ControlLogix Time Synchronization Module

High accuracy position application

Catalog Number 1756HP-TIME Series B

Rockwell Automation

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	IMPORTANT: Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Contents

Studio 5000 Environment

The Studio 5000™ Engineering and Design Environment combines engineering and design elements into a common environment. The first element in the Studio 5000 environment is the Logix Designer application. The Logix Designer application is the rebranding of RSLogix™ 5000 software.

The Studio 5000 environment is the foundation for the future of Rockwell Automation® engineering design tools and capabilities. This environment is the one place for design engineers to develop all the elements of their control system.

1756HP-TIME Overview

This document describes the additional functionality, of the 1756HP-TIME module Series B, firmware revision 3.002, which allows for the use of an external Trimble GPS unit to provide a more accurate positioning application.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Integrated Architecture and CIP Sync Configuration Application Technique, publication IA-AT003	This document explains CIP Sync technology and how you can synchronize clocks within the Rockwell Automation® Integrated Architecture.
ControlLogix System User Manual, publication 1756-UM001	Describes the necessary tasks to install, configure, program, and operate a ControlLogix system.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-IN414	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.
ControlFLASH® Firmware Upgrade Software 1756-um105	Describes the necessary tasks to install, and use ControlFlash to update the module firmware.
1756HP-TIME User Manual 1756-UM542	Describes the necessary tasks to install, configure, program, and operate a 1756HP-TIME module.

You can view or download publications at
http:/www.rockwellautomation.com/literature/

Introduction

This document serves as an additional document to describe a specific feature of the 1756HP-TIME module, namely the high accuracy application. This application will be illustrated using a Trimble BX982 unit.

Hardware

The basic system comprises the following hardwware componetns:

- 1756HP-TIME module
- Trimble BX982 GNSS receiver enclosures
- Trimble Zephyr Antennas
- ControlLogix Equipment, Chassis, Controller and Ethernet Card

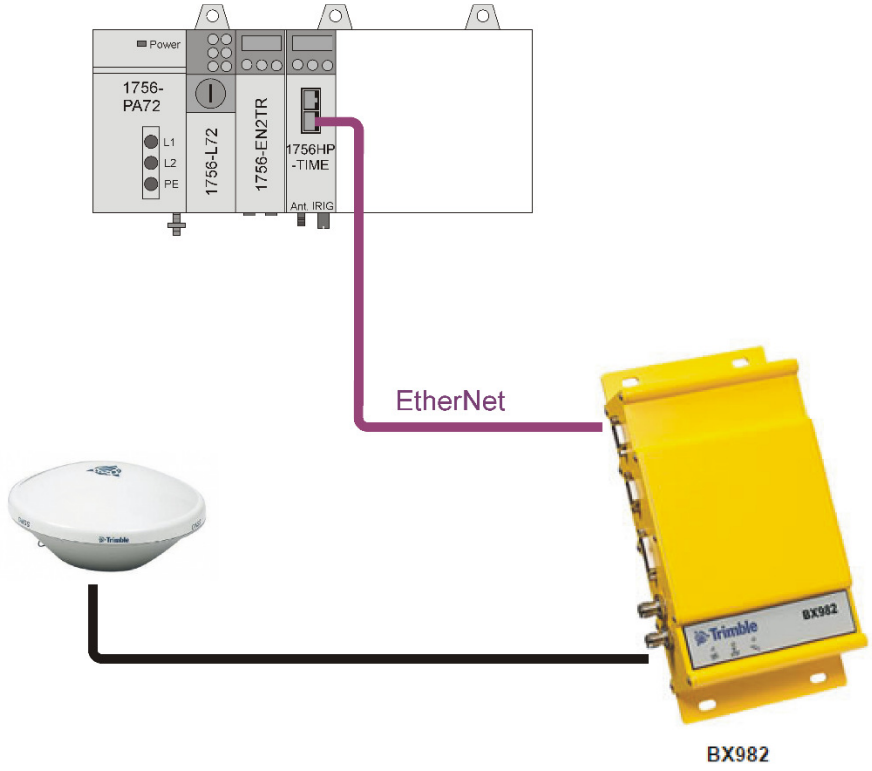


Figure 1: Setup

The picture above describes the most basic setup using one BX982 unit, there are other alternatives which include using 2 BX982 units (for example: one as a base, and one as a rover, using differential calculations) to obtain higher accuracy. Contact your local Trimble representative for more options and configurations.

Software

The following software is needed to configure and use the 1756HP-TIME module:

- The Studio 5000 Logix Designer application ladder example code.
- The Add-on Profile (AOP) for the 1756HP-TIME module both of which are available for download at: http://www.hiprom.com/Pages/Products/1756_CLX/1756HP-TIME/web/1756HP-TIME.htm
- Web browser.

Setup

Initial Setup

Please consult the 1756HP-TIME user manual for additional instructions on how to configure the IP address of the module, use ControlFlash to upgrade to the latest firmware, and install/configure the Add-On-Profile (AOP).

Basic Operation

The system makes use of the Trimble BX982 unit to obtain high accuracy position measurements.
There are 4 levels of position accuracy (1 sigma) you can reach with the Trimble units, depending on the method/setup used:

- Autonomous only: ~1.5m hor. / 3m vert.
- Autonomous with SBAS: 0.5m hor. / 0.85m vert. (e.g. with EGNOS)
- DGPS / DGNSS: 0.25m hor. / 0.5m vert. + 1ppm (L1-only)
- Full RTK: 0.8cm hor. / 1,5cm vert. + 1ppm (L1/L2 or L1-only versions)

The positioning data is then passed to the 1756HP-TIME module over Ethernet, using the GSOF protocol, and the relevant data is available in Studio 5000, in the Time Module Input tags as well as a specifically created UDT. See the Operation Section for more information on this data.

Software

The BX982 unit can be configured using any internet browser. The 1756HP-TIME is configured using Studio 5000 Logix Designer software. An example project is available for download (available here) which contains logic capable of transforming the ECEF (Earth-Centered-Earth-Fixed) coordinates to a local metric based coordinate system, as well as a message instruction to get additional data from the Trimble unit.

Configuration

1756HP-TIME

The 1756HP-TIME module and Trimble unit communicate using the GSOF protocol over Ethernet. Therefore the TIME module and Trimble unit must be connected to the same physical EtherNet network, either on the same subnet or with a suitable gateway configuration.
In this document the IP configuration parameters are as follows:

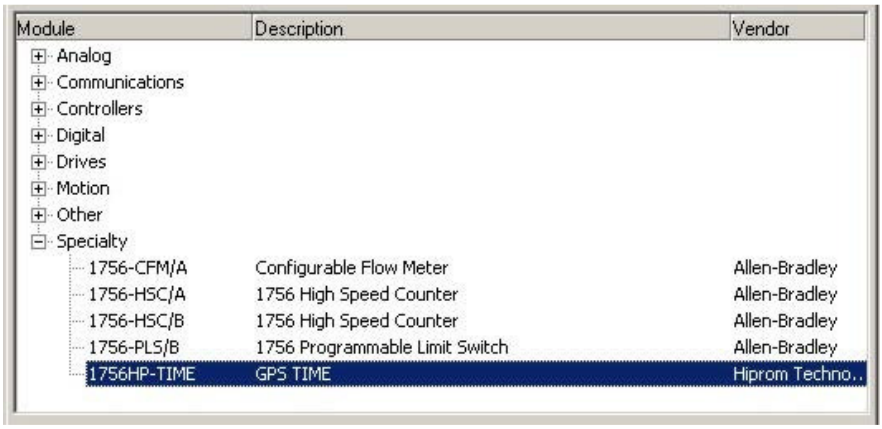
Trimble BX982	192.168.1.98
1756HP-TIME module	192.168.1.151

Before you can configure the 1756HP-TIME module, the AOP for the module must be installed. The installer for the AOP can be found at http://www.hiprom.com/Pages/Products/1756_CLX/1756HP-TIME/web/1756HP-TIME.htm

IMPORTANT Each 1756HP-TIME module is programmed to work with a single Logix5000 Controller.

