 16 or greater (ie. 16 to 23).
   Range: 0 to 7
   Default: 0

6. When finished, click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Configure maintenance settings

The **Maintenance** tab shows general system information, along with various overrides.

Use the **Maintenance** tab to disable aspects of the MultiSync 100 during maintenance or troubleshooting, reset the MultiSync 100 to factory default settings, or set the text shown in the software login banner.



Configure clock identification and maintenance overrides

1. Click the **Maintenance** tab in the GE Config window.
2. Enter text in these fields to help identify and locate the MultiSync 100 GPS Clock.
   - **Clock Designation**: Enter up to 255 characters. The Clock Designation appears in the configuration file and the Discovery window. Default entry is “MultiSync”.
   - **Clock Contact**: Enter up to 255 characters. This field is provided in order to enter a contact person and other contact information for the clock. Default entry is “GE Multilin”.
   - **Clock Location**: Enter up to 255 characters. This field is provided in order to enter location information such as the location of the clock on the LAN or WAN, for differentiation of purpose or location. Default entry is blank.
3. Check or uncheck to enable or disable to following MultiSync 100 GPS Clock features:
   - **Enable Supervisor mode**: When enabled, supervisor mode only allows users who belong to a supervisor group to store changes to the MultiSync 100. (Unchecked by default.)

When a user not in a supervisor group tries to store changes to the MultiSync 100, they are prompted to save their changes and send them to a supervisor. The supervisor can then load, review, and store the changes. Only supervisors can enable supervisor mode; supervisor groups are configured using the **Is Supervisor** checkbox for each group on the **User** tab.

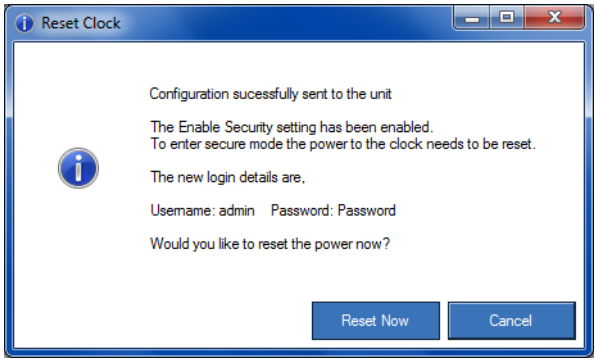
- **Enable Ethernet Config**: When enabled, ethernet configuration permits the MultiSync 100 to be configured through the Ethernet port (Eth). When disabled, the MultiSync 100 can only be configured through the USB port (USB). This setting can only be changed when configuring the MultiSync 100 through the USB port. (Checked by default.)
- **Enable GPS**: When enabled, allows the MultiSync 100 to sync to GPS/GLONASS and report GPS sync related alarms (such as loss of satellites, antenna failure, and loss of GPS sync). When not enabled, GPS time signals are ignored. (Checked by default.)
- **Enable Security**: When enabled, security enforces user account settings on the MultiSync 100, so that a user must have a username and password to configure the MultiSync 100. When disabled, no username or password is required to change configuration. (Checked by default.)

NOTICE

If you check Enable Security on an unsecured clock, the clock will restart and revert to the original factory default username and password:

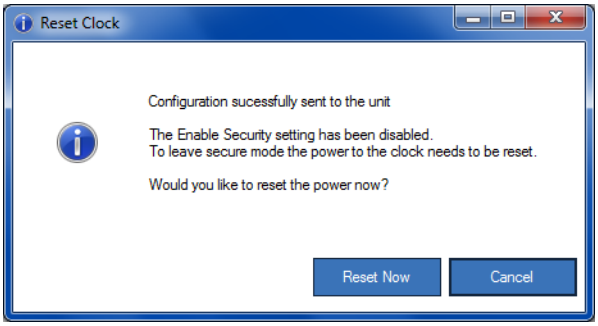
User Name: **admin**

Password: **Password**



NOTICE

If you disable Security on a clock, the clock will restart. Restart the GE Clock Configuration Tool, and click **Discover** to find the clock.

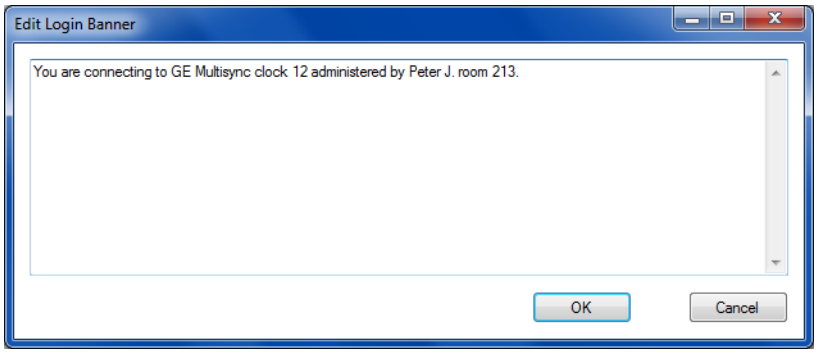


With security disabled, the **User** tab and **Access Control** tab are not shown.

