# TSC 4411A GPS Disciplined Crystal Reference

# Operations and Maintenance Manual

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TSC 4411A GPS Disciplined Crystal Reference Operations and Maintenance Manual



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Revision History:

| Revision | Description | Date | Approved |
|---|---|---|---|
| A | Initial Release | 6/14/05 | Greg Read |
| B | Updated specs and added Declaration of Conformity | 9/14/05 | Mason Stone |

# Contents

# 1: Introduction

**Note**

**FIRST READ THIS MANUAL THROUGHLY!**
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**

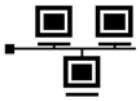
This symbol means the following information is a note that gives you important information that may affect how you use the 4411A.

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 4411A.

"Chapter 1, Introduction" on page 1 explains symbols that appear in the manual and on the unit as well as documentation conventions. The chapter also briefly describes the 4411A.

"Chapter 2, Installing and Setting Up the 4411A" on page 7 contains important safety information and describes how to install the 4411A, and assign a fixed IP address.

"Chapter 3, Monitoring the 4411A" on page 13 describes how to monitor alarms and the time.

"Chapter 4, Troubleshooting the 4411A" on page 19 describes how to replace the fuse and battery and how to verify operational problems.

"Chapter 5, Warranty and Shipping Information" on page 23 explains how to contact Timing Solutions Corporation for warranty service and provides shipping guidelines.

"Chapter 6, Declaration of Conformity" on page 24 provides the information required for CE compliance.

"Appendix A, Specifications" on page 25 contains the detailed specifications for the 4411A.

"Appendix B, Lightning Arrestor Installation" on page 28 describes connection of the lightning arrestor option.

## 1.2.1 Conventions

This manual uses several typographical conventions to help explain how to use the 4411A.

| Convention | Definition |
|---|---|
| **Bold** | Words in **bold** show:<br>■ Buttons and icons to click<br>■ Menu options to select<br>■ Commands to type<br>■ Non-variable information displayed in response to commands |
| *Italics* | Words in *italics* show:<br>■ Names of windows and dialog boxes<br>■ Variable information displayed in response to commands |

# 1.3 4411A Overview

The TSC 4411A is a time and frequency recovery system that generates precise signals which can be traceable to Universal Coordinated Time (UTC), housed in a 1U (1.75") high 19-inch rack-mount chassis. It uses a GPS-disciplined crystal frequency reference to provide precise timing signals to 16 output connectors.

An Ethernet port on the rear panel provides 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, crystal oscillator, and GPS input.

Figure 1 shows the 4411A's front panel, and Figure 2 shows the 4411A's rear panel.

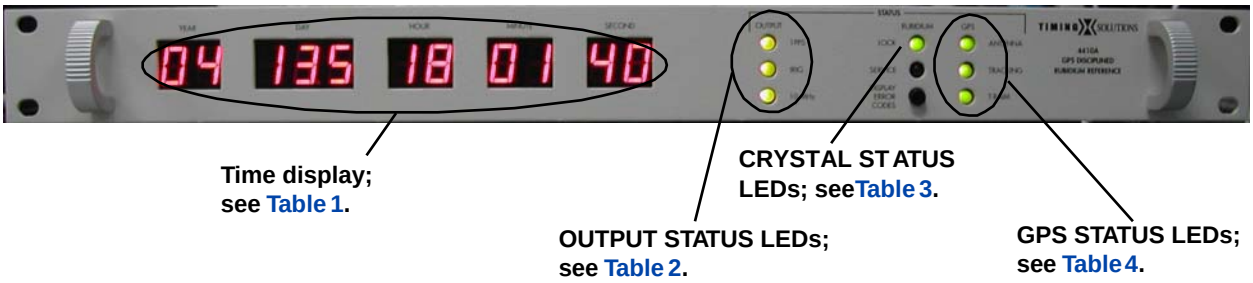



*Figure 1: Front panel*

*Table 1: Time display LEDs*

| Time display | Description |
|---|---|
| Year | ■ Last two digits of the current year<br>■ Example: "04" for 2004<br>■ Range: 00 to 99<br>■ The four-digit year value is known, though it is not displayed. |
| Day | ■ Julian day of the year<br>■ Example: "366" for 31 Dec 2004 (a leap year)<br>■ Range: 1 to 366<br>■ Displays the value "366" for the last day of a leap year. |
| Hour | ■ Hour of the day in military time<br>■ Example: "23" for 11 p.m.<br>■ Range: 0 to 23 |
| Minute | ■ Minute of the hour<br>■ Range: 0 to 59 |
| Second | ■ Second of the minute<br>■ Range: 0 to 60<br>■ Displays the value "60" during a positive leap second. |