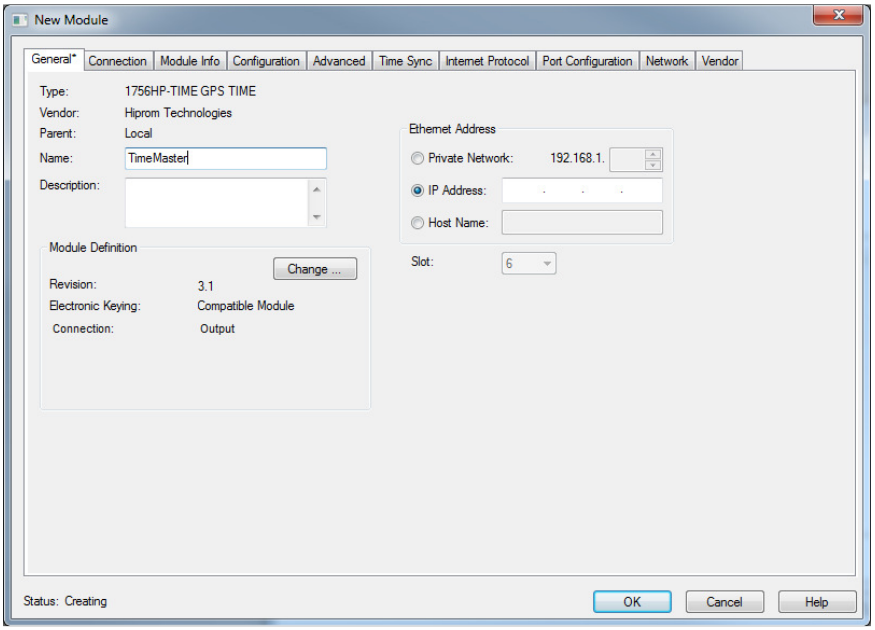
Follow these steps to configure the 1756HP-TIME module in the Logix Designer application.

1. Double-click the 1756HP-TIME module in the I/O tree in the Logix Designer Application.

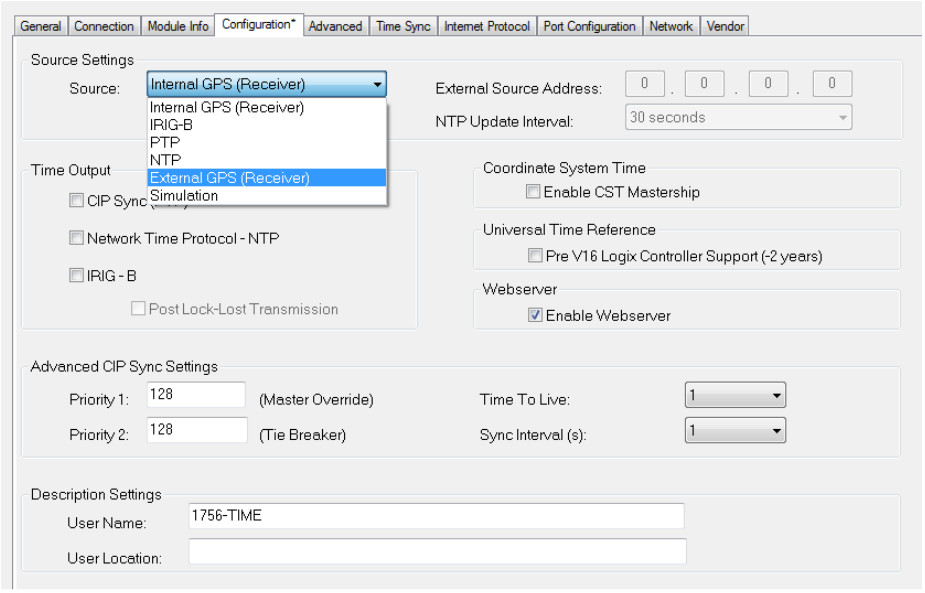


The New Module dialog box appears.

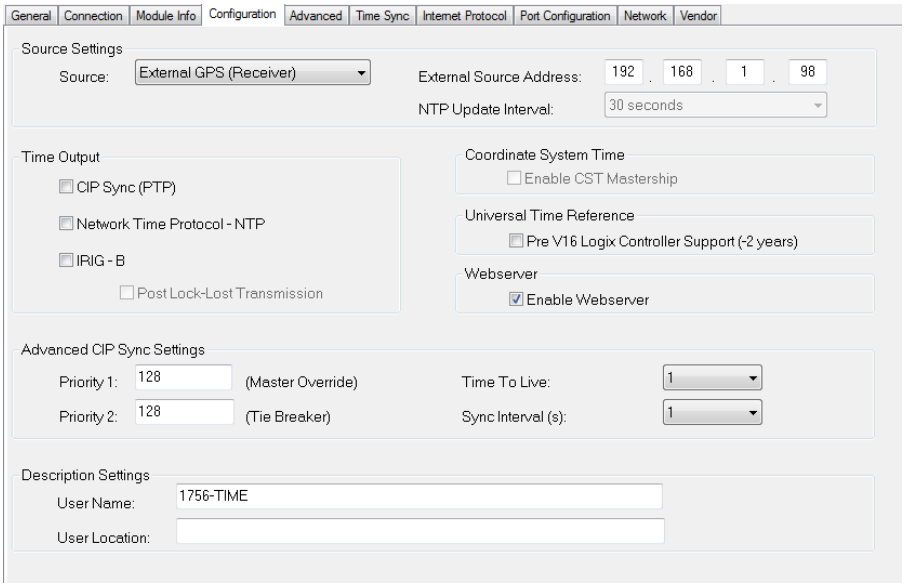
2. Enter a Name for the module.



3. Click the Configuration tab.
4. From the Source Setting pull-down menu, choose the External GPS (Receiver) option.
5. Click the Apply button.



6. Enter the IP address of the Trimble BX982 in the External Source Address



The properties of the 1756HP-TIME module are now configured.

Trimble BX982

There are many varieties of Trimble BX982 units to choose from, contact your local Trimble representative to order the unit that best suits your application.

Basic setup of the unit should include the following:

1. Install the unit in a suitable position such that the antenna has an unimpeded view of the sky.
2. Connect to the unit using the configured IP address. To accomplish this, please follow the manufacturer's instructions.
3. Log in to the webserver using the default security parameters:
    - Username : **admin**
    - Password : **password**
4. Navigate to **Receiver Configuration | Antenna**, and select the correct antenna configuration.
5. The unit should now start tracking satellites and resolving its position.
6. Navigate to **I/O Configuration | Port Configuration** and add a new TCP/IP port, as follows :
    - Type : GSOF
    - Port : 5017
    - Client : Off
    - Output Only : On
    - UDP Mode : Off
7. Select the following **Input/Output GSOF** messages, with a 1Hz frequency.
    - Current Time UTC
    - Lat, Long, Ht
    - Position Sigma
    - Position Time
    - Velocity
    - ECEF Position

Please see Appendix A for screenshots of how to set up the BX982 unit to communicate with the 1756HP- TIME module.

Once the TIME module and BX982 units are successfully configured and communication the 'SYNC' LED on the TIME module should turn green.

If you are using two Trimble units for differential corrections, one will need to be configured as a fixed base station, and one as a moving rover. The base station will send the CMR/RTCM Differential Corrections to the rover for relative positioning. See Appendix B for a description on how to configure a base station/rover application.

