

**TSC 4420A
TSC 4421A
TSC 4421A-DC
Network Time Server**

**Operation and Maintenance
Manual**

For use with software version nts5-1-2 or higher



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TSC 4420A Network Time Server with GPS Disciplined Rubidium Reference
TSC 4421A Network Time Server with GPS Disciplined Crystal Reference
TSC 4421A-DC Network Time Server with GPS Disciplined Crystal Reference

Operations and Maintenance Manual

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Revision	Description	Date	Approved
A	Initial Release	3/1/05	GAR
B	Correct C and R command	3/13/05	GAR
C	New command set	6/28/05	GAR
D	Update Specs and add Declaration of Conformity	9/14/05	MSS
E	Merge 4420A and 4421A, add 4421A-DC	3/27/06	GAR
F	Clarify position_mode, status bits, fix front panel description	5/17/06	GAR
G	Correct position update time	6/29/06	GAR
H	Clarify bit 20 and correct bit 18 of status word	8/03/06	GAR
I	SEL1 and SEL2 corrections in chapters 3 and 4	8/11/06	GAR

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1: Introduction



Note

FIRST READ THIS MANUAL THOROUGHLY!

This is especially true for the sections regarding **Safety** and **Installation**.

1.1 Symbols

These symbols appear throughout the manual as well as on the unit itself.



Note

This symbol means the following information is a note that gives you important information that may affect how you use the unit.



Caution, refer to manual. Read all instructions in Manual before using this product.



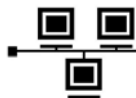
CE marking, attesting compliance to applicable European Directives



Caution – Risk of Electrical shock



Fuse symbol



LAN port, NETWORK, DO NOT CONNECT TO TELECOM CONNECTIONS THAT CARRY HAZARDOUS VOLTAGES.



Earth terminal symbol: Used to indicate an earth ground connection to chassis.

1.2 About This Manual

This manual tells you how to install, set up, monitor, and troubleshoot the 4420A, 4421A, and 4421A-DC.

“[Chapter 1, Introduction](#)” on page 1 explains symbols that appear in the manual and on the unit as well as documentation conventions and a brief description.

“[Chapter 2, Installing and Setting Up the Network Time Server](#)” on page 7 contains important safety information and describes how to install the unit.

“[Chapter 3, Monitoring the Network Time Server](#)” on page 13 describes how to monitor alarms and the time.

“[Chapter 4, Troubleshooting and Maintaining the Network Time Server](#)” on page 23 describes how to replace the fuse and battery and how to solve operational problems.

“[Chapter 5, Warranty and Shipping Information](#)” on page 25 explains how to contact Timing Solutions Corporation for warranty service and provides shipping guidelines.

“[Chapter 6, Declaration of Conformity](#)” on page 26 provides the information required for CE compliance.

“[Appendix A, Specifications](#)” on page 27 contains the detailed specifications for the unit.

“[Appendix B, Lightning Arrestor Installation](#)” on page 30 describes connection of the lightning arrestor option.

1.2.1 Conventions

This manual uses several typographical conventions to help explain how to use the unit.

Convention	Definition
Bold	Words in bold show: <ul style="list-style-type: none">■ Buttons and icons to click■ Menu options to select■ Commands to type■ Non-variable information displayed in response to commands
<i>Italics</i>	Words in <i>italics</i> show: <ul style="list-style-type: none">■ Names of windows and dialog boxes■ Variable information displayed in response to commands

1.3 Network Time Server Overview

The TSC 4420A and 4421A are Stratum 1 Network Time Protocol (NTP) Servers that generate precise signals which can be traceable to Universal Coordinated Time (UTC). The units are housed in a 1U (1.75") high 19-inch rack-mount chassis. They use a GPS-disciplined frequency reference to provide precise timing signals, and will continue to provide all signals if the GPS signal is lost.

An Ethernet port on the rear panel provides the NTP server interface, and the capability to remotely monitor the status of the GPS receiver, oscillator and all output signals. Any internal or output failure in the unit will immediately send an alarm to this port. The front panel provides a time display as well as status LEDs for the output, internal oscillator, and GPS receiver.

Figure 1 shows the Network Time Servers' front panel, and Figure 2 shows the rear panel.

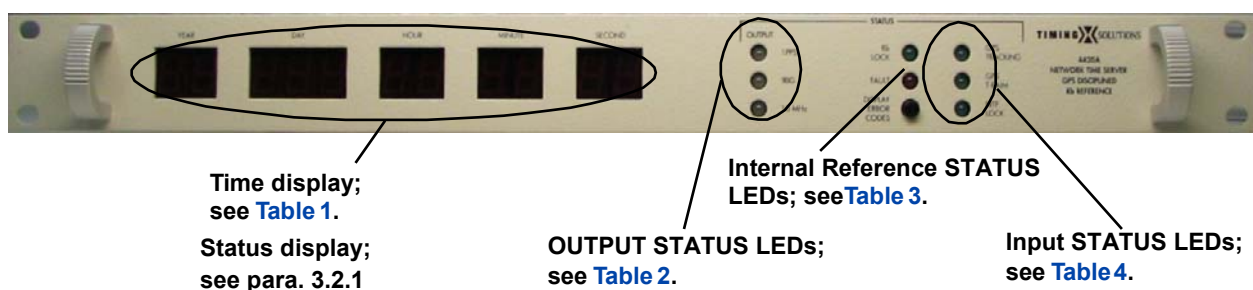


Figure 1: Front panel

Table 1: Time display LEDs

Time display	Description
Year	<ul style="list-style-type: none"> ■ Last two digits of the current year ■ Example: "04" for 2004 ■ Range: 00 to 99 ■ The four-digit year value is known, though it is not displayed.
Day	<ul style="list-style-type: none"> ■ Julian day of the year ■ Example: "366" for 31 Dec 2004 (a leap year) ■ Range: 1 to 366 ■ Displays the value "366" for the last day of a leap year.
Hour	<ul style="list-style-type: none"> ■ UTC Hour of the day in military time ■ Example: "23" for 11 p.m. ■ Range: 0 to 23
Minute	<ul style="list-style-type: none"> ■ Minute of the hour ■ Range: 0 to 59
Second	<ul style="list-style-type: none"> ■ Second of the minute ■ Range: 0 to 60 ■ Displays the value "60" during a positive leap second.