*Table 2: OUTPUT STATUS LEDs*

| LED | State | Description |
|---|---|---|
| 1PPS | Off | ■ Waiting for valid GPS signal.<br>■ The 1 PPS ports on the back of the device are inactivated. |
| | Green | ■ Valid GPS signal acquired.<br>■ All of the 1 PPS ports on the back of the device are producing valid waveforms. |
| | Red | ■ 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 | ■ Waiting for valid GPS signal.<br>■ The IRIG ports on the back of the device are only producing the 1 kHz IRIG carrier signal. |
| | Green | ■ Valid GPS signal acquired.<br>■ All of the IRIG ports on the back of the device are producing valid waveforms. |
| | Red | ■ 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 | ■ Waiting for determination about the quality of the 10 MHz signal. |
| | Green | ■ Crystal frequency standard is producing a valid 10 MHz signal. |
| | Red | ■ The 10 MHz signal has been determined to be out-of-spec. |

*Table 3: CRYSTAL STATUS LEDs and button*

| LED | State | Description |
|---|---|---|
| LOCK | Green | ■ The crystal frequency standard is locked to the UTC time scale of the GPS receiver. |
| SERVICE | Red | ■ A Crystal fault (error code=9) or any of the Communication error counters > or = 8 will cause the SERVICE LED to turn on. This error is non-fatal and the light will go off if the error ceases. The Crystal Fault is suspended for several minutes during power up since the Crystal can be out of lock during startup. |
| DISPLAY ERROR CODES | N/A | ■ Press to display any errors that are currently affecting the system in the time display LEDs. |

*Table 4: GPS STATUS LEDs*

| LED | State | Description |
|---|---|---|
| ANTENNA | Off | ■ The GPS receiver is in the process of determining the state of the antenna port.<br>■ Waiting for the GPS receiver to begin tracking at least one GPS satellite signal. |
| | Green | ■ The GPS receiver has determined that a 50 Ω load has been attached to its antenna port (presumably a 50 Ω antenna). |
| TRACKING | Off | ■ Waiting for the GPS receiver to begin tracking at least one GPS satellite signal. |
| | Green | ■ The GPS receiver is currently tracking at least one GPS satellite signal. |
| T-RAIM<br>(time receiver autonomous integrity monitoring) | Off | ■ Waiting for the GPS receiver to track enough satellites (at least 4) to ensure that faulty satellites are detected, isolated, and removed from the solution. |
| | Green | ■ The GPS receiver is tracking at least 4 satellites. |

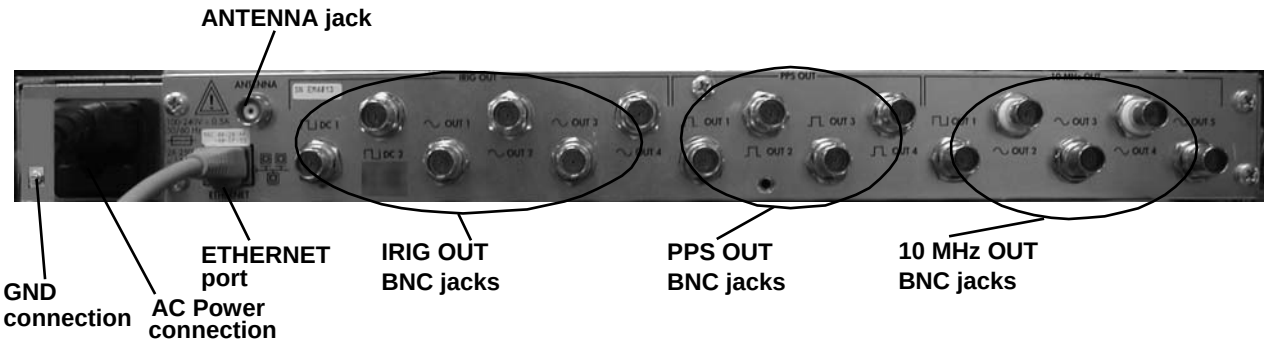



*Figure 2: Rear panel*

*Table 5: Rear panel connections*

| Connections | Description |
|---|---|
| POWER | ■ 100–240 V AC, 50/60 Hz power signal |
| ETHERNET | ■ Interface for Ethernet communications with the device<br>■ Bi-directional<br>■ MAC address published on device<br>■ TCP/IP<br>■ Port 10001<br>■ No prompt displayed |
| ANTENNA | ■ Interface for the GPS antenna.<br>■ 5 VDC, 80 mA maximum supplied on center conductor for antenna bias. |

