Taurus

Portable Seismograph

User Guide

Nanometrics INC.
SEISMOLOGICAL INSTRUMENTS
Kanata, Ontario • Canada

Taurus Portable Seismograph Version 3.5 User Guide

The information in this document has been carefully reviewed and is believed to be reliable. Nanometrics Inc. reserves the right to make changes at any time without notice to improve the reliability and function of the product.

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About This Document

Document Conventions

Essential and Supplementary Information		
	Warning	Explains a risk of irreversible damage to data, software, or equipment and provides recommendations for preventive action.
	Caution	Explains a risk of damage to data, software, or equipment where recovery is likely to be troublesome and provides recommendations for preventive action.
	Note	Provides additional information related to the current text.
	Tip	Explains a best practice or provides helpful information related to the current text.
	Example	Provides an example related to the current text.
Text Conventions		
	bold text	Identifies referenced elements in the graphical user interface (GUI) (for example, "click **Cancel** to discard the changes").
	italic text	Identifies variables such as parameter names and value placeholders (for example, "select Configuration > *Sensor Name*").
	`courier text`	Identifies commands that must be entered exactly as shown (for example, "type `mkdir $APOLLO_LOCATION/config`").

Changes Included in This Revision

Revision number 15148R13 includes the following changes:

- Documented changes to the Data Retrieval settings, which are now called Channel Naming settings.
- Documented changes to the NP UDP/HTTP streamer settings and the Digitizier detector settings.
- Documented the new NP UDP receiver functionality.

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Part 1

Installing, Powering, and Operating

Chapter 1
Getting Started

1.1 Introducing the Taurus Portable Seismograph

The Taurus Portable Seismograph is a compact, self-contained Digitizer and data logger that combines exceptional performance with versatility and low power consumption. The Taurus incorporates a three-channel 24-bit Digitizer, GPS receiver and system clock, removable data storage media, and remote communication options. The three time series data channels of the Digitizer are constantly digitizing data, which is recorded by the Taurus Controller and written to the Store. Up to two Trident 305 Digitizers can be connected to a Taurus using an NMXbus cable to expand the total number of channels supported by a single Taurus from three to six or nine channels. The software programmable front-end gain supports a wide range of sensor types, including many third party sensors. Nanometrics supplies cables of varying lengths for connecting the Taurus to sensors.

The Taurus can be deployed as a stand-alone unit to record continuous data on removable media for extended periods of time or as a network device that allows data downloads, dual sample rate data streaming, and remote configuration changes while also recording data to the storage media.

For a networked deployment, the acquired time series data can be streamed in real time via UDP/IP multicast or HTTP to any data acquisition server, such as Apollo Server.

For a stand-alone deployment, this data can be recorded in MiniSEED format to a FAT32 formatted CompactFlash card, which can easily be transferred to a computer or laptop for immediate analysis. It can also be extracted from the Store in MiniSEED, MiniSEED Sorted, Seisan, SEGY, SAC and ASCII formats.

The Taurus can be configured locally using the colour display screen and integrated browser and/or remotely using any Web browser over a TCP/IP connection. The Web pages provide onboard and remote access to real-time and historic data, GPS status, instrument configuration, and field procedures.

1.1.1 Retrieving Data From a Taurus

Time series data, state of health (SOH) data, system configuration information, system information, and logs are recorded by the Taurus. There are various methods for viewing and retrieving this data:

- Stream time series and SOH data from a Taurus to a data acquisition system, such as Apollo Server, via UDP or HTTP (Chapter 11 "Streaming and Receiving Data").
- Record MiniSEED and SOH files to a FAT32 CompactFlash card (Chapter 12 "Recording MiniSEED and SOH Data Files").
- Retrieve data from the Store using an external Web browser over an IP connection.
  - Time series data can be extracted in the following formats: MiniSEED, MiniSEED Sorted, ASCII, SEGY, Seisan, or SAC (Section 13.2 "Retrieving Time Series Data" on page 81).
  - Other information, such as SOH data, system configuration information, system information, and logs can be downloaded as described in
    - Section 15.2 "Extracting State of Health Data" on page 109.
    - Section 14.11 "Viewing the Configuration History" on page 105.
    - Section 14.12 "Viewing System Information" on page 106.
    - Section 14.13 "Viewing System Logs and Alert Messages" on page 106.
- Access data on removed recording media (Section 13.3 "Accessing Store Files on the Recording Media" on page 87).
- Download data using Apollo Project.