IMPORTANT	The LED colors are different to what is observed in normal operation when the module is in External GPS mode. The SYNC LED, when green, indicates a connection to the Trimble unit. The PPS LED is tied to the onboard GPS unit, and illustrates the accuracy of the time when in External GPS mode. If accurate time is needed along with the positioning, the internal GPS unit must have an antenna connected. Once the GPS receives lock it will synchronize the PPS and the time will be accurate to GPS time (within ±50 ns). A flashing red PPS LED is not indicative of any error in communication with the external Trimble unit. See 1756HP-TIME Module Status Indicators section for more information.

Operation

Logix5000 Controller Input Image

There are certain Input image tags which are specific for the External GPS mode of operation. These are outlined in more detail below.

Table 1 – Logix5000 Controller Input Image Parameters Specific to External GPS

Parameter	Description	Value
Source	Indicates the current time source.	1 = GPS 2 = IRIG-B 3 = PTP 4 = NTP 5 = External GPS 6 = Simulation
Time.TimeValid	Indicates if a valid time is being received from the time source.	0 = Time being received from source is invalid 1 = Time being received from source is valid
Time.Year	Displays the current year received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Year = 2010
Time.Month	Displays the current month received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Month = 4
Time.Day	Displays the current day received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Day = 27
Time.Hour	Displays the current hour received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Hour = 13
Time.Minute	Displays the current minute received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Minute = 45
Time.Second	Displays the current second received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Second = 22
Time.Microsecond	Displays the current microsecond received from the time source.	Example: 27/04/2010 13:45:22 - 234567 µs Microsecond = 234567 Note: The time is only valid if the Time.TimeValid bit is set.
Time.UTC	This is the current UTC in microseconds since the time base. The time origin is based on all versions of the Studio 5000 Logix Designer. Please refer to the example code for how this is used to time-stamp events in sequence-of-events (SOE) modules in RSLogix versions earlier than 18.	Example: 02 April 2014 14:12:41 UTC = 87277992127872
GPS.GPSLock	Indicates if the GPS receiver has lock.	0 = GPS receiver does not have lock 1 = GPS receiver has locked onto sufficient satellites
GPS.AntennaOK	Indicates if the antenna is connected and is operational.	0 = The antenna is either not present or is faulty 1 = The antenna is connected correctly and is operational

GPS.HDOPOk	Horizontal Dilution of Precision (HDOP) occurs when there are sufficient satellites in lock, but two or more satellites occupy similar positions in the sky (therefore decreasing the number of effective satellites).	0 = HDOP is currently active 1 = HDOP is not active
GPS.PPS	The pulse per second toggles at the exact moment the second changes and the microseconds are zero. Note: because the actual RPI is 50 ms, the accuracy is lost in the input image.	0 = It has been more than 100 ms since the roll-over pulse of the last second 1 = It has been less than 100 ms since the roll-over pulse of the last second
GPS.FaultCode	Reserved.	–
GPS.Mode	These bits can be used to determine the quality of the position, to ensure that the data being received is of the required accuracy. See table 2 below for details.	–
GPS.SVCount	Indicates the number of satellites that the GPS receiver is locked on.	This is a number between 0…12
GPS.Latitude	Displays the current position Latitude in degrees.	Example: S26°05'17.0 " E28°00'21.3 " Elev:
GPS.Longitude	Displays the current position Longitude in degrees.	Example: S26°05'17.0 " E28°00'21.3 " Elev:
GPS.Altitude	Displays the current position Altitude in meters.	Example: S26°05'17.0" E28°00'21.3" Elev: 1577m Elevation =
GPS.RelativePositionX	The relative position variables help to give an increased accuracy position parameter; as the calculations are performed in the Time module using floating point math, to remove any rounding errors. The values indicates the relative position from the reference station that the antenna is (in meters). The formula to calculate is as follows: GPS.RelativePositionX = PositionX *(from Ext GPS)* – ReferencePositionX *(from Output Image)*.	See Example code for use and implementation
GPS.RelativePositionY	GPS.RelativePositionY = PositionY *(from Ext GPS)* – ReferencePositionY *(from Output Image)*.	See Example code for use and implementation
GPS.RelativePositionZ	GPS.RelativePositionZ = PositionZ *(from Ext GPS)* – ReferencePositionZ *(from Output Image)*.	See Example code for use and implementation

Table 2: GPS Mode Interpretation

Bit	Description	Interpretation
0	New position	0: No. 1: Yes.
1	Clock fix calculated for current position	0: No. 1: Yes.
2	Horizontal coordinates calculated this position	0: No. 1: Yes.
3	Height calculated this position	0: No. 1: Yes.
4	Weighted position	0: No. 1: Yes.
5	Overdetermined position	0: No. 1: Yes.

6	Ionosphere-free position	0: No. 1: Yes.
7	Position uses filtered L1 pseudo ranges	0: No. 1: Yes.
8	Differential position	0: Differential position is an autonomous or a WAAS solution. 1: Position is a differential solution.
9	Differential position method	0: Code 1: Phase including RTK, HP or XP OmniSTAR (VBS is not derived from Phase).
10	Differential position method'	0: Code (DGPS) or a float position (RTK). Uncorrected position is Autonomous (if bit 0 = 0). 1: Position is fixed integer phase position (RTK). Uncorrected position is WAAS (if bit 0 = 0).
11	OmniSTAR solution	0: Not active 1: OmniSTAR differential solution (including HP, XP, and VBS)
12	Position determined with static as a constraint	0: No. 1: Yes.
13	Position is network RTK solution	0: No. 1: Yes.
14	Position is Location RTK	0: No. 1: Yes.
15	Position is Beacon DGPS	0: No. 1: Yes.

Logix5000 Controller Output Image

This section provides descriptions for the Logix5000 controller output image parameters.

Table 3 – Logix5000 Controller Output Image Parameters

Parameter	Description	Value
ReferencePositionX	The reference position variables help to give increased accuracy to the RelativePosition input image tags; as the calculations are performed in the Time module using floating point math, to remove any rounding errors. The formula to calculate is as follows: GPS.RelativePositionX = PositionX *(from Ext GPS)* – ReferencePositionX *(from Output Image)*.	See Example code for use and implementation
ReferencePositionY	GPS.RelativePositionY = PositionY *(from Ext GPS)* – ReferencePositionY *(from Output Image)*.	See Example code for use and implementation
ReferencePositionZ	GPS.RelativePositionZ = PositionZ *(from Ext GPS)* – ReferencePositionZ *(from Output Image)*.	See Example code for use and implementation

Example Code

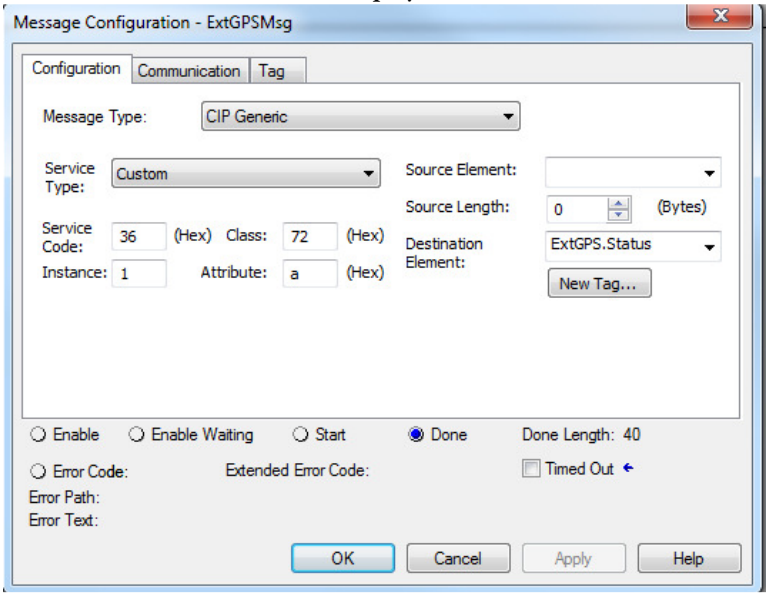
The example code found at http://www.hiprom.com/Pages/Products/1756_CLX/1756HP-TIME/web/1756HP-TIME.htm has the following components:

- CIP message to read additional External GPS data from the 1756HP-TIME module.
- UDT (ExtGPS) which allows the data received in the message to be displayed in a manageable format.
- Add-On-Defined code to transform the ECEF Cartesian coordinates referenced to a Base Origin to local North, East and Upward.