| Connections | Description |
|---|---|
| IRIG OUT | ■ All ports produce IRIG-B.<br>■ The 4411A has:<br>• Two DC IRIG-B ports<br>• Four modulated IRIG-B ports<br>■ Output impedance = 50 Ω |
| PPS OUT | ■ Four one pulse-per-second ports<br>■ 10 μs pulse width<br>■ Minimum 4.4 V pulse height<br>■ Output impedance = 50 Ω |
| 10 MHz OUT | ■ One square wave 10 MHz port; 55% duty cycle<br>■ Four sinusoidal 10 MHz ports, 13 ±1 dBm<br>■ Output impedance = 50 Ω |
| GND | ■ Grounding stud for affixing permanent ground connection to chassis |

# 2: Installing and Setting Up the 4411A

## 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 TSC 4411A 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 4411A

The 4411A ships ready for installation into a standard 19" (48.3 cm) rack. The only hardware configuration required is if you want to set up the IRIG-B output to include year.

## 2.4.1 Required Materials For Installation

- Local power cord. One will be supplied with the unit.
- GPS antenna and cable, options available with the unit.
- Customer-supplied double-shielded RG223 cables with BNC connectors for the number of devices you plan to connect to the 4411A.
- 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 4411A 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. Remove the top cover of the unit.
2. Using proper ESD precautions, remove the jumper installed on SEL1.
3. Reinstall the top cover.

## 2.4.3 Making Connections

### 2.4.3.1 Input Power

The input power to the unit is supplied through a 3-prong power cable.

**To connect the 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 this power supply cord is connected to a properly grounded mains receptacle.

**Warning**
Since the unit does not have an AC Mains Power Switch, both the Appliance 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 AC Disconnect Means for the unit.

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### 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.

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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.

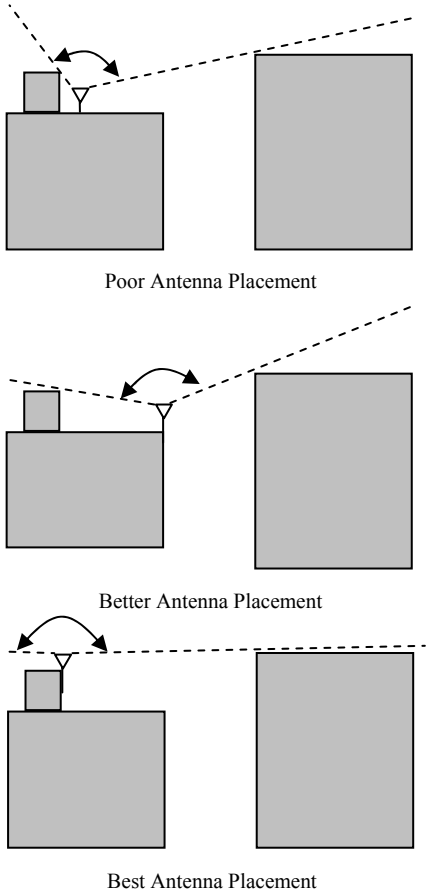


Figure **3.** Effect of antenna placement on sky coverage.

Once a suitable antenna location has been identified, it is necessary to ensure that the GPS signal that reaches the TSC 4411A is of suitable quality. The TSC 4411A requires a minimum of 15 dB gain from the combination of the antenna and cable loss. The optional antenna included with the TSC 4411A has 27 dB gain, so the total cable losses in the system must not exceed 12 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:

$$MIN\_Gain(dB) = \frac{Cable\_Loss(dB/100\,ft) * Cable\_Length(ft)}{100} - 12 \qquad \text{Eq. 1.}$$

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 TSC 4411A. 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