  Apollo Project is an advanced data archive application that automatically tracks data availability updating the archive whenever missing data becomes available. Apollo Project will manage the archiving of any time series data recorded by the Taurus, combine the data into network files, and output the data in the format of choice (MiniSEED, SEGY, SAc, ASCII).

1.1.2 Taurus CompactFlash Adapter

The Taurus CompactFlash Adapter is a CompactFlash (CF) to 1.8" IDE hard drive converter that allows two CF cards to be installed in the media slots of the Taurus at the same time. One CF card is formatted as ext3 and is installed permanently in the Taurus. It is used for recording the Taurus Store. The other CF card is formatted as FAT32, which can be read by any Windows, Mac, or Linux computer with a CF reader. Together with the Taurus Data Archive feature, the FAT32 CF card is used for recording MiniSEED files and SOH data. It can be quickly swapped out at any time with an empty FAT32 CF card for transferring data to a computer.

Refer to the instructions included with the Taurus CompactFlash Adapter for installation information. For more information on the Data Archive feature, see Chapter 12 "Recording MiniSEED and SOH Data Files."

1.1.3 Taurus Cables

You can purchase the following cables from Nanometrics for use with your Taurus:

Table 1-1 Taurus cables

Name	Part Number	Description
Cable – Taurus to Trillium seismometer	16777–3M 16777–5M 16777–10M 16777–15M 16777–25M	A double-shielded, ultra-flexible cable with a a Taurus right-angled connector on one end and a Trillium seismometer connector on the other end for connecting a Taurus to a Trillium seismometer Available in lengths of 3 m, 5 m, 15 m, and 25 m Custom cable lengths are available upon request.
Cable – Taurus to Trillium seismometer, regulating	16163–3M 16163–5M 16163–10M 16163–15M 16163–25M	A double-shielded, ultra-flexible cable with a Taurus right-angled connector on one end and a Trillium seismometer connector on the other end for connecting a Taurus to a Trillium seismometer The Taurus connector contains a power supply that filters out power-induced noise. Available in lengths of 3 m, 5 m, 15 m, and 25 m Custom cable lengths are available upon request.
Cable – Taurus to open end	16171-3M 16171-5M 16171-15M 16171-25M	An ultra-flexible cable with a Taurus connector on one end and open ended at the other end for attaching the connector of a third-party seismometer Available in lengths of 3 m, 5 m, 15 m, and 25 m Custom cable lengths are available upon request.
Power cable	14983-3M 14983-5M 14983-6M 14983-8M 14983-10M	An unshielded 22 AWG power cable Available in lengths of 3 m, 5 m, 6 m, 8 m, and 10 m
Power cable	14268-3M 14268-5M 14268-10M 14268-15M	A shielded 18 AWG power cable Available in lengths of 3 m, 5 m, 10 m, and 15 m
Ethernet cable	15228-10M	A 10 m Ethernet cable

1.1.4 Recording Your Serial Number

The serial number is located on the back of the Taurus. Record the serial number and keep it accessible. You will need to reference this number if you need to contact Nanometrics Technical Support.

1.1.5 Technical Support and Maintenance

If you need technical support, please submit your request by email. Include a full explanation of the problem and supporting data, to help us direct your request to the most knowledgeable person for reply. Before returning a unit for repair, contact Nanometrics Technical Support to obtain an RMA number.

The Taurus mechanical and electronic elements have been designed to be robust and reliable, to ensure there is no need to open units for on-site maintenance.

Chapter 2
Deployment Options

Default Settings

When you first receive your Taurus from Nanometrics, it is configured with the following default settings:

- Sample rate: **100 samples per second**
- Sensor type: **Trillium Compact Seismometer**
- Running mode: **Communications**

It is recommended that you do most of the configuration work before field deployment using a Web browser over a network connection. You can also use the Taurus display screen and keypad to change the configuration in the field.

2.1 Stand-alone Deployment

In a stand-alone deployment, a Taurus is temporarily deployed as a "do-it-all" unit in a remote location along with a seismometer. The recorded time series data is written in MiniSEED format to a FAT32 formatted CompactFlash card (CF) and written in NP format to the Taurus Store on a Linux ext3 formatted CF card or an IDE hard drive.

An operator must visit the Taurus out in the field to retrieve the data, which they do by replacing the full recording media with empty media or by retrieving the Taurus and extracting data from the Store back in the lab (see Chapter 12 "Recording MiniSEED and SOH Data Files" and Chapter 13 "Retrieving Time Series Data from the Store").

Since network access is not required, the Taurus should be configured to run in Buffered mode. The Taurus consumes less power in this mode because the Controller only runs when the Taurus is recording MiniSEED data to the CF or buffered data to the Store. In this mode, the Taurus only records data to the Store when the buffer is full or when the centre key on the display screen is pressed.