A brief explanation of each follows.

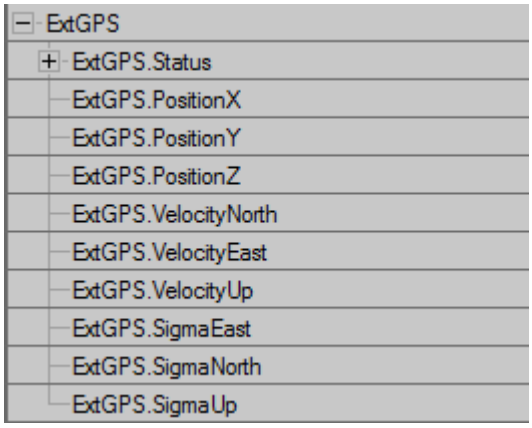
CIP Message

The parameters for the CIP message required to read the External GPS data from the 1756HP-TIME module is displayed in the screenshot below:

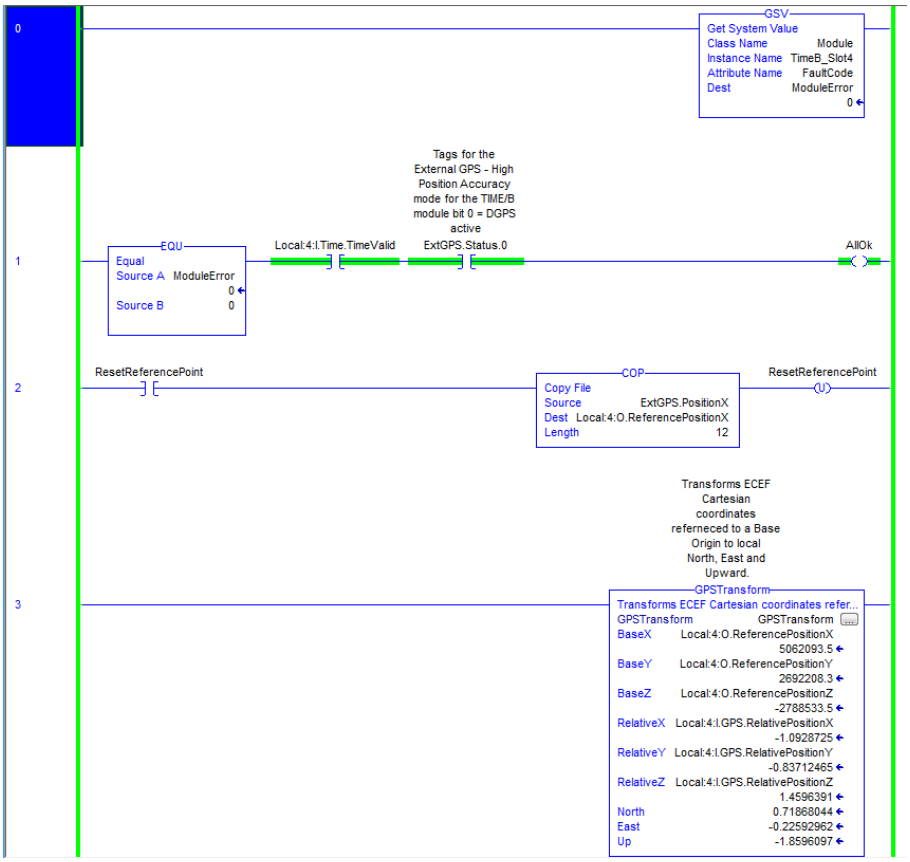


ExtGPS UDT

The UDT (User Defined Type) is used to store the result of the CIP message defined above. The structure is as follows.



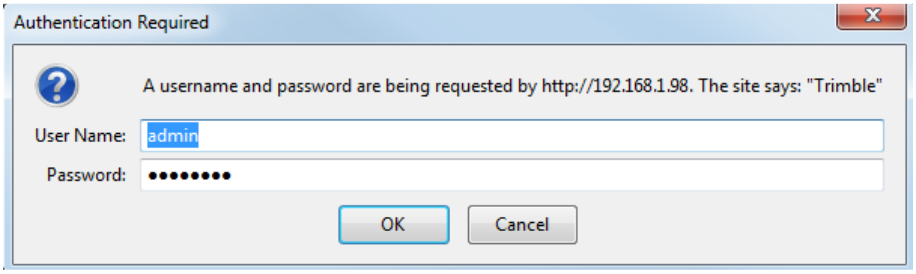
GPSTransform AOI



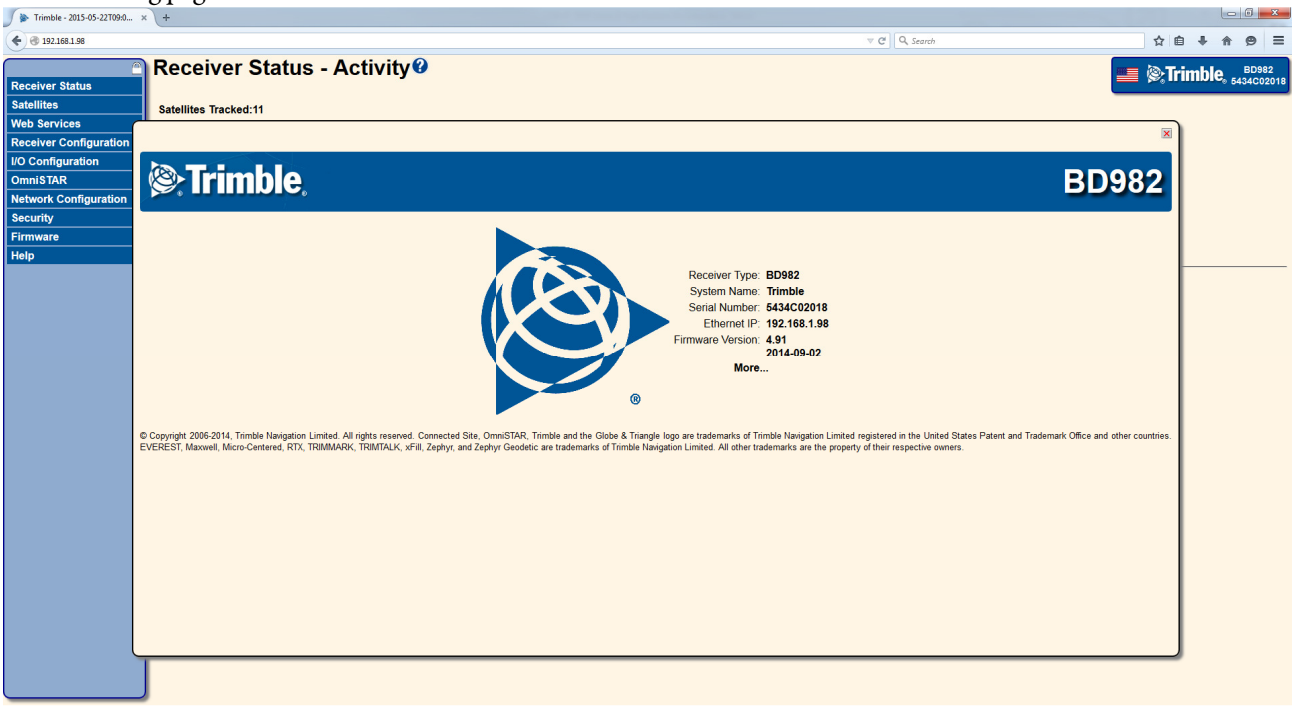
The GPSTransform takes a base X, Y and Z position (use the Output Image Tags for this purpose) and the current relative positions (calculated in the 1756HP-TIME module, and found in the Input Image) to give Local North, East and Upward values.