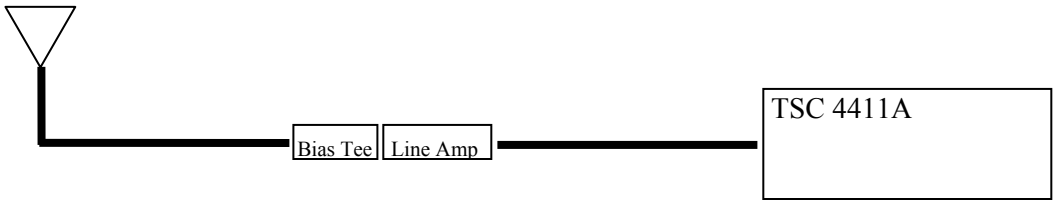


**Figure 4.** Typical configuration for longer cable runs.

means of powering the GPS antenna. The antenna voltage from the 4411A must be blocked from the amplifier output using a DC block. A bias-tee can provide a DC voltage to the antenna without disrupting the GPS signal. It is imperative that the bias-tee operate between 1200 MHz and 1600 MHz.

### 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.

### 2.4.3.4 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 4411A 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 crystal oscillator is producing a valid signal and lights the 10 MHz LED.
3. Verifies that the antenna is connected and lights the ANTENNA LED.
4. Locks onto GPS satellites and lights the TRACKING LED.
5. Locks onto enough GPS satellites to distinguish between good and bad satellite signals and lights the T-RAIM LED.
6. Crystal oscillator locks onto the 1 PPS coming from the GPS antenna and lights the LOCK and 1 PPS LEDs.
7. Downloads the almanac from the GPS, then displays the time and lights the IRIG LED.
   - This download can take up to 13 minutes.

When the 4411A is operating normally, all of the LEDs, except the SERVICE LED, should be lit and green.

## 2.6 Assigning a Static IP Address

The 4411A contains a Lantronix® Xport™ Ethernet to RS-232 converter, which provides the 4411A's Ethernet connection.

The 4411A ships from the factory with a default IP address of 0.0.0.0, which enables DHCP. If the network has a DHCP server, it will automatically assign the unit an IP address, gateway address, and subnet mask when the unit starts up.

To monitor multiple 4411As remotely through their Ethernet connections without DHCP re-assigning IP addresses, you must assign each unit a static IP address. You identify which unit is the source of an alarm by its IP address. Each unit has its own unique hardware address, labeled "MAC address", on a label on the rear panel. Follow the instructions in this section to manually assign a unit's static IP address.

**Note**

For more detailed information, see the *Xport™ User Manual.* Section 3.3 discusses several different ways that you can assign IP addresses. Chapter 4 explains how to configure a static IP address. You can download the *Xport™ User Manual* from the Lantronix® Web site as an Adobe® Acrobat® PDF file. Go to: http://www.lantronix.com to download the program.

If you want to configure a static IP address of many different 4411As, you can install the Lantronix® DeviceInstaller software. This software is available only by downloading from the Lantronix® Web site. Go to: http://www.lantronix.com to download the program. Alternatively, you can use your company's IT protocol to determine the IP address assigned to a particular hardware address, then set a static address.

To manually assign the static IP address using the Lantronix® DeviceInstaller software:

1. Obtain the following network information from your system administrator for each 4411A you want to install:

   IP Address: _____ _____ _____ _____

   Subnet Mask: _____ _____ _____ _____

   Gateway: _____ _____ _____ _____

2. Connect a Windows® PC to the same local subnet as the 4411A.
3. Install and start the Lantronix® DeviceInstaller software.
4. Click the Search Network icon and search for XPORT devices connected to the network, press save and then exit.
5. Click the **IP** icon or select **Assign IP Address** on the **Tools** menu.
   - The hardware device number and IP address appear in the Assign IP Address dialog box.
6. Type the new IP address for the appropriate **Hardware or Ethernet address** and click **Set IP address**.
   - The new IP address appears in the Lantronix® DeviceInstaller window.
7. Test the IP address by pinging the 4411A's Xport™ on the Lantronix Xport Installer window. Click the **Ping** icon or select **Ping Device** on the **Tools** menu.
   - The Ping Device window should show the IP address of the 4411A's Xport™ device, and it should show successful replies if the IP address has been configured correctly.
8. Exit the browser.

**To change the IP address using telnet:**

1. Telnet to the assigned address, port 9999.
2. Press **Enter** within five seconds to enter the setup mode.
3. Select Option 0.
4. Set the IP address and follow on screen commands to save the setting.

Sending an **I** command lets you verify that you are communicating with the correct device via the Ethernet port. It does so by turning the three front panel output LEDs off for two seconds, then turning them green for two seconds, then returning to normal operation. This provides the capability for the user to ensure they are communicating over the Ethernet connection to the correct device via front panel feedback.