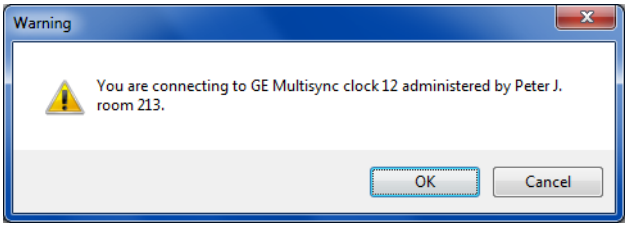
Set software login banner

1. Click the **Maintenance** tab in the GE Config window.

2. Click **Login Banner**.
3. Enter the warning text you want displayed by the GE Clock Configuration Tool software on connection to the clock, and click **OK**.



The changed banner text is saved to the clock, and displayed when users connect to the clock through the GE Clock Configuration Tool.

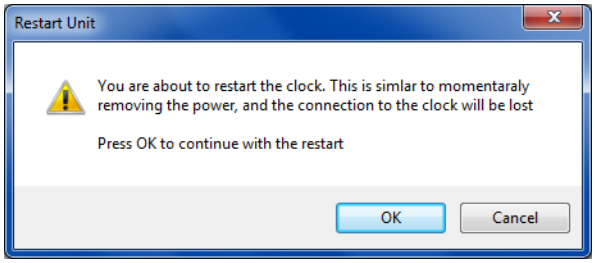


4. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Restart the MultiSync 100 GPS Clock

Use the Restart button to restart the clock in a manner similar to disconnecting and reapplying power.

1. Click the **Maintenance** tab in the GE Config window.
2. Click **Restart Unit**.



3. Click **OK** in the warning message window to confirm the factory reset.

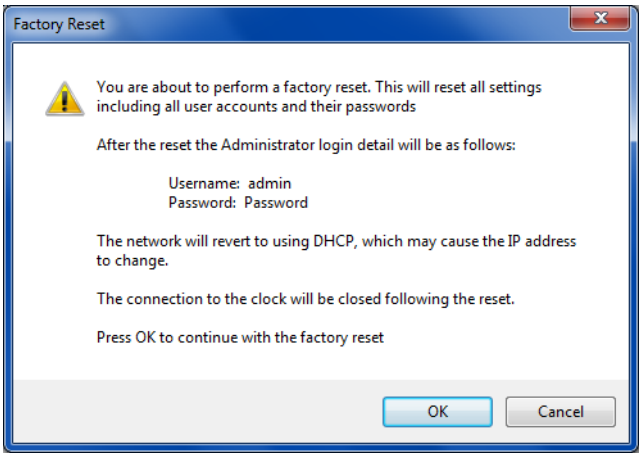
NOTICE

Restarting the clock closes the connection between the clock and the GE Clock Configuration Tool software. Restart the GE Clock Configuration Tool, and click **Discover** to find the clock.

Restarting the clock resets the GNSS receiver memory, discarding the stored almanac.

Reset the MultiSync 100 GPS Clock to factory defaults

1. Click the **Maintenance** tab in the GE Config window.
2. Click **Factory Reset**.



3. Click **OK** in the warning message window to confirm the factory reset.
4. Restart the GE Clock Configuration Tool, and click **Discover** to find the clock.

   Resetting to the factory defaults changes the Administrator account back to the default password:

   User Name: **admin**

   Password: **Password**

NOTICE

Resetting to factory defaults resets all user accounts and passwords as well as all other configuration settings and the GNSS receiver memory. Use with caution.