Appendix A – Trimble BX982 Setup

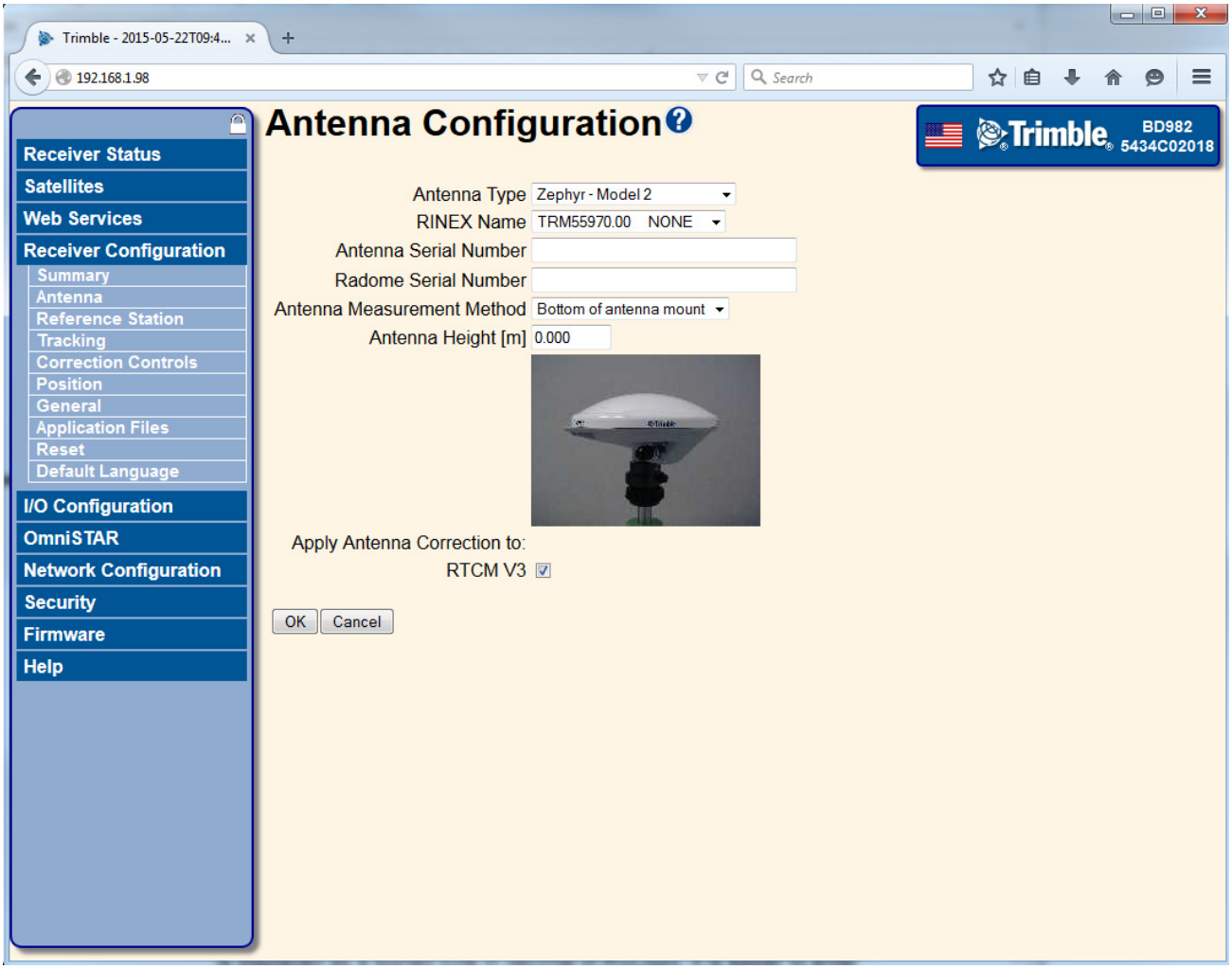
Open a web browser, and point the address to the configured IP address of the BX982. The default username and password are ‘admin’ and ‘Password’ respectively.