**Note**

If you move the 4411A to a different network connection after setting up the static IP address, the host computer may not be able to make a connection. You may need to release the IP address lease on your host computer's operating system.

# 3: Monitoring the 4411A

## 3.1 Accessing the System

You access the 4411A system 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 publishes alarms as they occur.

When users Telnet to the CNR port, the system does not display a prompt. If the Telnet session is stopped and re-started, any alarms or time output that occurred during the time the Telnet session is disconnected are not published upon re-connection. Turn echo off on the telnet session to inhibit display of the user typed characters.

## 3.2 Checking System Status

When you send commands to check the system status, you do not need to type a carriage return or line feed. All commands are case sensitive.

### 3.2.1 Understanding Alarms

If you have software that is monitoring the 4411A's alarms, you will see alarms in the following format:

**ALARM***cccccc***\r\n** where

- The *cccccc* represents hexadecimal numbers, with each bit position representing one output. Least significant bit (LSB) is farthest right. The most significant bit (MSB) is farthest left.
- *cccccc* is the current alarm where 0 = no alarm condition and 1 = alarm condition.
- Example: ALARM000008\r\n indicates IRIG-B SINE OUT 2 has a fault.

Table 6 describes each alarm bit.

*Table 6: Alarm bit descriptions*

| Bit position | Bit function | Description |
|---|---|---|
| 23 | UTC Time Status | ■ 0 = acquired<br>■ 1 = acquiring |
| 22 | PUSH_TIME STATUS | ■ 0 = enabled<br>■ 1 = disabled |
| 21 | FLYWHEEL STATUS | ■ 0 = not flywheeling<br>■ 1 = flywheeling |

| Bit position | Bit function | Description |
|---|---|---|
| 20 | INSTRUMENT FAULT STATUS | ■ 0 = no fault<br>■ 1 = fault |
| 19 | CRYSTAL LOCK STATUS | ■ 0 = locked<br>■ 1 = not locked |
| 18 | GPS T-RAIM STATUS | ■ 0 = solved<br>■ 1 = not solved |
| 17 | GPS TRACKING STATUS | ■ 0 = tracking<br>■ 1 = not tracking |
| 16 | GPS ANTENNA STATUS | ■ 0 = 50 Ω load present<br>■ 1 = cable shorted or open |
| 15 | PPS OUTPUTS | ■ 0 = enabled<br>■ 1 = disabled |
| 14 | 10 MHZ SINE OUT 4 | ■ 0 = no fault<br>■ 1 = fault |
| 13 | 10 MHZ SINE OUT 3 | ■ 0 = no fault<br>■ 1 = fault |
| 12 | 10 MHZ SINE OUT 2 | ■ 0 = no fault<br>■ 1 = fault |
| 11 | 10 MHZ SINE OUT 1 | ■ 0 = no fault<br>■ 1 = fault |
| 10 | 10 MHZ SQUARE OUT 1 | ■ 0 = no fault<br>■ 1 = fault |
| 9 | PPS OUT 4 | ■ 0 = no fault<br>■ 1 = fault |
| 8 | PPS OUT 3 | ■ 0 = no fault<br>■ 1 = fault |
| 7 | PPS OUT 2 | ■ 0 = no fault<br>■ 1 = fault |
| 6 | PPS OUT 1 | ■ 0 = no fault<br>■ 1 = fault |
| 5 | IRIG-B SINE OUT 4 | ■ 0 = no fault<br>■ 1 = fault |
| 4 | IRIG-B SINE OUT 3 | ■ 0 = no fault<br>■ 1 = fault |
| 3 | IRIG-B SINE OUT 2 | ■ 0 = no fault<br>■ 1 = fault |
| 2 | IRIG-B SINE OUT 1 | ■ 0 = no fault<br>■ 1 = fault |

| Bit position | Bit function | Description |
|---|---|---|
| 1 | IRIG-B DC OUT 2 | ■ 0 = no fault<br>■ 1 = fault |
| 0 | IRIG-B DC OUT 1 | ■ 0 = no fault<br>■ 1 = fault |

## 3.2.2 Checking System Status

You can access the system status to check current alarms and alarms which have occurred since the last status request.

**To check system status:**

1. Type: **S** (case sensitive)
   - You do not need to type a carriage return or line feed.
   - The system returns **S***cccccc*,*llllll***r****n** where
     - Both *cccccc* (current alarms) and *llllll* (alarms since the last status request) are hexadecimal numbers representing alarms (see "3.2.1 Understanding Alarms" on page 13).
   - Example: S400000,400001\r\n
     - No current alarms.
     - Output 1 alarmed since the last status request.
     - The PUSH_TIME function is disabled.
2. Continue to type **S** to see any other alarms since you last checked the system status.