Table 2: OUTPUT STATUS LEDs

LED	State	Description
1PPS	Off	<ul style="list-style-type: none"> ■ Waiting for valid GPS Timing signal. ■ The 1 PPS ports on the back of the device are inactivated.
	Green	<ul style="list-style-type: none"> ■ Valid GPS Timing signal initially acquired. ■ All of the 1 PPS ports on the back of the device are producing valid waveforms.
	Red	<ul style="list-style-type: none"> ■ The amplitude of one or more of the 1 PPS ports on the back of the device has been determined to be out of spec. Connect to the Ethernet port and read the data to determine which ports are at fault.
IRIG	Off	<ul style="list-style-type: none"> ■ Waiting for valid initial GPS input signal. ■ The IRIG ports on the back of the device are only producing the 1 kHz IRIG carrier signal.
	Green	<ul style="list-style-type: none"> ■ Valid initial GPS input signal acquired. ■ All of the IRIG ports on the back of the device are producing valid waveforms.
	Red	<ul style="list-style-type: none"> ■ The amplitude of one or more of the IRIG ports on the back of the device has been determined to be out of spec. Connect to the Ethernet port and read the data to determine which ports are at fault.
10 MHz	Off	<ul style="list-style-type: none"> ■ Waiting for the status of the internal frequency reference 10 MHz signal.
	Green	<ul style="list-style-type: none"> ■ The internal frequency reference is producing a valid 10 MHz signal.
	Red	<ul style="list-style-type: none"> ■ The internal frequency reference is reporting a failure, or one or more of the outputs has low amplitude.

Table 3: Internal reference STATUS LEDs and DISPLAY ERROR CODES button

LED	State	Description
Rb or OSC LOCK	Green	<ul style="list-style-type: none"> ■ The internal frequency reference is locked to the UTC time scale of the GPS receiver.
FAULT	Red	<ul style="list-style-type: none"> ■ An internal reference fault or any internal communication errors will cause the FAULT LED to turn on. This error is non-fatal and the light will go off if the error ceases. The internal reference fault is suspended for several minutes during power up since the internal reference can be out of lock during startup. ■ The position determined by the GPS receiver autosurvey does not match the position stored in the persist file within 30 meters. This can be cleared by setting the correct position, or changing to 3D mode and deleting the stored position.
DISPLAY ERROR CODES	N/A	<ul style="list-style-type: none"> ■ Press once and hold to display any errors that are currently affecting the system in the time display LEDs.

Table 4: Input STATUS LEDs

LED	State	Description
GPS TRACKING	Off	■ The GPS receiver is in the process of determining the state of the antenna port.
	Green	■ The GPS receiver is tracking at least one satellite.
GPS T-RAIM	Off	■ Time Receiver Autonomous Integrity Monitoring (T-RAIM) not active.
	Green	■ GPS receiver using redundant satellite measurements to confirm the integrity of the timing solution (TRAIM active).
NTP	Off	■ The NTP server is not available.
	Green	■ NTP is locked to the internal reference and providing NTP services.

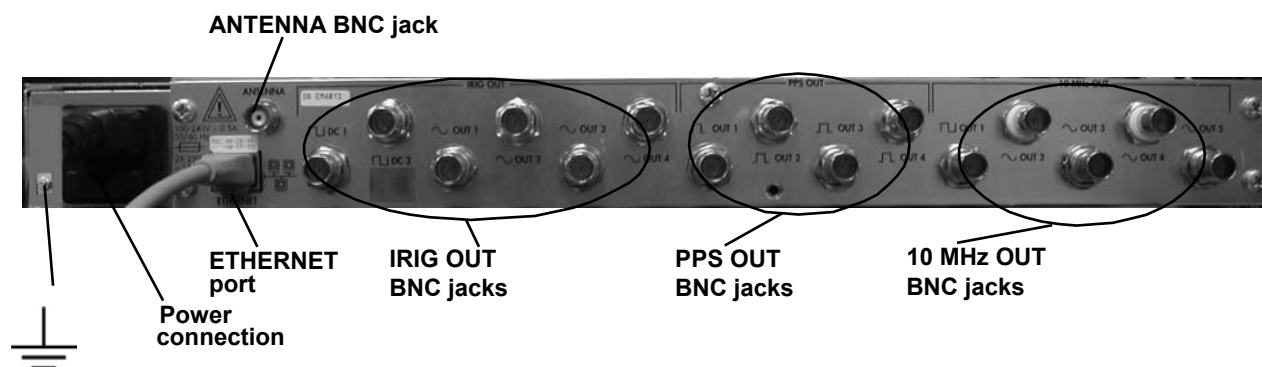



Figure 2: Rear panel

Table 5: Rear panel connections

Connections	Description
POWER	<ul style="list-style-type: none"> ■ 100–240 V AC, 50/60 Hz power signal ■ 4421A-DC only: 12-32 V DC
ETHERNET	<ul style="list-style-type: none"> ■ Interface for Ethernet communications with the device ■ Bi-directional ■ TCP/IP ■ Port 10001 for monitoring status ■ No prompt displayed
ANTENNA	<ul style="list-style-type: none"> ■ Interface for the GPS antenna ■ 5 VDC, 80 mA maximum supplied on center conductor for antenna bias ■ Short circuit protected
IRIG OUT	<ul style="list-style-type: none"> ■ All ports produce IRIG-B <ul style="list-style-type: none"> • Two DC IRIG-B ports • Four amplitude modulated IRIG-B ports ■ Output impedance = 50 Ω
PPS OUT	<ul style="list-style-type: none"> ■ Four one pulse-per-second ports ■ 100 μs pulse width ■ Minimum 4.4 V pulse amplitude ■ Output impedance = 50 Ω
10 MHz OUT	<ul style="list-style-type: none"> ■ One square wave 10 MHz port; 55% duty cycle ■ Four sinusoidal 10 MHz ports, 13 \pm1 dBm ■ Output impedance = 50 Ω
	<ul style="list-style-type: none"> ■ Grounding stud for affixing permanent ground connection to chassis

2: Installing and Setting Up the Network Time Server

2.1 Safety First!



Warnings:

This unit is for INDOOR USE ONLY. It is not sealed to prevent moisture from entering the enclosure.

Do not attempt to install or operate this equipment if you have not first acquired proper training.

Equipment is intended to be installed in an enclosed or open type equipment rack.

Ensure that all cables are properly connected. The power cord must be easy to remove from the back.

Verify that input line voltage and current capacity are within specifications before turning on power to the unit.

Disconnect all sources of input power before removing the top cover of this unit.

Operating and maintenance personnel must receive proper training before installing or maintaining electrical equipment.

2.2 Unpacking

To unpack the unit:

1. Unpack and carefully inspect the unit.
2. Check for physical damage.
3. If no physical damage is apparent, then proceed with making appropriate connections.
4. If physical damage is observed, then immediately contact Timing Solutions and the carrier. Save the shipping container for submitting any necessary claims to the carrier.