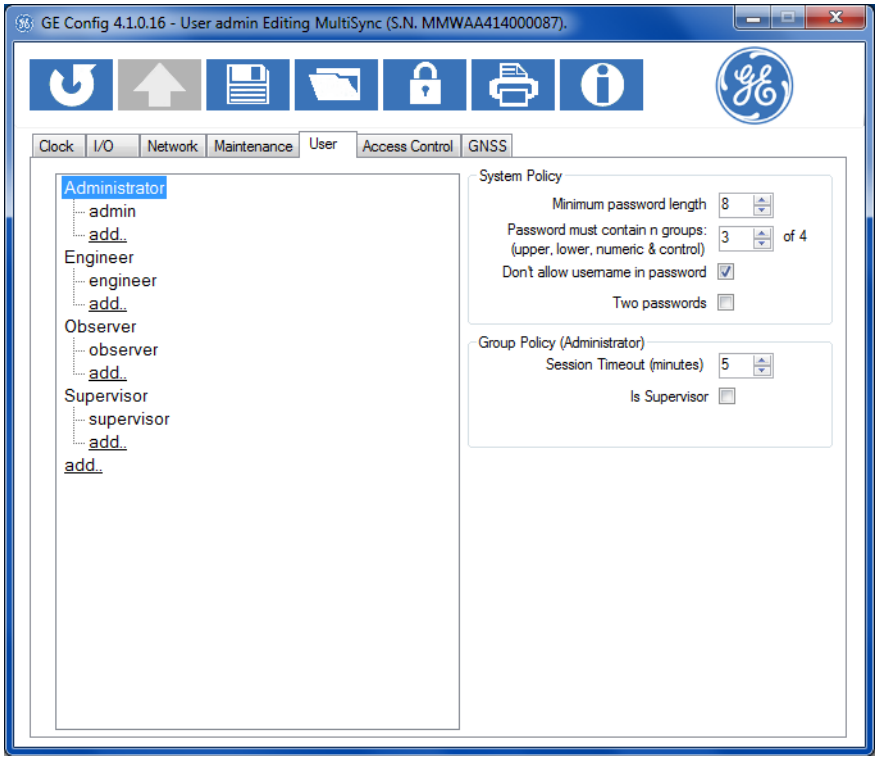
Configure user settings

The **User** tab shows all configured users and user groups, and the preferences associated with each user.

Use this tab to add and remove users, configure user groups, and change user preferences and passwords as needed. You must be an administrator (with a user account in the Administrator group) to change settings on the **User** tab.

NOTICE

The **User** tab is not shown if security is disabled on the **Maintenance** tab. Ensure **Enable Security** is checked in order to configure users.



Set password requirements

1. Click the **User** tab in the GE Config window.
2. In the **System Policy** area on the right, set the following:

   Minimum password length: The minimum length for a valid password.

   Range: 3 to 20

   Default: 8

   Password must contain n groups: The number of character types that must be included in a valid password. Character group types include: upper case letters, lower case letters, numbers, and symbols

   Range: 1 to 4

   Default: 3

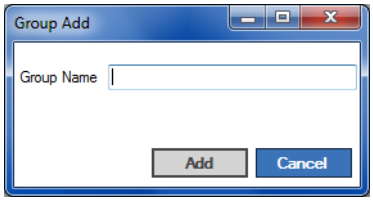
   Don't allow username in password: Check to decline passwords containing the username. (Checked by default.)

Two passwords: Check to allow a user to set separate passwords for authentication, and for privacy. (Unchecked by default; a single password is used.) When enabled, a password reset is required. When disabled, the authentication password is used as the single password.

3. Click the Update icon  at the top of the GE Config window to save the changed password requirements to the clock.

Add a user group

1. Click the **User** tab in the GE Config window.
2. At the bottom of the list of users and user groups, click **add**.



3. Enter a name for the new user group.
4. Click **Add** to add the user group.
5. With the group name selected, in the **Group Policy** area, set the following:

   Session Timeout (minutes): Set the idle time after which users in this group are prompted for a response, and if none is received, is disconnected from the clock.

   Range: 0 to 3600

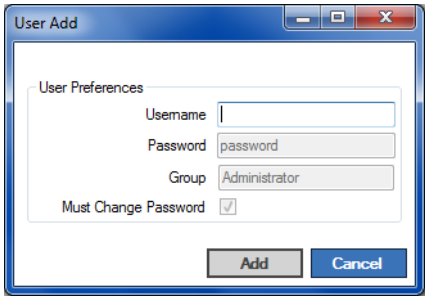
   Default: 5

   Is Supervisor: If checked, users in this group can be given supervisor privileges when Supervisor Mode is enabled on the Maintenance tab. Supervisor Mode requires non-supervisors to save their configuration changes to a file and submit them to a supervisor to load to the clock. (Unchecked by default.)

6. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Add users, configure users, and reset user passwords

1. Click the **User** tab in the GE Config window.
2. Locate the user group the new user will be in, and expand the user group by clicking the + on the left.
3. At the bottom of the list of user group members, click **add**.



4. In the **User Add** dialog, enter a Username.

   The **Password** field displays the default password for the user. All new users must change their password when they login.
5. Click **Add** to add the user.
6. With the user name selected, in the **User Preferences** area, set the following:

   Authentication Method: Sets the authentication protocol.

   Range: MD5, SHA

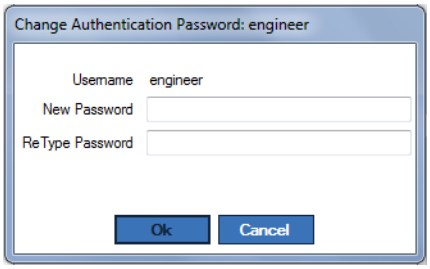
   Default: SHA

   Privacy Method: Sets the privacy protocol.