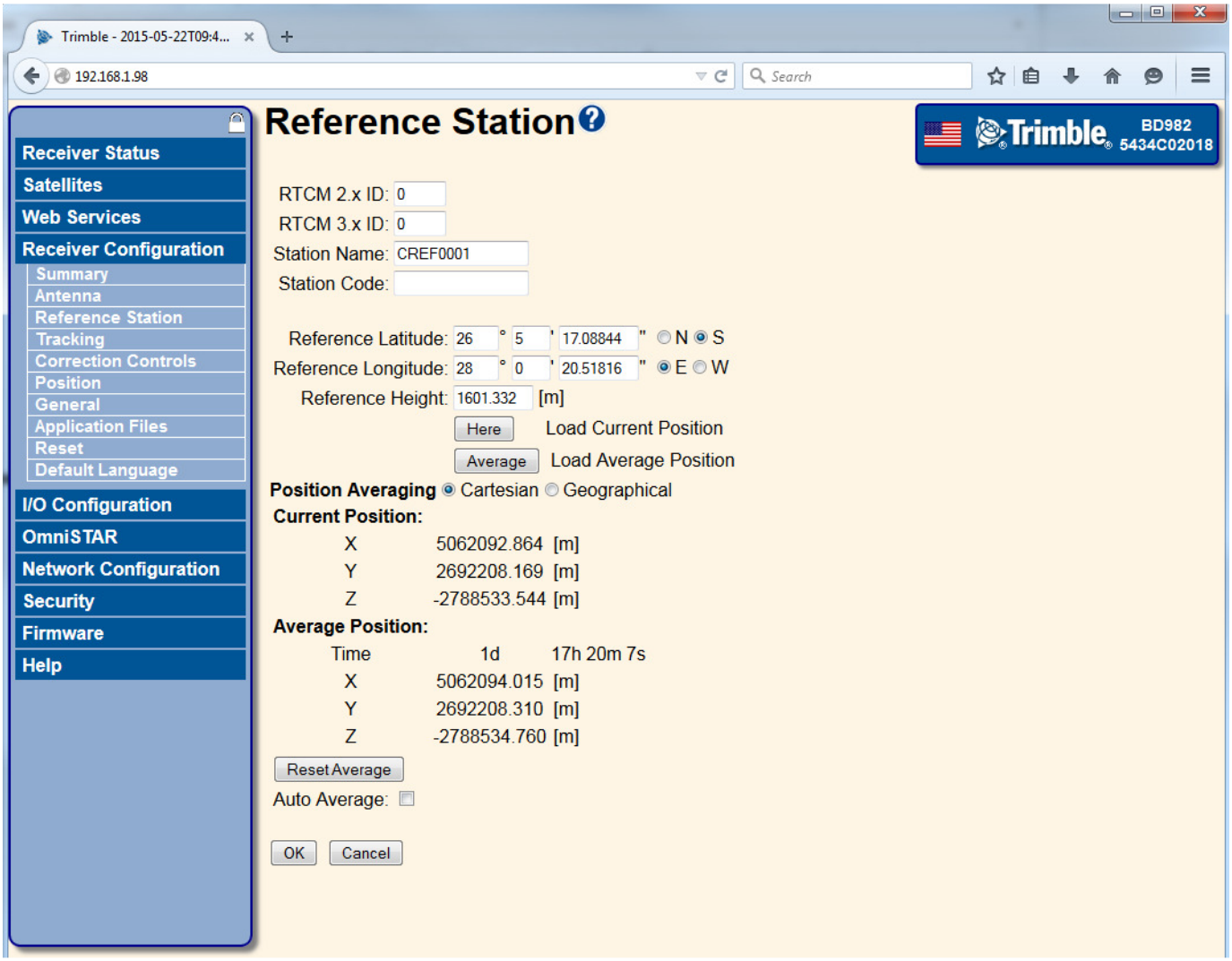


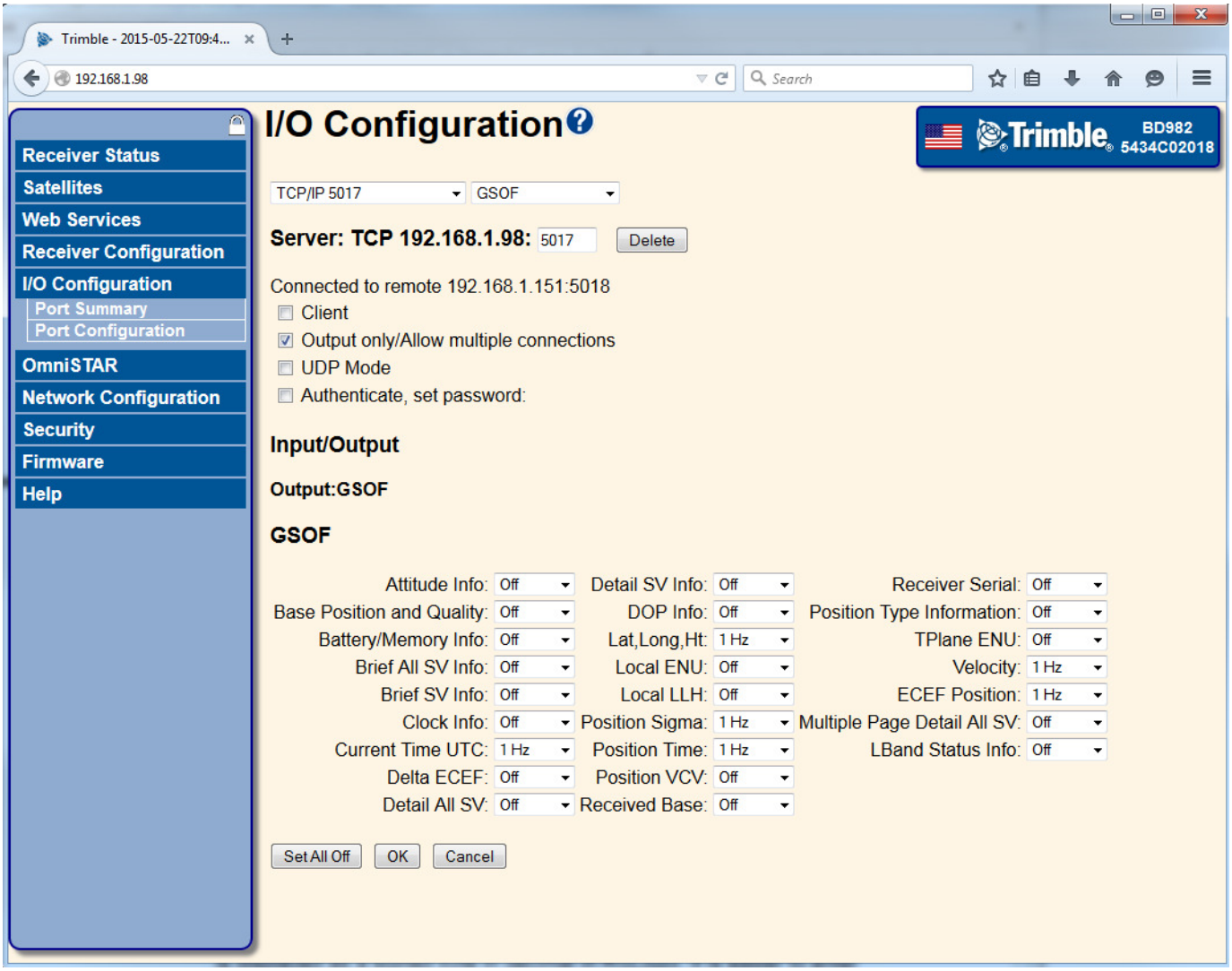
The following page should then be available.



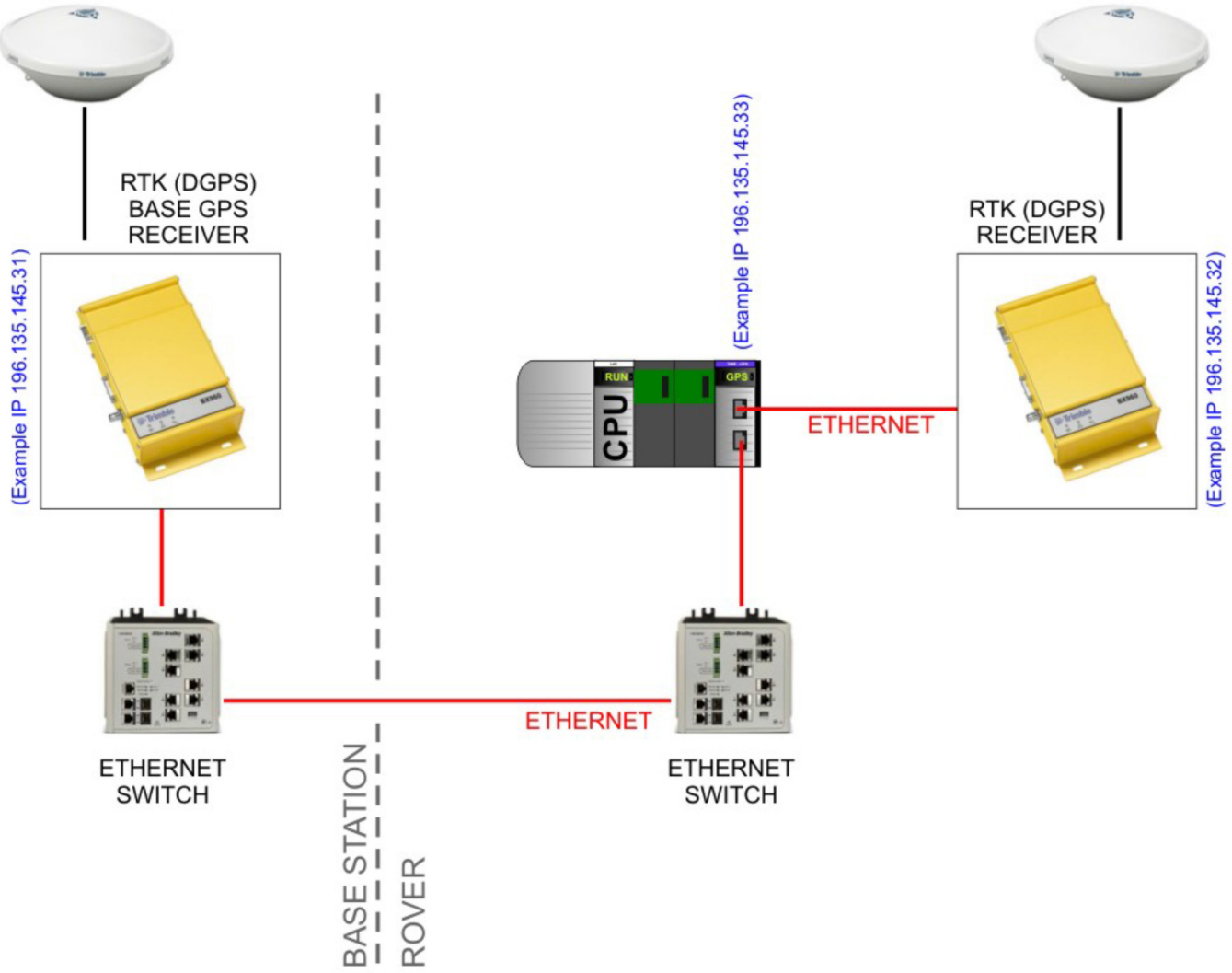
The navigation pane on the left hand side can be used to view various status, activity and configuration parameters of the BX982.