2.3 Cleaning



Warning

Do not spray or use too much liquid when cleaning the unit. Liquid can enter the unit and damage sensitive electronic components.

Clean the main chassis with a soft cloth dampened with a mild soap and water solution.

2.4 Installing the Network Time Server

The unit ships ready for installation into a standard 19" (48.3 cm) rack. You can use mounting slides from General Devices with part numbers C-300-S-126, -128 and -130.

2.4.1 Required Materials For Installation

- North American or European IEC power cord. One or the other will be supplied with the unit.
- GPS antenna and cable, options available with the unit
- Customer-supplied double-shielded RG223 cables with BNC connectors from source for the number of devices you plan to connect to the 4420A.
- Customer-supplied shielded CAT 5 LAN cable for network connection (RJ-45).
- Rack-mount slide kit from General Devices, C-300-S-126, -128 or -130 (Optional).
- Rack mounting screws if mounting in a rack.
- Screwdriver for the rack mount screws and slide as needed.

2.4.2 Setting IRIG-B Time Code Output to Include Year

The Network Time Server ships from the factory with an internal jumper set to not include the year in the IRIG-B time code. To change this jumper setting to include the year, follow these steps:

1. Disconnect power from the rear of the unit.
2. Remove the top cover of the unit.
3. Using proper ESD precautions, remove the jumper installed on SEL1.
4. Reinstall the top cover.

2.4.3 Making Connections

2.4.3.1 Input Power

The 4420A and 4421A AC input power to the unit is supplied through a 3-prong power cable.

To connect the AC power cable:

1. Plug the female end into the male IEC-320 plug on the rear of the unit.
2. Plug the male end of the cable into a 100–240 V AC, 50/60 Hz power source.

**Warning**

Ensure that the AC power supply cord is connected to a properly grounded mains receptacle.

The 4421A-DC input power (12-32 V DC) is supplied through a customer supplied cable. The power connector on the unit is manufactured by Souriau (PN: D38999/20WA98PN) with the following connections: Pin B: GND, Pin C: 28VDC. This input does not contain a user replaceable fuse.

**Warning**

Since the unit does not have a Mains Power Switch, both the Power Inlet Connector and the Plug on the detachable power supply cord are considered to be suitable Disconnect Means for disconnecting the unit from the AC Mains Supply. If the rear of the unit is not accessible after installation in the instrument rack, you must provide a suitable external Disconnect Means for the unit.

2.4.3.2 GPS Antenna

**Warning**

If an outside antenna is connected to the product, be sure the antenna is grounded so as to provide some protection against voltage surges and built-up static charges. Article 810 of the National Electrical Code, ANSI/NFPA 70 provides information with regard to proper grounding of the mast and supporting structure, grounding of the lead-in wire to an antenna discharge unit, size of grounding connectors, location of antenna discharge unit, connection to grounding electrodes, and requirements for the grounding electrode. An outside antenna system should not be located in the vicinity of overhead power lines or other electric light or power circuits, or where it can fall into such power lines or circuits. When installing an outside antenna system, extreme care should be taken to keep from touching such power lines or circuits as contact with them might be fatal.

Once the antenna is installed, connect the GPS antenna cable to the ANTENNA BNC connector on the rear panel of the unit.

New Antenna Installation

The primary consideration in choosing an antenna location should be sky coverage. Sky coverage is the amount of unobstructed sky that is viewed by the antenna. Poor antenna placement can severely limit the amount of sky coverage. To maximize sky coverage the antenna should be placed above the height of the building as much as possible. It should also not be placed near other features that can obstruct its view of the sky (e.g., buildings, trees, satellite dish). Figure 3 illustrates the effect antenna placement has on sky coverage. There are often multiple obstructions that must be contended with and complete sky coverage may not be a possibility. In those instances, personal judgment must be used in determining the best antenna location.

Once a suitable antenna location has been identified, it is necessary to ensure that the GPS signal that reaches the unit is of suitable quality. The Network Time Server antenna input requires between 18 and 36 dB of gain from the combination of the antenna and cable loss. The optional antenna available with the unit has 27 dB gain, so the total cable losses in the system must not exceed 9 dB at 1.5 GHz.

If the location of the antenna dictates that a longer cable must be used then a line amplifier will need to be inserted into the signal path. A line amplifier is a device used to amplify the GPS signal to overcome the losses resulting from longer cable runs. In selecting a line amplifier it is necessary to make sure that it provides an adequate amount of gain and that it operates from 1200 MHz to 1600 MHz.

The amount of gain required from a line amplifier can be calculated by knowing the total loss of the antenna cables being used. The signal loss due to a cable varies depending upon the frequency of the signal. For the purposes of GPS antennas the cable loss should be calculated at 1500 MHz. The manufacturer of the cable being used should be able to provide an estimate of the cable loss at 1500 MHz. Once the cable loss is known it can be inserted into Equation 1 to calculate the required gain of the line amplifier:

$$MIN_Gain(dB) = \frac{Cable_Loss(dB/100\ ft) * Cable_Length(ft)}{100} - 12 \quad \text{Eq. 1.}$$

The *MIN_Gain* value in Equation 1 serves as the minimum gain required from the line amplifier being used. It is possible to use amplifiers with a slightly higher gain than the minimum value but it will not improve the performance of the system. Using amplifiers with significantly higher gain values can also cause degradation of the GPS signal.

Placement of the line amplifier is also a concern in a properly designed system. Placing the amplifier too close or too far from the antenna may cause unexpected degradation in the GPS signal. The best place for the amplifier is typically half way between the antenna and Network Time Server. Figure 4 shows the block diagram of a typical installation that requires a longer antenna cable. In addition to the line amplifier being used it is also necessary to provide some

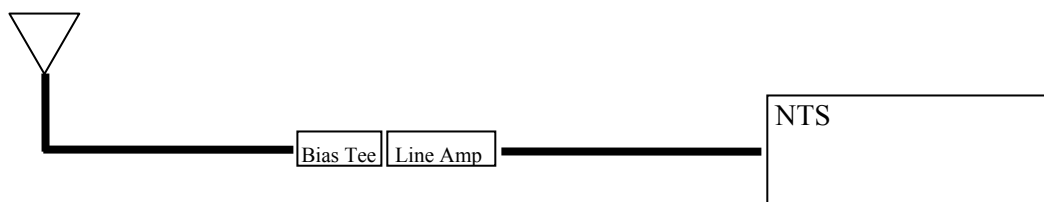


Figure 4. Typical configuration for longer cable runs.

means of powering the GPS antenna. The Antenna voltage supplied by the unit must be DC blocked from the amplifier input when using an in-line amplifier. A bias-tee can provide a simple solution to power the antenna by allowing a DC voltage to be applied to the antenna cable without disrupting the GPS signal. Once again it is imperative that the bias-tee operate between 1200 MHz and 1600 MHz.