   Range: None, DES, AES

   Default: AES

   Set Password: Select to set the password for the selected user, or reset a forgotten user password. Passwords must conform to the rules set in the System Policy area.



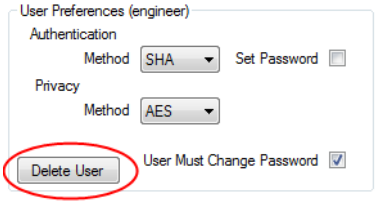
NOTICE

If two passwords are required there will be two buttons, one for resetting each password.

7. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Delete a user

1. Click the **User** tab in the GE Config window.
2. Locate the user group the user is in, and expand the user group by clicking the + on the left.
3. Click to select the user name.
4. In the **User Preferences** area, click the **Delete User** button.



5. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Delete a user group

1. Click the **User** tab in the GE Config window.

2. Select the User group to delete, and delete all users from the user group.
3. Delete the user group name by double clicking on the group name and deleting all the characters.
4. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

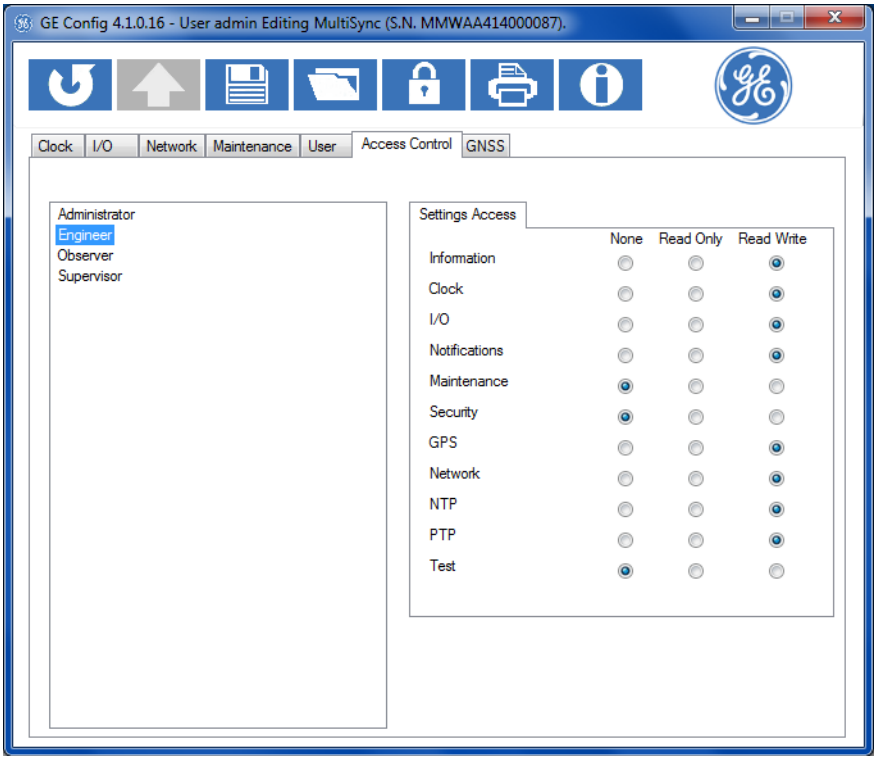
Configure access control settings

Use the **Access Control** tab to assign access levels to different user groups. User groups are defined in the **User** tab.

NOTICE

The **Access Control** tab is not shown if security is disabled on the **Maintenance** tab. Ensure **Enable Security** is checked in order to configure access control.

1. Click the name of a user group.



NOTE

Access levels cannot be changed for the Administrator user group. Move users to a different user group if you need to change access levels.

2. On the **Clock Settings** tab, click the radio buttons to set user group access levels for different clock settings. Allowed settings are None, Read Only, and Read/Write.

   Refer to the following table for the effect of different **Access Control** tab setting:

Clock Setting	Controls Access to...
Information	**Maintenance** tab: Clock Designation, Clock Location, Clock Contact, the License entry, and System Information *Read Only access (no Read Write access available):* **Clock** tab: Model and Firmware Version **Network** tab: IP address, Netmask, and MAC address under Network Information **GNSS** tab: antenna connection status
Clock	**Clock** tab: Time, Localization (DST), System Information, and Clock Sources **Network** tab **> NTP > Advanced Options > Client (SNTP)**: SNTP client offset from master Note: Does not include configuration of Test Source on the **Clock** tab.
I/O	**I/O** tab: I/O Ports P1 and P2, Sync area report settings (not Holdover time). Note: If both I/O and Notifications access is set to None, the **I/O** tab is removed.
Notifications	**Network** tab: Notifications sub-tab **I/O** tab: RELAY-Alarm Output configuration, Sync area Holdover time.
Maintenance	**Maintenance** tab **GNSS** tab: Reset GNSS button Note: If Maintenance access is set to None, the **Maintenance** tab is removed regardless of the GNSS or Information settings.
Security	**User** tab **Access Control** tab **Network** tab: SNMP sub-tab. Note: If security is disabled on the **Maintenance** tab, The **User** tab and **Access Control** tab are removed.
GNSS	**GNSS** tab Note: If GNSS access is set to None, the **GNSS** tab is removed.
Network	**Network** tab: Basic sub-tab
NTP	**Network** tab: NTP sub-tab
PTP	**Network** tab: PTP sub-tab
Test	**Clock** tab: Clock Sources and configuration of Test Source

3. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

Configure GPS/GLONASS settings

Use the **GNSS** tab to view satellite coverage, change GNSS parameters, reset the GNSS receiver, view statistics, and log GNSS signals to a file. Both GPS and GLONASS can be configured on this tab, hence the generic term GNSS (Global Navigation Satellite System).

NOTE

The time required to acquire GPS/GLONASS satellites and obtain tracking and synchronization for a new clock (given a good view of the sky) is typically within a minute. Reactivating a clock that has been synchronized previously will take longer, but not more than 45 minutes.

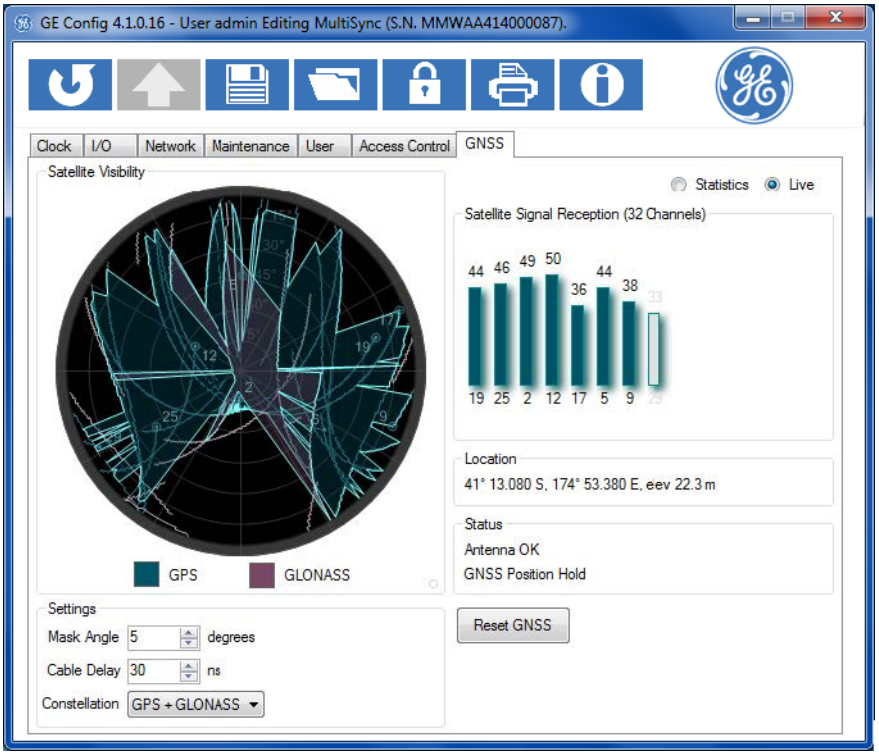


Figure 8: GNSS tab with both GPS and GLONASS satellites selected

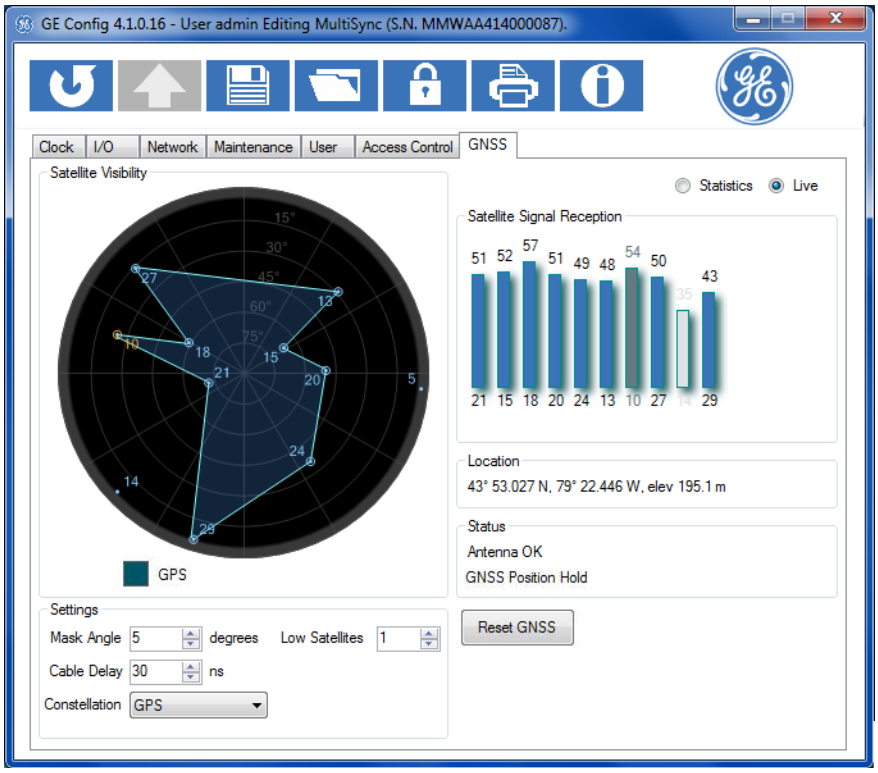


Figure 9: GNSS tab with GPS selected and synchronized

Change GNSS parameters

1. Click the **GNSS** tab in the GE Config window.
2. In the **Settings** area, set the **Mask Angle**.

   Range: 0 to 90 degrees

   Default: 5 degrees

   Mask angle is the lowest angle, in degrees above the horizon, included in the field of view used by the GNSS when searching for satellites suitable for calculating the time. Setting a larger mask angle may help eliminate timing errors resulting from multi-path satellite signals which are low in the sky.