Trimble - 2015-05-22T09:4...
192.168.1.98
Search
Antenna Configuration
Trimble
BD982
5434C02018
Receiver Status
Satellites
Web Services
Receiver Configuration
Summary
Antenna
Reference Station
Tracking
Correction Controls
Position
General
Application Files
Reset
Default Language
I/O Configuration
OmniSTAR
Network Configuration
Security
Firmware
Help
Antenna Type
Zephyr - Model 2
RINEX Name
TRM55970.00 NONE
Antenna Serial Number
Radome Serial Number
Antenna Measurement Method
Bottom of antenna mount
Antenna Height [m]
0.000
Apply Antenna Correction to:
RTCM V3
OK
Cancel


Trimble - 2015-05-22T09:4...
192.168.1.98
Search
Receiver Status
Satellites
Web Services
Receiver Configuration
Summary
Antenna
Reference Station
Tracking
Correction Controls
Position
General
Application Files
Reset
Default Language
I/O Configuration
OmniSTAR
Network Configuration
Security
Firmware
Help
Reference Station
Trimble BD982 5434C02018
RTCM 2.x ID: 0
RTCM 3.x ID: 0
Station Name: CREF0001
Station Code:
Reference Latitude: 26 ° 5 ' 17.08844 " N S
Reference Longitude: 28 ° 0 ' 20.51816 " E W
Reference Height: 1601.332 [m]
Here Load Current Position
Average Load Average Position
Position Averaging Cartesian Geographical
Current Position:
X 5062092.864 [m]
Y 2692208.169 [m]
Z -2788533.544 [m]
Average Position:
Time 1d 17h 20m 7s
X 5062094.015 [m]
Y 2692208.310 [m]
Z -2788534.760 [m]
Reset Average
Auto Average:
OK Cancel


Trimble - 2015-05-22T09:4...
192.168.1.98
Search
Receiver Status
Satellites
Web Services
Receiver Configuration
I/O Configuration
Port Summary
Port Configuration
OmniSTAR
Network Configuration
Security
Firmware
Help
I/O Configuration
Trimble BD982 5434C02018
TCP/IP 5017
GSOF
Server: TCP 192.168.1.98: 5017
Delete
Connected to remote 192.168.1.151:5018
Client
Output only/Allow multiple connections
UDP Mode
Authenticate, set password:
Input/Output
Output:GSOF
GSOF
Attitude Info: Off
Base Position and Quality: Off
Battery/Memory Info: Off
Brief All SV Info: Off
Brief SV Info: Off
Clock Info: Off
Current Time UTC: 1 Hz
Delta ECEF: Off
Detail All SV: Off
Detail SV Info: Off
DOP Info: Off
Lat,Long,Ht: 1 Hz
Local ENU: Off
Local LLH: Off
Position Sigma: 1 Hz
Position Time: 1 Hz
Position VCV: Off
Received Base: Off
Receiver Serial: Off
Position Type Information: Off
TPlane ENU: Off
Velocity: 1 Hz
ECEF Position: 1 Hz
Multiple Page Detail All SV: Off
LBand Status Info: Off
Set All Off
OK
Cancel

Appendix B – Base station with Rover Setup



Base station setup:

1. Install the unit in a suitable position such that the antenna has an unimpeded view of the sky.
2. Connect to the unit using the configured IP address. To accomplish this, please follow the manufacturer's instructions.
3. Log in to the webserver using the default security parameters:
   - Username : **admin**
   - Password : **password**
4. Navigate to **Receiver Configuration | Antenna**, and select the correct antenna configuration.
5. The unit should now start tracking satellites and resolving its position.
6. Navigate to **Receiver Configuration | Reference Station** and select the "Load Current Position" by pressing the "**Here**" button.
7. Navigate to **I/O Configuration | Port Configuration** and add a new TCP/IP port, as follows :
   - Type : CMR
   - Port : 5018
   - Client : Off
   - Output Only : On
   - UDP Mode : Off
   - Delay : 0 ms

Rover setup:

1. Install the unit in a suitable position such that the antenna has an unimpeded view of the sky.
2. Connect to the unit using the configured IP address. To accomplish this, please follow the manufacturer's instructions.
3. Log in to the webserver using the default security parameters:
   - Username : **admin**
   - Password : **password**
4. Navigate to **Receiver Configuration | Antenna**, and select the correct antenna configuration.
5. The unit should now start tracking satellites and resolving its position.
6. Navigate to **I/O Configuration | Port Configuration** and add a new TCP/IP port, as follows :
   - Type : GSOF
   - Port : 5017
   - Client : Off
   - Output Only : On
   - UDP Mode : Off
   - Remote IP : (*IP address of Base Station*) : 5018
   - CMR Input : Disabled
7. Select the following **Input/Output GSOF** messages, with a 1Hz frequency.
   - Current Time UTC
   - Lat, Long, Ht
   - Position Sigma
   - Position Time
   - Velocity
   - ECEF Position