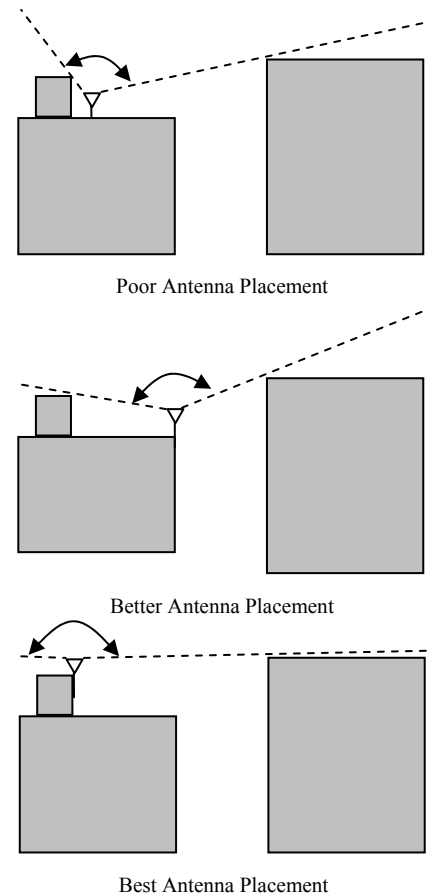


Figure 3. Effect of antenna placement on sky coverage.

2.4.3.3 Output Signals

- Connect up to fifteen double shielded coaxial cables to the IRIG OUT, 1 PPS OUT, and 10 MHz BNC connectors on the rear panel of the unit.



2.4.2.4 LAN - Ethernet Network Port

- Connect a shielded CAT 5 LAN cable (not supplied with the unit) to the Ethernet port on the rear panel of the unit.

2.5 Understanding the Startup Sequence

The Network Time Server automatically starts up and performs the following startup sequence:

1. Tests all of the seven-segment displays and LEDs, via operator visual verification.
2. Verifies that the rubidium oscillator is producing a valid signal and lights the 10 MHz LED.
3. Locks onto GPS satellites and lights the GPS TRACKING LED.
4. Locks onto enough GPS satellites to distinguish between good and bad satellite signals and lights the T-RAIM LED.
5. Reference oscillator locks onto the 1 PPS coming from the GPS receiver, and lights the LOCK and 1 PPS LEDs.
6. Downloads the almanac from the GPS, then displays the time and lights the IRIG LED.
 - The GPS almanac download after first power up can take up to 13 minutes.
7. Factory default GPS receiver mode is 3D. It will remain in this mode unless the user changes it. The NTS checks the persist file for a stored position. If there is a stored position, the GPS receiver will be commanded to complete an automatic site survey. The survey to determine the position will be complete approximately 2.5 hours after locking to the first satellite. An alarm will be raised on the FAULT LED if the stored position is off from the GPS receiver's surveyed position by more than 30 meters. The user will need to set the correct position, as the antenna coordinates have changed due to moving the antenna to a different location.

When the Network Time Server is operating normally, all of the LEDs except the FAULT LED should be lit and green.

2.6 Assigning an IP Address

The unit's IP address is set to 192.168.0.1 at the factory. A web browser can be used to access the device's web page to change the IP address, net mask and default router. To set the IP address, you must be using a computer in the 192.168.x.x private domain. You may also connect directly to the unit from a computer through a cross-over network cable. If you use this method, the IP on the computer must be set to an address like 192.168.0.100. Once you have made a

network connection to the unit, use a web browser to open the web page at the default IP address 192.168.0.1. At this point you can follow the on screen instructions to change the IP address to suit your specific needs. Once the IP address has been changed on the web page, the unit needs to be power cycled to set the new IP address.

You can determine the IP address from the front panel by using the DISPLAY ERROR CODES button. First press and release this button and then hold it in to display the IP address.

If the IP address of the unit is incorrectly re-configured and you can not find the device on the network, you will need to reset the device to the factory default address. To reset to the default IP address, press and release the DISPLAY ERROR CODES button, and then press and hold it in. The IP address will display, followed a short time later by a count down to zero.

2.7 NTP Server Capability

The unit provides standard NTP v4 server functionality over the Ethernet connection located on the module panel. After power up, the alarm LED will turn on for a few minutes until the server is ready to provide NTP service. Once the unit is providing NTP server functionality, the front panel NTP Lock LED will light.

NTP client software is available for free on the internet for most operating systems. UNIX users can find information on how to set up a computer for NTP client capability on the www.ntp.org web site. Windows users can refer to the document <http://download.microsoft.com/download/2/0/f/20f61625-7b2a-4531-b007-1c714f1e51b7/wintimeserv.doc> for information on the windows time service or to the web site <http://geodsoft.com/howto/timesync/> for a description of NTP for windows and some of the client software available on the internet.

3: Monitoring the Network Time Server

3.1 Accessing the System

You access the Network Time Server remotely by connecting to its Command-And-Response (CNR) Port through the Ethernet connection. The CNR port (Port 10001), which uses TCP/IP, lets you input commands, displays results of the commands, and pushes fault information as it changes.

When users Telnet to the CNR port the system displays a flashing underscore prompt. Turn echo off on the telnet session if you wish to inhibit display of the user typed characters.

3.2 Checking System Status

When you send commands to check the system status, you need to append the command with /n if it is not included as part of the connection setup. All commands are case sensitive. Valid responses to commands include a line with the text

OK: 2005-05-23, 21:54:46Z, MJD=53513, Day_of_year=142

This line provides the user with a response that the command was successful, and the time the response was sent. The time is not provided if the unit has just been powered up and time is not available. The unit will respond with an error message “unknown command”, along with “ERROR” and the time if the command is invalid. Each response line shown in this document is appended with \r\n in the actual response from the unit.