3. In the **Settings** area, set the **Cable Delay**.

   Range: 0 to 65535 ns

   Default: 0 ns

   Cable delay indicates the signal delay introduced by the length of the antenna cable. To optimize precision, enter a value of 4 ns per meter of antenna cable.
4. In the **Settings** area, set the **Constellation**.

   Range: GPS, GLONASS, GPS + GLONASS

   Default: GPS + GLONASS

   Constellation selects the constellation of satellites the connected clock uses for synchronization.
5. In the **Settings** area, set the **Low Satellites** alarm level.

   Range: 0 to 13

   Default: 1

The low satellites alarm level triggers an alarm if the number of satellites the clock syncs to drops below this configured threshold. The Low Satellite alarm must also be enabled on the **I/O** tab.

6. Click the Update icon  at the top of the GE Config window to save the changed configuration to the clock.

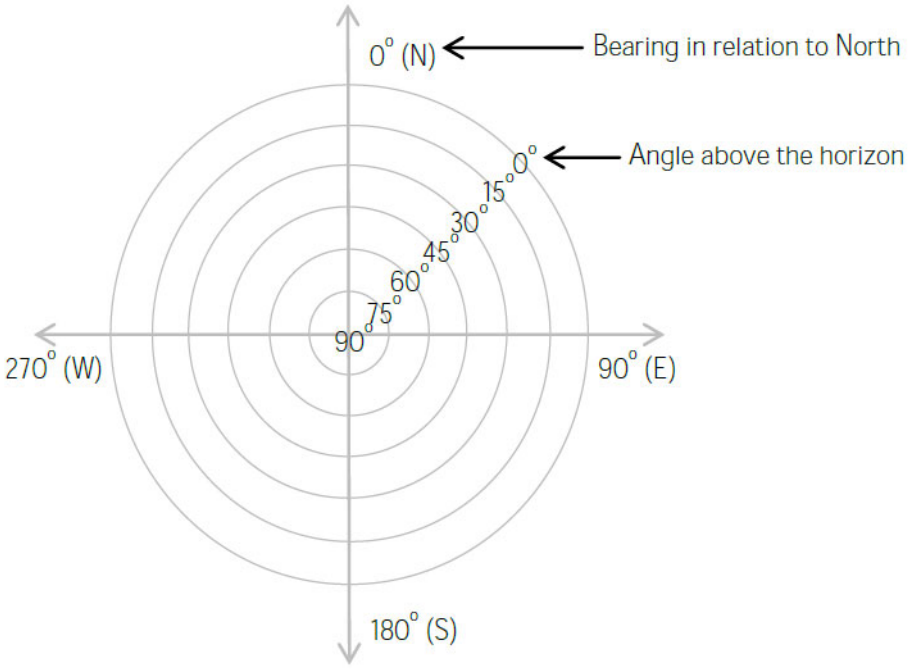
Reset the GNSS

1. Click the **GNSS** tab in the GE Config window.
2. Click **Reset GNSS**, and confirm when prompted.

   Clicking **Reset GNSS** resets the on-board GNSS receiver in the MultiSync 100 and forces a full reset, clearing the GNSS memory and discarding the stored almanac. It takes time for the GNSS to re-establish a position hold after a reset, but should do so in less than 45 minutes.