## 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: **I**
  - The system returns **I4411A-***00***r****n**.
    - The device is a 4411A revision 0.
  - Sending an **I** command lets you verify that you are communicating with the correct device via the Ethernet port. It does so by turning the three front panel output LEDs off for two seconds, then turning them green for two seconds, then returning to normal operation.

**To check the software version:**

- Type: **V**
  - The system returns **V***xx***r****n** where *xx* is the software version.
  - Example: V80\r\n.

## 3.2.4 Checking the Time

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

**To check the time:**

- Type: **T**
  - The system returns **T***yy:ddd:hh:mm:ss***\r\n.**
    - *yy*—last two digits of the current year.
    - *ddd*—current day of the year.
    - *hh*—current hour of day.
    - *mm*—current minute of hour.
    - *ss*—current second of minute.
  - Example: T04:366:23:59:60\r\n
    - 31 Dec 2004 during the application of a positive leap second.

## 3.2.5 Checking the Position

You can check the position of the 4411A.

**To check the position:**

- Type: **P**
  - The system returns **P***aaaaaaaa,oooooooo,hhhhhhhh***\r\n**
    - *aaaaaaaa* is a hexadecimal number that represents the latitude in milliarcseconds (mas). Negative values are represented via twos complement.
      - Range: –324000000 to +324000000
      - (–90° to +90°)
    - *oooooooo* is a hexadecimal number that represents the longitude in mas. Negative values are represented via twos complement.
      - Range: –648000000 to +648000000
      - (–180° to +180°)
    - *hhhhhhhh* is a hexadecimal number that represents the height in centimeters (cm). Negative values are represented via twos complement.
      - Range: –100000 to +1800000
      - (–1000 m to +18000 m)
  - Example: P089654dd,e96b0b5d,00026e7a\r\n
    - Latitude = +40.02 (40.02 N)
    - Longitude = –105.24 (105.24 W)
    - Height = 159354 cm (1593.54 m)

## 3.2.6 Starting and Stopping the Time "Push"

You can tell the 4411A to "push" the time to any devices programmed to receive the time from the 4411A.

**To start the time push:**

- Type: **F**
  - The system returns **F\r\n**.
    - From that point forward, the system will return the system time in the following format every second: **N***yy:ddd:hh:mm:ss***\r\n**

**To stop the time push:**

- Type: **Q**
  - The system returns **Q\r\n**.
    - The system stops sending the system time every second.

## 3.2.7 Setting the Position Manually

You can set the GPS position in the 4411A manually so that you do not have to wait for auto-survey to complete. To set the position, type **B** followed by 25 ASCII hex nibbles ranging from 0-f. The first nibble must be one of the following:

**0** – Enable normal 3d positioning mode.

**1** – enable position hold mode.

**3** – enable auto-survey mode.

The remaining nibbles are GPS position and should be all **f** except in the case when the first nibble is **1**. When the first nibble is **1**, the remaining nibbles should be in the format:

**lllllllloooooooohhhhhhhh** where :

**l** – latitude in milli-arc-seconds

**o** – longitude in milli-arc-seconds

**h** – height in cm

Note that there is no carriage return or new line required at the end of the data, \r\n is returned if the data was accepted.

## 3.2.8 GPS Signal Delay Compensation

To compensate for delays in the cabling from the GPS antenna to the 4411A, the **C** command can be sent to align the unit's 1 PPS signal with the GPS 1 PPS. A delay must be entered in order to align the unit's 1 PPS with GPS 1 PPS. The range of delay settings is from 0.0 to .999999999 seconds in 1 ns increments. Enter C followed by 8 LOWER CASE ASCII hex nibbles ranging from 0-f. There is a 5 second time-out to allow manual entry of the command and data. Note that there is no CR or LF required at the end of the data, \r\n is returned if the data was accepted.

EXAMPLE: If you have a cable that is causing the unit's 1 PPS to lag 100 ns relative to GPS 1 PPS, you will need to delay the unit 1 PPS by 999,999,900 ns to compensate appropriately. You would enter the command "C3b9ac99c" because '3b9ac99c' in hexadecimal equals 999,999,900 in decimal.