3.2.1 Checking Alarms

If you have software that is polling for the units’ status and alarms, you will see the response to the **alarms** command in the following format:

alarms

cccccc, llllll

output status:

<i>IRIGB DC output #1</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>IRIGB DC output #2</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>IRIGB modulated output #1</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>IRIGB modulated output #2</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>IRIGB modulated output #3</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>IRIGB modulated output #4</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>PPS output #1</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>PPS output #2</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>PPS output #3</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>PPS output #4</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>10MHz (square wave) output #1</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>10MHz (sine wave) output #2</i>	<i>(current): OK</i>	<i>(latched): OK</i>
<i>10MHz (sine wave) output #3</i>	<i>(current): OK</i>	<i>(latched): OK</i>

```

10MHz (sine wave) output #4    (current): OK    (latched): OK
10MHz (sine wave) output #5    (current): OK    (latched): OK
unused
PPS outputs                    (current): ON
IRIGB outputs                  (current): ON
gps status:
  satellites tracked: 7
  have accurate time
  autosurvey off
surveyed position:
  lat:  40:01:09.93400 lon: -105:14:20.72400 alt: 1596.55005
stored position:
  lat:    <none> lon:    <none> alt:    <none>
ntp status:
  locked
reference clock status:
  sync to PPSREF
  beat: 238669, lockedCnt: 4, unlockedCnt: 0
OK: 2006-03-27, 17:26:21Z, MJD=53821, Day_of_year=086

```

where

- *cccccc* and *llllll* are hexadecimal numbers, with each bit position representing one status value. Least significant bit (LSB) is farthest right. The most significant bit (MSB) is farthest left. In this example, all bits are 0.
- *cccccc* is the current alarm where 0 = no alarm condition and 1 = alarm condition.
- *llllll* are the latched alarms where 0 = no alarm condition and 1 = alarm condition. Bits 15 and above are non-latchable alarms.
- Text following the alarms bits in the response is a human readable representation of the status of the unit.

Note: Some units have a different Rubidium, where the reference clock status changes to the following:

```

reference clock status:
  Unit is OK
  unlocked
  lamp switch off
  FXO enabled
  1PPS output enabled
  AC MOS output enabled
  Low C-field
  SINE output @ 50%
  beat: 8243, lockedCnt: 1, unlockedCnt: 2

```

Table 6 describes each alarm bit.

Table 6: Alarm bit descriptions

Bit position	Bit function	Description
23	Comm. Timeout with CPU	<ul style="list-style-type: none"> ■ 0 = OK ■ 1 = No comm.
22	Unused	<ul style="list-style-type: none"> ■ 0 = always
21	Unused	<ul style="list-style-type: none"> ■ 0 = always
20	Oscillator lock status	<ul style="list-style-type: none"> ■ 0 = Locked to GPS 1PPS ■ 1 = Not locked
19	Reset Network	<ul style="list-style-type: none"> ■ Set when active ■ Cleared on send
18	Unused	<ul style="list-style-type: none"> ■ 0 = After successful initialization
17	IRIG-B Outputs	<ul style="list-style-type: none"> ■ 0 = ON ■ 1 = OFF
16	PPS Outputs	<ul style="list-style-type: none"> ■ 0 = ON ■ 1 = OFF
15	Unused	<ul style="list-style-type: none"> ■ 0 = always
14	10 MHZ SINE OUT 4	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
13	10 MHZ SINE OUT 3	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
12	10 MHZ SINE OUT 2	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
11	10 MHZ SINE OUT 1	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
10	10 MHZ SQUARE OUT 1	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
9	PPS OUT 4	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
8	PPS OUT 3	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
7	PPS OUT 2	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
6	PPS OUT 1	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
5	IRIG-B SINE OUT 4	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault

Bit position	Bit function	Description
4	IRIG-B SINE OUT 3	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
3	IRIG-B SINE OUT 2	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
2	IRIG-B SINE OUT 1	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
1	IRIG-B DC OUT 2	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault
0	IRIG-B DC OUT 1	<ul style="list-style-type: none"> ■ 0 = no fault ■ 1 = fault

Pressing and holding the front panel button will display the present status of the unit. Bit 0 is the right most bit. The displayed code has the same definitions as the above alarm response with the following exceptions:

- Bits 20 and 21 on the front panel code represent internal jumper positions SEL1 and SEL2 respectively. SEL1 and SEL2 will each report a “0” when the jumper is installed, and a 1 when it is not installed. SEL1 is used for setting the IRIG-B time code to include year (jumper not installed). SEL2 is for future use.
- Bits 24-31 shown as all zeros on the front panel are not reported in the alarm response.

3.2.2 Monitoring Faults

When you are connected to the units’ Ethernet port, the unit will report faults as they occur and clear. These faults are reported in the same format as the hexadecimal current and latched ALARMS response defined in section 3.2.1, and include the date, day of year and time of the fault. Latched faults will clear automatically in the fault output when the fault condition is corrected.

Example indicates an NTP lock fault:

Faults: 080000,080000, 2006-03-23, 082, 17:51:42

3.2.3 Checking Model Number and Software Version

You can check the system model number and software version.

To check the model number:

- Type: **model**
 - The system returns for example:
model
4420A
OK: 2005-05-23, 21:54:46Z, MJD=53513, Day_of_year=142

To check the software version:

- Type: **software_version**
 - The system returns for example:

software_version

CVS tag:

nts5-1-2-1

4421A:

v 1.41 2006/03/14 17:10:23, MAK00270-C2

Time source:

v 2.2 APR 28 2004

OK: 2006-03-23, 17:57:29Z, MJD=53817, Day_of_year=082

3.2.4 Checking the Time and Date

You can check the time that the device has recovered from GPS.

To check the time:

- Type: **date**

- The system returns for example:

date

2005-05-23, 21:52:55Z, MJD=53513, Day_of_year=142

OK: 2005-05-23, 21:52:55Z, MJD=53513, Day_of_year=142

3.2.5 Checking or Setting the Position

You can check the position of the antenna as reported by the GPS receiver. Position is updated every second.

To check the position:

- Type: **position**

- The system returns for example:

position

surveyed position:

lat: 40:01:09.57800 lon: -105:14:20.79900 alt: 1633.17004

stored position:

lat: <none> lon: <none> alt: <none>

OK: 2005-05-23, 21:52:55Z, MJD=53513, Day_of_year=142

To set the position:

- Type (for example): **position 40:01:09.87000 -105:14:20.7 1596.8**

- The system returns for example:

position 40:01:09.87 -105:14:20.7 1596.8

surveyed position:

lat: 0:00:00.00000 lon: 0:00:00.00000 alt: 0.00000

stored position:

lat: 40:01:09.87000 lon: -105:14:20.70000 alt: 1596.8

OK: 2006-03-31, 18:44:38Z, MJD=53825, Day_of_year=090

Note: Latitude and longitude must be in the range + 180 to – 180.

3.2.6 Starting and Stopping the Time “Push”

You can tell the unit to “push” the time and position to the Ethernet port every second.

To start the time push:

- Type: **broadcast on**

The system returns

broadcast on

OK: 2006-03-23, 17:58:31Z, MJD=53817, Day_of_year=082.