Specifications

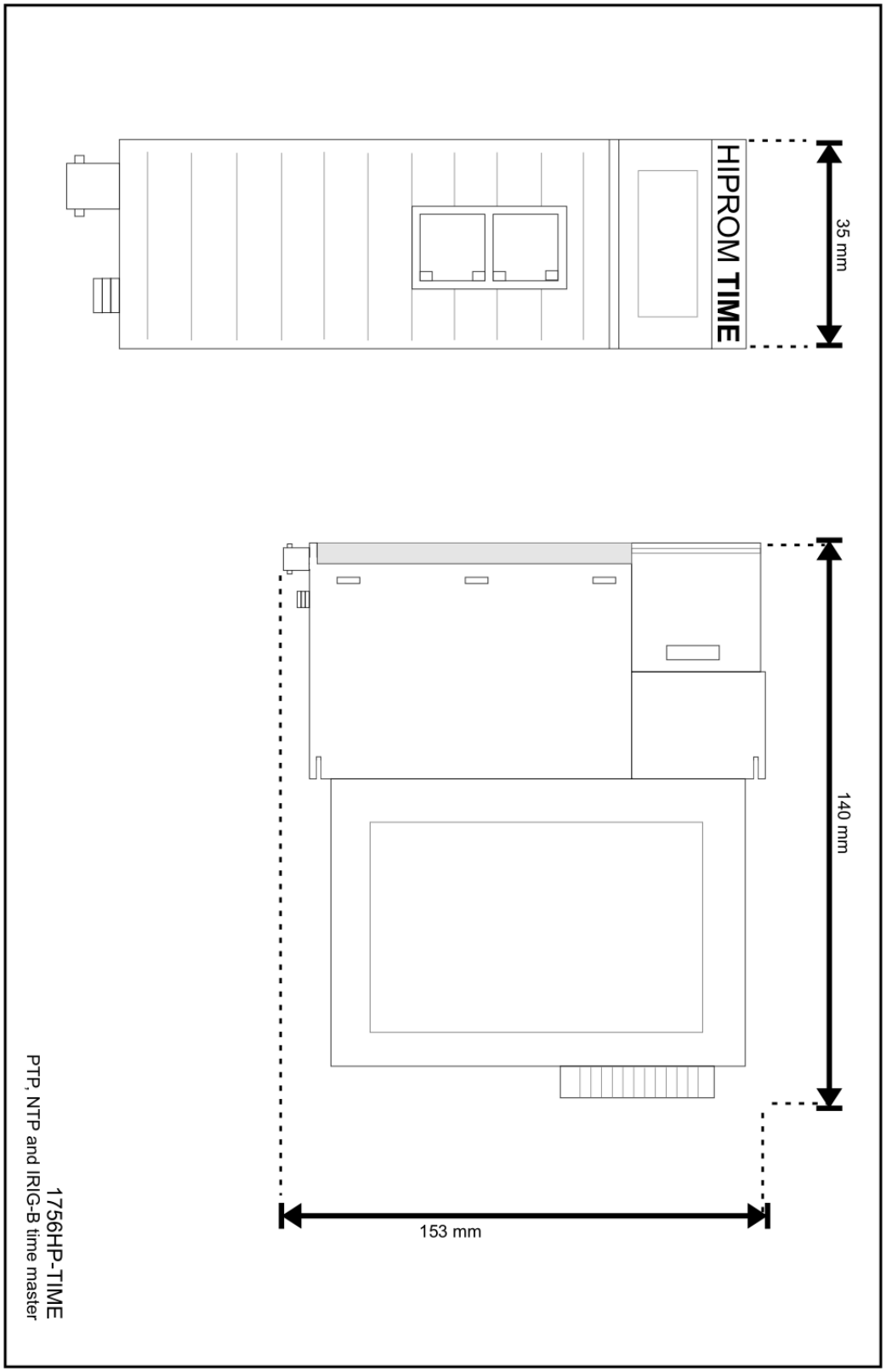
Technical Specifications

The following table lists the technical specifications for the 1756HP-TIME module. Additional information will be made available once the values have been ascertained.

Attribute	Value
Power requirements	All power is derived from the 1756 backplane. Current draw @ 5 V – 736 mA Current draw @ 24 V – 1.64 mA
Power consumption	
Operating temperature	0…50 °C (32…122 °F)
Storage temperature	
Relative humidity	5… 95% noncondensing
Operating shock	TBA
Storage shock	TBA
Vibration	TBA
Emissions	TBA
ESD immunity	TBA
Radiated RF immunity	TBA
EFT/B immunity	TBA
Conducted RF immunity	TBA
Enclosure type rating	IP20
Ethernet conductor	CAT5 STP

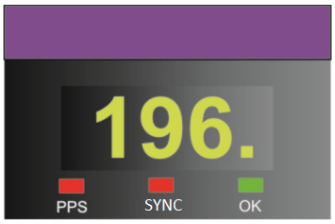
Dimensions

The following drawing shows the dimensions of the 1756HP-TIME module.



1756HP-TIME Module Status

The display on the front of the 1756HP-TIME module provides status indicators and messages.



Status Indicators

The 1756HP-TIME module provides three status indicators on the display. These LEDs indicate slightly different information when in External GPS mode than in any other Input mode.

Status Indicator	Description
PPS	This indicator is toggled every second for 100 ms at the exact PPS (Pulse Per Second). Green = the internal GPS is locked and receiving a valid PPS from the satellites. Red = the internal GPS is not locked, or the antenna is missing.
LOC	Green = the module is communicating properly with the External Trimble unit. Red = the module is not communicating properly with the External Trimble unit.
OK	Green = the module has started successfully. Red = the module has a hardware fault.

Glossary

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication AG-7.1

Add-On Instructions Add-on instructions are custom Studio 5000 Logix Designer application instructions that you design and create. With add-on instructions, you can create new instructions for sets of commonly-used logic, provide a common interface to this logic, and provide documentation for the instruction.

Best Master Clock Algorithm The algorithm performed by each node to determine the clock that will become the master clock on a subnet and the grandmaster clock for the domain. The algorithm primarily compares priority1, clock quality, priority2, and source identity to determine the best master among available candidates.

Boundary Clock A boundary clock has more than one port, for example, a managed Ethernet switch, and perform the duties as a master or slave clock.

Common Industrial Protocol (CIP) The Common Industrial Protocol (CIP) is an open industrial protocol for industrial automation applications.

CIP Sync CIP Sync is the Open DeviceNet Vendors Association (ODVA) implementation of the Institute of Electrical and Electronics Engineers (IEEE) 1588-2008 standard. The protocol provides a mechanism to synchronize clocks between controllers, I/O devices, and other automation products.

Clock A node participating in the PTP protocol that is capable of providing a measurement of the passage of time since a defined epoch. There are three types of clocks in IEEE 1588-2008: boundary, transparent, and ordinary clocks.

Coordinated System Time (CST) In its simplest form, CST is a backplane clock propagated between all modules on the ControlLogix backplane. Its presence is necessary whenever time coordination between modules in the chassis is required.

Device Level Ring (DLR) A DLR network is a single-fault tolerant ring network intended for the interconnection of automation devices. This topology is also implemented at the device level. No additional switches are required.

Domain A logical grouping of clocks that synchronize to each other by using the PTP protocol, but that are not necessarily synchronized to clocks in another domain.

Greenwhich Mean Time (GMT) GMT is the mean solar time of the longitude (0°) of the former Royal Observatory at Greenwich, England, or Greenwich meridian. UTC replaced GMT as the basis for the main reference time scale or civil time in various regions on 1 January 1970.

Global Positioning System (GPS) GPS is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS provides reliable timing services (as well as positioning and navigation) on a continuous basis in all weather, day and night, anywhere on or near the Earth that has an unobstructed view of four or more GPS satellites.

Grandmaster (GM) Within a domain, a clock that is the ultimate source of time for clock synchronization by using the CIP Sync protocol.

Local Clock	The clock on a device.
Master Clock (M)	In the context of a single CIP Sync communication path, a clock that is the source of time to which all other clocks on that path synchronize on a local subnet.
Network Time Protocol (NTP)	A protocol for synchronizing the clocks of computer systems over packet-switched, variable-latency data networks.
Priorities (P1 and P2)	Parameters that can override the best master clock algorithm to choose a different grandmaster.
Precision Time Protocol (PTP)	The PTP protocol is a time-transfer protocol defined in the CIP Sync IEEE 1588-2008 standard that allows precise synchronization of networks.
Slave Clock	A clock that synchronizes its local clock to a master time.
Sequence of Events (SOE)	Sequence of events are any events that needs to be compared against a second event.
Synchronized Clocks	Two clocks are synchronized to a specified uncertainty if they have the same epoch and their measurements of the time of a single event at an arbitrary time differ by no more than that uncertainty.
System Time	The absolute time value as defined by CIP Sync in the context of a distributed time system where all devices have a local clock that is synchronized with a common master clock. System time is a 64-bit integer value in units of nanoseconds or microseconds with a value of 0 corresponding to an epoch of January 1, 1970.
Time Sync Object	The time sync object provides a Common Industrial Protocol (CIP) interface to the IEEE 1588 (IEC 61588) standard for a precision clock synchronization protocol for networked measurement and control systems. This information can be collected to be used in diagnostics.
Transparent Clocks	A device that measures the time taken for a PTP event message to transit the device and provides this information to clocks receiving this PTP event message.
Coordinated Universal Time (UTC)	The time standard for 'civil time', representing time at the Prime Meridian (0 degrees longitude). The time does not include time zone or daylight savings time offsets. System time is the same as UTC.
Wall Clock Time (WCT)	Wall clock time is the controller's time based on UTC system time.

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products at:
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You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit
http://www.rockwellautomation.com/services/online-phone

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator http://www.rockwellautomation.com/rockwellautomation/support/overview.pa Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

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