## 3.2.9 Robust Status Information

Detailed status information can be obtained by sending the **R** command. The response is in the form of ASCII nibbles **R***ppppppp,llll,oooo,nnnnnnn***r****n** where

*ppppppp* = PPS delay, hex values

*llll* = GPS status, hex values

MSB Bits 15-13:

111 = 3D fix (default power up setting)
110 = 2D fix
101 = Propagate mode
100 = Position hold
011 = Acquiring satellites
010 = Bad geometry
001 = Reserved
000 = reserved

Bit 12-11Reserved
Bit 10 Narrow band tracking mode
Bit 9 Fast acquisition position
Bit 8 Filter reset to raw GPS solution
Bit 7 Cold start (no almanac, almanac out of date or have almanac but time and position unknown)
Bit 6 Differential fix
Bit 5 Position lock
Bit 4 Autosurvey mode
Bit 3 Insufficient visible satellites
Bit 2-1 Antenna sense: 00 = OK
01 = OC
10 = UC
11 = NV
Bit 0 Code location
0 = External
1 = Internal

*oooo* = Oscillator status, used by factory for troubleshooting

*nnnnnnn* = additional status information not presently used.

# 4: Troubleshooting and Maintaining the 4411A

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 4411A 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.

The status that displays is the same as the alarm codes you can access from the Ethernet port. For more information, see "3.2.1 Understanding Alarms" on page 13.

In addition, the **DISPLAY ERROR CODES** button can display error codes. Pressing the Display error codes Button causes the display to switch from time to error codes for the duration of the press. The rightmost 6 digits is the same as the status message sent over the Ethernet connection. The leftmost digit is the status from the crystal oscillator, with the following codes:

0: warming up
1: tracking set-up
2: track to PPSREF
3: sync to PPSREF - this is normal operation
4: Free Run Track OFF
5: Free Run PPSREF unstable
6: Free Run No PPSREF
7: factory used
8: factory used
9: Fault or crystal out of lock

The next digit to the right is the number of crystal Communication errors. Next is the number of startup initialization Communication errors to the GPS receiver. Next is the number of Communication errors to the GPS receiver after startup. These digits are limited to the range of 0-F and do not wrap. They are fatal errors indicating a problem with the unit and can only be cleared by cycling power. Six initialization errors will cause the unit to reset and attempt re-initialization.

## 4.2 Replacing Fuses

If you know that a local event caused blown fuses throughout a rack, you can replace the fuses in each 4411A 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 4411A.
2. Using a small screwdriver, open the fuse cover on the back of the 4411A.
3. Replace the old fuses as necessary.
4. Close the fuse cover.
5. Reconnect the power cable to the back of the 4411A.

## 4.3 Replacing the Oscillator

If the SERVICE LED lights and remains on, the crystal oscillator may need to be serviced or replaced. Return the unit to Timing Solutions for repair.

## 4.4 Verifying Operational Problems

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

- the correct power is applied to the rear of the 4411A, 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

A minimal amount of maintenance is required for the TSC 4411A. 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 TSC 4411A is necessary 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 TSC 4411A.

1. Follow proper electronics industry ESD precautions when performing these tasks.
2. Remove power from the unit and then remove the top cover of the TSC 4411A.
3. 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.
4. Re-install the top cover of the TSC 4411A.

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# 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 4411A.

## 5.1 Warranty Information

The 4411A 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 4411A 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 4411A
Product Options: All

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 July, 2004

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 4411A.

*Table 7: Electrical specifications*

| Item | Specification |
|---|---|
| Protection Class | Class I (Grounded Type) |
| Power Input | Voltage: 100–240 V AC<br>Power draw: 40 W, 40 VA<br>**Note:** Fluctuations not to exceed ± 10% of nominal supply voltage. |
| 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 V on center conductor, 80 mA maximum antenna bias output on center conductor |
| 10 MHz Sine Output (4) | ■ Connector: BNC female<br>■ Level: 1 ± 0.11 V AC RMS<br>■ Impedance: 50 ±5 Ω<br>■ SSB Phase Noise:<br>• -85 dBc/Hz at 1 Hz<br>• -115 dBc/Hz at 10 Hz<br>• -135 dBc/Hz at 100 Hz<br>• -145 dBc/Hz at 1kHz<br>• -150 dBc/Hz at 10kHz<br>■ Short Term Stability<br>• $<2 \times 10^{-11}$, 1 to 100 seconds<br>■ Long Term Stability in Holdover<br>• $<10 \times 10^{-10}$ per day |