- From that point forward, the system will return the system time and present position in the following format every second:

2006-03-23, 082, 17:58:32, 40:01:09.85300, -105:14:20.70500, 1594.00000

To stop the time push:

- Type: **broadcast off**

- The system returns

broadcast off

OK: 2006-03-23, 17:58:37Z, MJD=53817, Day_of_year=082

3.2.7 Setting the Position Mode

You can set the GPS position mode to either continuously update position (3D mode), automatic site survey (auto) and then hold a position, or set the position manually(fixed). The factory default mode is 3D. If a position was entered by the user or an automatic site survey was completed prior to a power cycle, the GPS receiver will first perform a 2.5 hour automatic site survey, then change to fixed mode using the stored position. If the stored position and the GPS automatic site survey position are off more than 30 m, the FAULT LED is lit. The NTS will use the automatic site survey position until the user resets the position to clear the FAULT LED.

If the unit was set to a fixed position, then back to 3D, the stored position needs to be deleted using the **position default** command to ensure the 3D mode persists.

- To set the position mode, replace **xxxxx** in the following command with 3D, auto or fixed:

position_mode xxxxx

- The system returns

position_mode xxxxx

OK: 2005-05-23, 21:52:49Z, MJD=53513, Day_of_year=142

The unit will respond with the presently set position mode if the command **position_mode** is sent.

3.2.8 Setting the Antenna Mask Angle

The antenna mask angle can be set and queried. The GPS receiver will attempt to track satellites for which the elevation angle is greater than the satellite mask angle. This parameter allows the user to control the elevation angle that was used for this decision.
Range: 0 to 89 degrees

Default value: 10 degrees

- Type (for example): **antenna_mask 10**

- The system returns

antenna_mask 10

OK: 2005-05-31, 21:16:51Z, MJD=53521, Day_of_year=151

3.2.9 Setting the Cable Delay

The GPS receiver outputs a 1PPS signal, the rising edge of which is placed at the top of the GPS or UTC one second time mark epoch as specified by the time mode. The 1PPS Cable Delay command allows the user to offset the 1PPS time mark in one nanosecond increments relative to the measurement epoch.

This parameter instructs the GPS receiver to output the 1PPS output pulse earlier in time to compensate for antenna cable delay. Zero cable delay is set for a zero-length antenna cable. The user should consult a cable data book for the delay per foot for the particular antenna cable used in order to compute the total cable delay needed for a particular installation.

The setting will persist if the unit is powered off and back on.

Range: 0 to 999999 ns

Default value: 0 ns

Resolution: 1 ns

- Type (for example): **cable_delay 0**

- The system returns

cable_delay

0

OK: 2005-05-31, 21:17:00Z, MJD=53521, Day_of_year=151

3.2.10 Using the Reset Command

A reset command can be issued to software reset the GPS receiver and computer that operates the unit.

- Type: **reset**

- The system returns:

reset

**** Program will restart in 30 seconds ****

OK : 2006-06-26, 16:00:16Z. MJD53912, DAY OF YEAR = 177

3.2.11 Viewing the Signal Strength

- Type: **signal_strength**

- The system returns:

```
signal_strength
Channel PRN Signal strength
-----
1      5      42
2      25     55
3      14     54
4      n/a    n/a
5      1      53
6      22     50
7      30     41
8      n/a    n/a
9      15     41
10     11     50
11     18     39
12     n/a    n/a
```

OK 2005-05-23, 21:54:46Z, MJD=53513, Day_of_year=142

3.2.12 Viewing the Velocity

Reports the velocity in meters per second.

- Type: **velocity**

- The system returns

```
velocity
0.000000
```

OK 2005-05-23, 21:54:46Z, MJD=53513, Day_of_year=142

3.2.13 Viewing the data in the persist file

The “persist” file contains the data that are stored for use in maintaining the user configured mode, position and cable delay after power has been cycled. The position and cable delay settings are stored. If these values are not changed from the factory default of no position stored and 0 ns cable delay, then the response is empty.

- Type: **persist**

- The system returns

```
persist
position      = 40:01:09.85300 -105:14:20.70500 1594
cable_delay   = 100
```

OK: 2006-03-23, 17:58:09Z, MJD=53817, Day_of_year=082

The command **persist delete** can be used to delete the information in the persist file.

3.2.14 Monitoring the NTP server performance

The operating performance of the NTP server can be monitored to ensure NTP clients can obtain the best time possible. To monitor the performance, use an application such as Telnet to log into the unit. The username and password are both “tsc”. Once you have logged into the system and the NTP LED is green, type in “cd /root” and then “ntpq -p”.

The system returns:

```
remote          refid    st t when poll reach  delay  offset  jitter
*REFCLK(25,0).GPS.  0  1  10  16  377   0.000   0.002   0.004
```

The response shows a current list of peers of the server, along with a summary of each peer's state. Summary information includes the address of the remote peer, the reference ID, the stratum of the remote peer, the type of the peer (local, unicast, multicast or broadcast), when the last packet was received, the polling interval, in seconds, the reach ability register, in octal, and the current estimated delay, offset and dispersion of the peer, all in milliseconds.

Other ntpq options available and are listed on the ntp.org web site.

4: Troubleshooting and Maintaining the Network Time Server

Perform all of the following procedures before returning the unit for service. If the unit still appears to have a problem, then call Timing Solutions Corporation (TSC) and request technical support. Have the serial number of your unit ready to provide to a technical representative.

4.1 Displaying Error Codes

You can see the status of the unit using the **DISPLAY ERROR CODES** button on the front panel. When you press and hold the **DISPLAY ERROR CODES** button, the status displays in the seven-segment displays on the front panel.

For more information, see “3.2.1 Checking Alarms” on page 13. The displayed code has the same definitions as the alarm response with two exceptions. Bits 20 and 21 on the front panel code represent internal jumper positions SEL1 and SEL2 respectively. SEL1 and SEL2 will report a “0” when the jumper is installed, and a “1” when it is not installed. SEL1 is removed for setting the IRIG-B time code output to include year. SEL2 is for future use.

4.2 Replacing Fuses

If you know that a local event caused blown fuses throughout a rack, you can replace the fuses in each Network Time Server power entry module.

Required for this procedure:

- Small flat-head screwdriver
- Replacement fuse for a standard IEC 320 power entry module with fuse (250V~1A Time Lag 5x20 mm)

To replace a fuse:

1. Disconnect the power cable from the back of the Network Time Server.
2. Using a small screwdriver, open the fuse cover on the back of the Network Time Server.
3. Replace the old fuses as necessary.
4. Close the fuse cover.
5. Reconnect the power cable to the back of the Network Time Server.