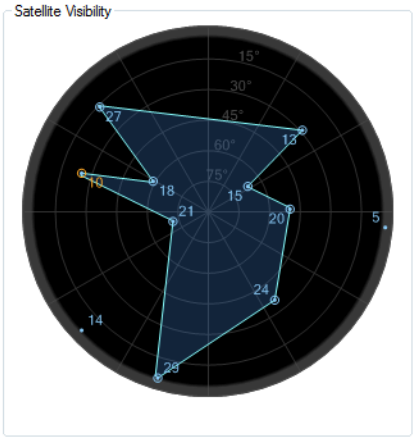
View GNSS status and coverage

In the **Satellite Visibility** area the top of the satellite map is the bearing in relation to north, with concentric circles on the map representing the angle above the horizon as shown below. The center of the map represents the space directly above the antenna, looking up into orbit.

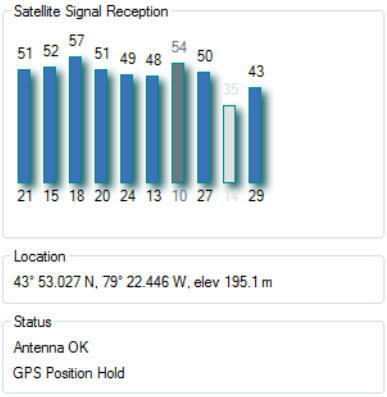


1. Click the **GNSS** tab in the GE Config window, and ensure the **Live** radio button is selected.
2. The **Satellite Visibility** area map plots the location of tracked satellites over time, with GPS satellites and their trails shown in blue while GLONASS satellites and trails are shown in red. The present location of each satellite marker is indicated by a circled dot

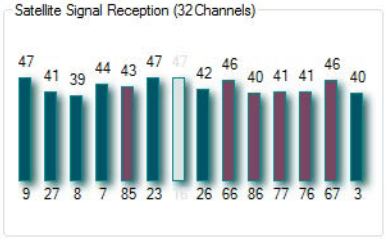
with the Satellite Vehicle Identifier alongside.



3. The **Satellite Signal Reception** area shows the corresponding strength of each satellite signal,.



- Numbers above each bar indicate the satellite strength; numbers below each satellite bar indicate the Satellite Vehicle Identifier.
- Click a satellite bar to highlight the bar in a darker color and the Satellite Vehicle Identifier in orange on the Satellite Visibility map, as shown in the two images above for satellite 10.
- Satellite bars shown in blue (above) correspond to satellites with a signal strength in excess of 35 dBHz, and if they are not below the antenna mask, are used to calculate time and position.
- Satellite bars shown in light grey are being tracked but not used for calculations, as shown above for satellite 14, or below for satellite 16.



- Satellite bars shown in blue correspond to GPS satellites; those shown in red correspond to GLONASS satellites (with constellation set to GPS + GLONASS).

4. In the **Location** area, the current stored position reported by the GNSS receiver is displayed.
5. In the **Status** area, the current state of both the antenna and GNSS is displayed.
   5.1. Antenna status messages give information on the antenna connection:
   Antenna current low: The antenna current circuit drain is low (typically under 3 mA). This could be caused by poor connections or by a self-powered antenna system with a low current drain.
   Antenna current high: The antenna current drain is high (typically over 100 mA). This could be caused by a short in the system, moisture in the circuit, or an antenna with a higher current drain specification.
   Antenna OK: The antenna system is connected and appears to be operating normally.
   5.2. GNSS status messages indicate the current GNSS receiver state in the cycle of acquiring satellite information.
   Acquiring: The GNSS is searching for satellites. Almanac is incomplete.
   Doing Fixes: The GNSS is synced to one or more satellites, and is now calculating position and time. Almanac downloading.
   GNSS Position Hold: GNSS is providing its most accurate time. Almanac is downloaded, and position is known.
   Bad Geometry: The GNSS has insufficient satellite distribution to calculate an accurate position.