| Item | Specification |
|---|---|
| 10 MHz TTL Output (1) | ■ Connector: BNC female<br>■ Level: 3 V typical into 50 Ω<br>■ 55% Duty Cycle |
| 1 PPS Output (4) | ■ Connector: BNC female<br>■ Level: 4.5 V typical into 50 Ω<br>■ Impedance: 50 ± 5 Ω<br>■ UTC offset accuracy: 50 ns rms after two days of warm-up, does not include cable and antenna delays.<br>■ Holdover accuracy: < 15 µs over 24 hours |
| IRIG-B Modulated Output (4) | ■ Connector: BNC female<br>■ Timecode: IRIG-B 123 (jumper configure to include year)<br>■ Impedance: 50 ± 5 Ω<br>■ Level: 3 Vpp typical into 50 Ω<br>■ Accuracy: 7 ± 2 µs relative to 1 PPS output |
| IRIG-B DC Level Shift Output (2) | ■ Connector: BNC female<br>■ Timecode: IRIG-B 003 (jumper configure to include year<br>■ Level: 4.5 V typical into 50 Ω |

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

Table 8 lists the environmental specifications for the 4411A.

*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

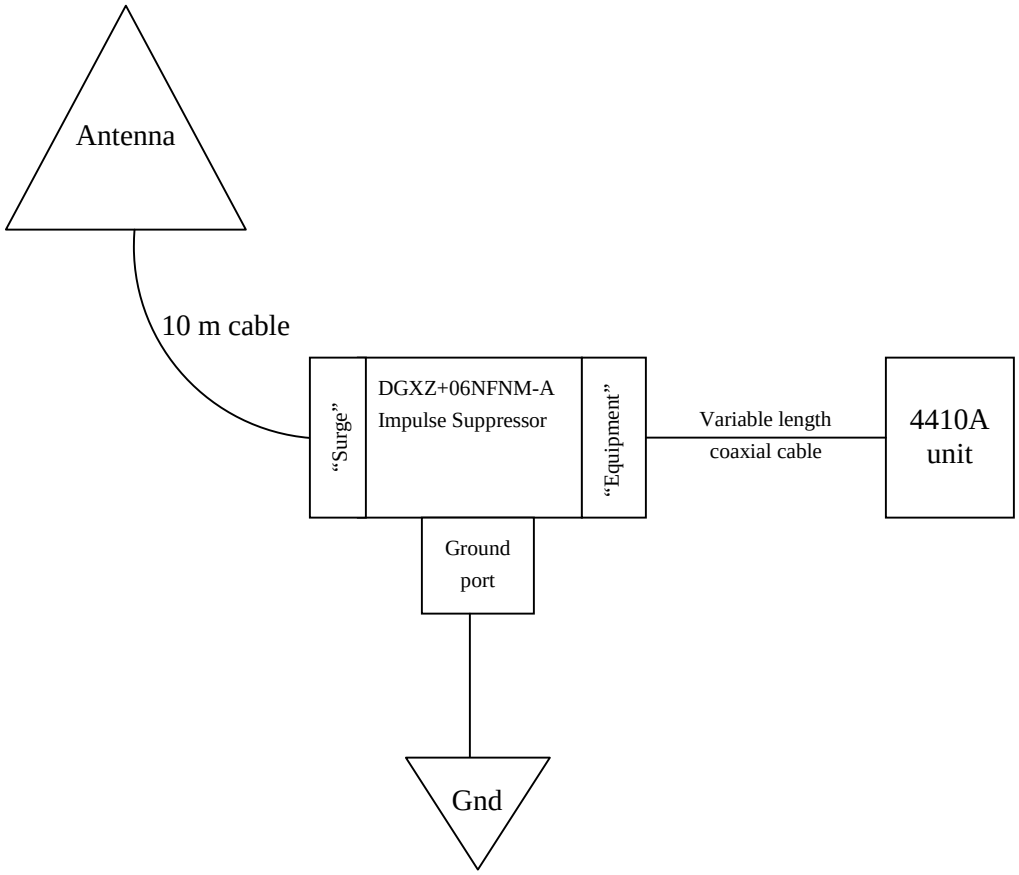
Table 9 lists the physical specifications for the 4411A.

*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 |
| PDF | portable document format |
| PWA | printed wiring assembly |
| RF | radio frequency |
| TSC | Timing Solutions Corporation |

# Index

## Numerics