4.3 Replacing the Oscillator

If the FAULT LED lights and remains on when all other lights are green, the oscillator may need to be serviced or replaced, call TSC to obtain a Returned Materials Authorization and return the unit to TSC for repair.

4.4 Solving Operational Problems

If the Antenna used to supply the NTS with GPS signals is moved more than 30 meters and the unit was previously in fixed position mode, an alarm will be raised and the FAULT LED will be red. To clear the alarm, you must re-set the position to one that is within 30 m of the position determined by the 2.5 hour long auto survey performed by the GPS receiver.

If the unit does not operate properly after you have verified that:

- the correct power is applied to the rear of the Network Time Server, that a good GPS antenna and cable are connected to the Antenna port
and
- the fuses are good,

call TSC to obtain a Returned Materials Authorization and return the unit to TSC for repair.

4.5 Maintenance



Caution

The 3 V lithium battery on the computer board must be replaced only by trained and authorized personnel, following all proper ESD precautions.

A minimal amount of maintenance is required for the Network Time Server. It is designed to operate continuously over long periods of time with little to no interaction. The primary factor in maintaining a working unit is to verify that it remains dust free. Dust and particles may enter the unit through vent holes and accumulate inside. Although this is typically not a major concern, it may be a significant concern in installations with high dust content. A yearly internal inspection should be performed on units in a high dust environment.

Internal Inspection

The internal inspection of the Network Time Server is recommended to ensure that all components are relatively free of dust and particles that may cause electronic components to fail. The following instructions outline the required steps in performing an internal inspection of the Network Time Server.

1. Remove power from the unit and then remove the top cover of the Network Time Server.
2. Visually inspect the various components and make sure that an excessive amount of dust is not present. Excessive dust can be removed by using low pressure compressed air to clean the electrical components of any accumulated dust.
3. Re-install the top cover of the Network Time Server.

5: Warranty and Shipping Information

This chapter provides information on how to contact Timing Solutions Corporation for warranty service, as well as shipping guidelines for the unit.

5.1 Warranty Information

The NTS carries a warranty from Timing Solutions Corporation for a period of 1 year from date of shipment.

For repairs, contact Timing Solutions Corporation:

- Phone (303) 939-8481
- Fax (303) 443-5152

Address written correspondence to:

Timing Solutions Corporation
4775 Walnut Street, Suite 1B
Boulder, CO 80301
USA

5.2 Shipping Information

If you need to ship this system for any reason, including returning equipment to Timing Solutions for warranty service, follow these shipping instructions. Failure to follow these instructions may damage your system.

5.2.1 Packing Instructions

- Always ship the unit appropriately packaged to protect it from damage, preferably in the package in which it was originally shipped.
- No cables or connectors may be attached to the rear of the chassis.
- Wrap the chassis in plastic to protect against moisture.

6: Declaration of Conformity

Declaration of Conformity According to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Timing Solutions Corporation

Manufacturer's Address: 4775 Walnut Drive Suite 1B
Boulder CO 80301 USA

declares that the product:

Product Name: GPS Disciplined Rb Reference

Model Number: TSC 4420A, TSC 4421A

Product Options: All except TSC 4421A-DC

Conforms to the following Product Specifications:

Safety:

EN61010-1:2000, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements

EMC

EN61326:2000, Electrical Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements EN55011, Class A Emissions

EN61000-3-2, AC Power Line Harmonics

EN61000-3-3, AC Power Line Flicker

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

This product was tested in a typical configuration.

Boulder, CO February, 2005

European Contact: Contact the Manufacturer directly at the address above

Appendix A: Specifications

A.1 Electrical Specifications

Table 7 lists the electrical specifications for the Network Time Server.

Table 7: Electrical specifications

Item	Specification
Protection Class	Class I (Grounded Type)
Power Input	Voltage: 100–240 V AC Power draw: 40 W, 40 VA Note: Fluctuations not to exceed $\pm 10\%$ of nominal supply voltage. 4421A-DC only: 12–32 V DC The power connector on the unit is manufactured by Souriau (PN: D38999/20WA98PN) with the following connections: Pin B: GND Pin C: 28VDC
Power Input Frequency	50–60 Hz
Power Inlet Type	IEC 60320 sheet C14
Power Supply Cord Set	18 AWG (0.75 mm 2 minimum)
Power Mains Fuse	(2) - 250V~1A Time Lag 5x20 mm.
GPS Antenna Input	■ BNC female with +5 VDC, 80 mA maximum output on center conductor.

10 MHz Sine Output (4)	<ul style="list-style-type: none">■ Connector: BNC female■ Level: 1 ± 0.11 V AC RMS■ Impedance: $50 \pm 5 \Omega$■ SSB Phase Noise:<table><tr><td></td><td>4420A</td><td>4421A</td></tr><tr><td>1 Hz</td><td><-72 dBc/Hz</td><td>-85 dBc/Hz</td></tr><tr><td>10 Hz</td><td><-90 dBc/Hz</td><td>-115 dBc/Hz</td></tr><tr><td>100 Hz</td><td><-125 dBc/Hz</td><td>-135 dBc/Hz</td></tr><tr><td>1 kHz</td><td><-140 dBc/Hz</td><td>-145 dBc/Hz</td></tr><tr><td>10 kHz</td><td><-145 dBc/Hz</td><td>-150 dBc/Hz</td></tr></table>■ Allan Deviation, 4420A<ul style="list-style-type: none">• At Tau = 1 second, $< 3 \times 10^{-11}$• At Tau = 10 seconds, $< 1 \times 10^{-11}$• At Tau = 100 seconds, $< 3 \times 10^{-12}$■ Allan Deviation, 4421A<ul style="list-style-type: none">• $< 2 \times 10^{-11}$, 1 to 100 sec.■ Long Term Stability in Holdover<ul style="list-style-type: none">• 4420A: $< 5 \times 10^{-11}$ per month• 4421A: $< 1 \times 10^{-10}$ per day		4420A	4421A	1 Hz	<-72 dBc/Hz	-85 dBc/Hz	10 Hz	<-90 dBc/Hz	-115 dBc/Hz	100 Hz	<-125 dBc/Hz	-135 dBc/Hz	1 kHz	<-140 dBc/Hz	-145 dBc/Hz	10 kHz	<-145 dBc/Hz	-150 dBc/Hz
	4420A	4421A																	
1 Hz	<-72 dBc/Hz	-85 dBc/Hz																	
10 Hz	<-90 dBc/Hz	-115 dBc/Hz																	
100 Hz	<-125 dBc/Hz	-135 dBc/Hz																	
1 kHz	<-140 dBc/Hz	-145 dBc/Hz																	
10 kHz	<-145 dBc/Hz	-150 dBc/Hz																	
10 MHz TTL Output (1)	<ul style="list-style-type: none">■ Connector: BNC female■ Level: 3 V typical into 50Ω■ 55% Duty Cycle																		
1 PPS Output (4)	<ul style="list-style-type: none">■ Connector: BNC female■ Level: 4.5 V typical into 50Ω■ Impedance: $50 \pm 5 \Omega$■ UTC offset accuracy error: < 50 ns peak and < 15 ns rms in fixed position mode. Does not include cable and antenna delays.■ Holdover accuracy<ul style="list-style-type: none">• 4420A $< 1 \mu\text{s}$ over 24 hours• 4421A $< 10 \mu\text{s}$ over 24 hours■ Pulse width: 100 μs																		
IRIG-B Modulated Output (4)	<ul style="list-style-type: none">■ Connector: BNC female■ Timecode: IRIG-B 123■ Impedance: $50 \pm 5 \Omega$■ Level: 3 Vpp typical into 50Ω■ Accuracy: $7 \pm 2 \mu\text{s}$ relative to 1 PPS output																		
IRIG-B DC Level Shift Output (2)	<ul style="list-style-type: none">■ Connector: BNC female■ Timecode: IRIG-B 003■ Level: 4.5 V typical into 50Ω■ Accuracy: ± 100 ns relative to 1 PPS output																		
NTP Server	<ul style="list-style-type: none">■ Stratum 1 via GPS■ Accuracy $< 100 \mu\text{s}$ @ 200 NTP packets per second.■ Network factors can limit LAN NTP client synchronization accuracy to 2 ms typical.																		