View and log GNSS statistics

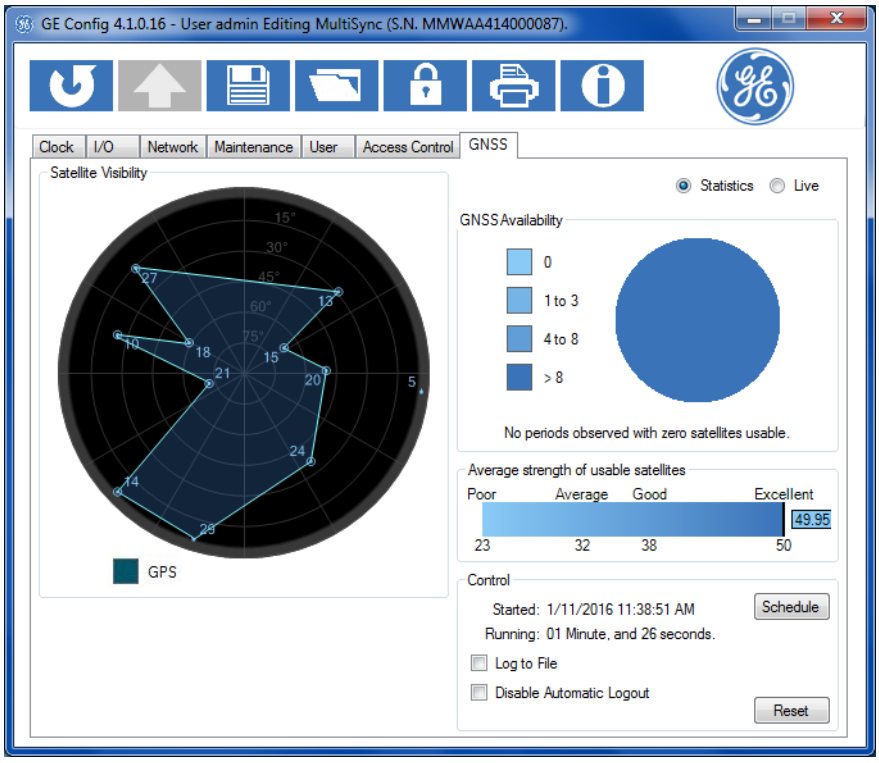
While connected to a clock, the GE Clock Configuration Tool software logs the GNSS status and presents the information graphically. Statistics can also be logged to a file.

When commissioning a GPS/GLONASS clock, it is recommended that once the antenna system is installed and the clock has been configured, satellite statistics should be logged for 12 hours to confirm the suitability of the antenna system.

The strength of usable satellite signals depends on the quality of the antenna signal. Ensure the antenna is installed with a clear line of sight to the sky (see *Install hardware* on page 23), and the total combined gain of the antenna system (antenna, cable, and connectors) should fall in the range of 10 to 35 dB, the optimum being 22 dB (see *Antenna requirements* on page 5).

6. Click the **GNSS** tab in the GE Config window, and ensure the **Statistics** radio button is

selected.



7. In the **GNSS Availability** area, the average number of satellites tracked over time is displayed as a pie chart.
8. In the **Average strength of usable satellites** area, the average strength is shown as a bar chart, in dBHz.
9. In the **Control** area:

   Started: is the start time for the displayed statistics.

   Running: is the elapsed time for the displayed statistics

   Log to file: Select to log statistics to a text file every 4 seconds.

   Begin: Logging start time.
   Range: Immediately to a future time, in 2 hour intervals (1:00 am, 3:00 am, etc.)
   Default: Immediately
   Duration: Logging duration.
   Range: Indefinite to 1052150 Days, 11 Hours, 12 Minutes
   Default: Indefinite

   Default filename is: *Clock Name*[*Clock Model*]_GNSS_*yyymmdd-hhmm*.txt.

   Disable Automatic Logout: When checked, overrides the configured group session timeout, allowing an indefinite connection in order to log statistics. Remains checked and unavailable until any scheduled logging is complete. (Unchecked by default.)

   Schedule: Sets the logging begin time and duration. Can be scheduled in advance. Click Cancel in the Schedule window to stop all logging.

   Reset: Click to restart logging.
10. Ensure all logging is stopped and **Disable Automatic Timeout** is turned off when you are done logging statistics.

GE
Grid Solutions

MultiSync 100 GPS Clock

Appendix

Warranty

For products shipped as of 1 October 2013, GE warrants most of its GE manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at https://www.gegridsolutions.com/multilin/warranty.htm

For products shipped before 1 October 2013, the standard 24-month warranty applies.

Release Notes

Table A–1: Release Dates

MANUAL	GE PART NO.	RELEASE DATE
GEK-119628	1601-0300-A1	March 2014
GEK-119628A	1601-0300-A2	February 2016
GEK-119628B	1601-0300-A3	July 2017

Table A–2: Major Updates for 1601-0300-A3

SECT (A2)	SECT (A3)	DESCRIPTION
Title	Title	Manual part number to 1601-0300-A3. CE logo removed.
Ch1	Ch1	Removed CE compliance from Testing and Certifications section.
Ch2	Ch2	Added GNSS and GLOBASS descriptions.
Ch4	Ch4	Updated GPS/GNSS settings to include GLONASS support.

Table A–3: Major Updates for 1601-0300-A2

SECT (A1)	SECT (A2)	DESCRIPTION
Title	Title	Manual part number to 1601-0300-A2. Changed branding to Grid Solutions.
Ch1	Ch1	Updated Specifications section.
Ch2	Ch2	Updated C37.118 extensions section.
Ch3	Ch3	Added LED indicators table. Added descriptions of front and back panels. Added Upgrade firmware section. Updated GE Configuration Tool software installation section. Moved GE Configuration Tool quick configuration from Ch4.
Ch4	Ch4	Updated screenshots, functionality, and configuration descriptions throughout.
App	App	Added Warranty information.