A.2 Environmental Specifications



Ordinary protection: This unit is for **INDOOR USE ONLY**. It is not sealed to prevent moisture from entering the enclosure.

Equipment intended to be installed in an Enclosed/Open type equipment rack.

- Pollution Degree 2 per EN61010-1/EN 61010-1
- Installation (Over-Voltage) Category II for transient over-voltages per EN 61010-1/EN 61326-1, Class A
- Equipment suitable for continuous operation

Table 8 lists the environmental specifications for the 4420A, and 4421A.

Table 8: Environment specifications

Item	Temperature	Relative Humidity	Altitude
In Use	0°C to 50°C	0% to 90% (non-condensing)	3,000 meters (9,843 feet)
Storage	-40°C to 70°C	0% to 90% (non-condensing)	
Transportation	-40°C to 70°C	0% to 90% (non-condensing)	

A.3 Physical Specifications

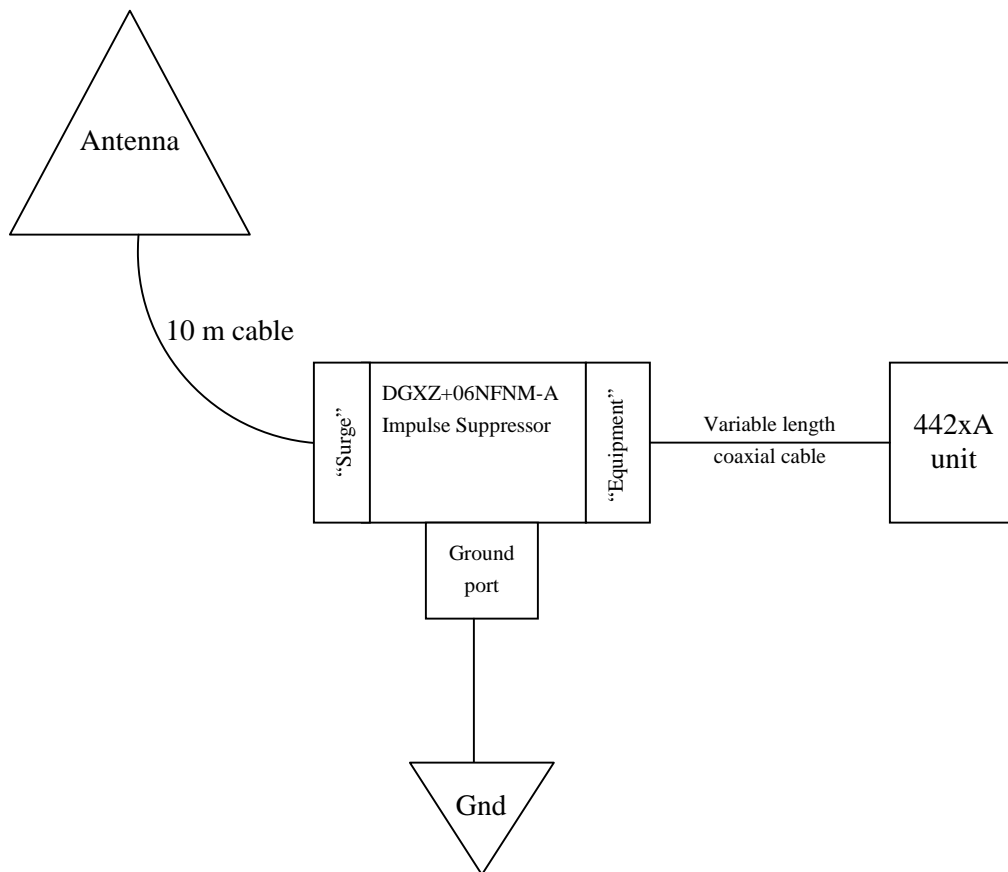
Table 9 lists the physical specifications for the 4420A, and 4421A.

Table 9: Physical specifications

Item	Specification
Width	Standard 19-inch rack mount
Height	Standard 1U (4.44 cm [~1.75 inches])
Depth	31.875 cm (12.75 inches)
Weight	Approximately 4.1 kg (8.5 pounds)

Appendix B: Lightning Arrestor Installation

B.1 Diagram



B.2 Instructions

- Use a 3/8" ring terminal for 10-12 AWG wire (TSC ELE1267 -- AMP 320577) to attach a 10 gauge grounding wire to the impulse suppressor's grounding port. The ring terminal is included; the grounding wire is not.

Glossary

\n	Line feed
\r	Carriage return
CNR	Command and Response
DHCP	Dynamic Host Configuration Protocol
ESD	electrostatic discharge
GPS	Global Positioning System
LED	light-emitting diode
LSB	least significant bit
MSB	most significant bit
NTP	Network Time Protocol
PDF	portable document format
PWA	printed wiring assembly
Rb	rubidium
RF	radio frequency
TSC	Timing Solutions Corporation

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