At a high level, you have to perform the following steps to set up a Taurus for stand-alone deployment:

1. In the lab, power up the Taurus and configure the following settings:
   - Sample rate (see Section 8.2 "Main Digitizer Settings" on page 47)
   - Sensor type (see Section 9.3 "Configuring Sensors" on page 59)
   - Enable the **Data Archive** feature (see Section Chapter 12 "Recording MiniSEED and SOH Data Files" on page 79)
   - **Buffered** running mode (see Section 10.1 "Changing General Taurus Settings" on page 65)
2. Insert the recording media into the media slots (see Section 3.4 "Installing Recording Media" on page 15).

If you are using two CompactFlash cards (one formatted as FAT32 and one formatted as ext3), follow the instructions for using the Taurus CompactFlash Adapter that are included with the adapter.

3. In the field, install the Taurus (see Section 3.2 "Installing a Taurus" on page 11).
4. Mount the GPS antenna and connect the seismometer.
5. Push the centre button to power up the Taurus and confirm it is working properly by monitoring the Waveform display and the LEDs (see steps 9 to 11 of Section 3.2 "Installing a Taurus" on page 11).

Confirm that the running mode is set to **Buffered** before you leave the Taurus (see Section 10.1 "Changing General Taurus Settings" on page 65).

2.2 Networked Deployment

In a networked deployment, a Taurus is permanently deployed as part of a network and the recorded time series data is written in NP format to the Store and then streamed over the network to a data acquisition server, such as Apollo Server, via UDP (see Chapter 11 "Streaming and Receiving Data").

The operator does not visit the Taurus in the field after it has been installed but instead uses a Web browser to make any necessary configuration changes and receive the streamed data. Although the data is not typically extracted from the Store in a networked deployment, the Taurus still requires a Store to buffer the data.

The Taurus must be configured to run in Communications mode and the appropriate network settings also have to be configured. In this mode, the Controller is running continuously, which results in higher power consumption than Buffered mode but allows continuous access to the Taurus via an IP connection.

At a high level, you have to perform the following steps to set up a Taurus for networked deployment:

1. In the lab, power up the Taurus and configure the following settings:
   - Sample rate (see Section 8.2 "Main Digitizer Settings" on page 47)
   - Sensor type (see Section 9.3 "Configuring Sensors" on page 59)
   - Network settings (see Chapter 7 "Configuring Taurus Communications")
2. Record the IP address listed on the Status page of the Taurus so that you will be able to access the Taurus via a Web browser after it has been deployed in the field.
3. Insert the recording media into the media slots (see Section 3.4 "Installing Recording Media" on page 15).
4. In the field, install the Taurus (see Section 3.2 "Installing a Taurus" on page 11).
5. Mount the GPS antenna and connect the seismometer.
6. Connect a Taurus Ethernet cable or serial cable (see Chapter 7 "Configuring Taurus Communications").

7. Push the centre button to power up the Taurus and confirm it is working properly by monitoring the Waveform display and the LEDs (see steps 9 to 11 of Section 3.2 "Installing a Taurus" on page 11).

Confirm that the running mode is set to **Communications** before you leave the Taurus (see Section 10.1 "Changing General Taurus Settings" on page 65).

Chapter 3
Installing a Taurus

The shipping box and packing foam for the Taurus have been designed and tested to protect the Taurus against accidental drops during hand-carrying and vibration and shock during shipping. To maintain warranty protection, the Taurus must always be transported in packaging approved by Nanometrics. Save the original packaging and reuse it any time you are transporting a Taurus. If custom packaging is required for a particular application, please contact Nanometrics (see Contacting Technical Support on page 159).

After transporting a Taurus to its installation site, you can safely remove it from the packaging and handle it with no special precautions but do not drop it or bang it against hard surfaces. When you unpack the Taurus, make sure that the following items are included with the shipment:

- Ethernet cable (1 m)
- GPS patch antenna with cable (5 m)
- Software CD
- CompactFlash Adapter (if you plan to use two CompactFlash cards as the recording media)

3.1 Tools and Materials Needed to Install a Taurus

To install a Taurus, you should have the following tools and materials available:

Table 3-1 Installation tools and materials

Name	Description
Grounding wire	To connect the Taurus to the site ground. **Note:** 10 AWG is recommended. Cut the cable to length to remove excess and minimize voltage drop.
1 grounding lug, M4	To ground the Taurus **Note:** The grounding lug must accommodate the gauge of the grounding wire used.

3.2 Installing a Taurus

To install a Taurus

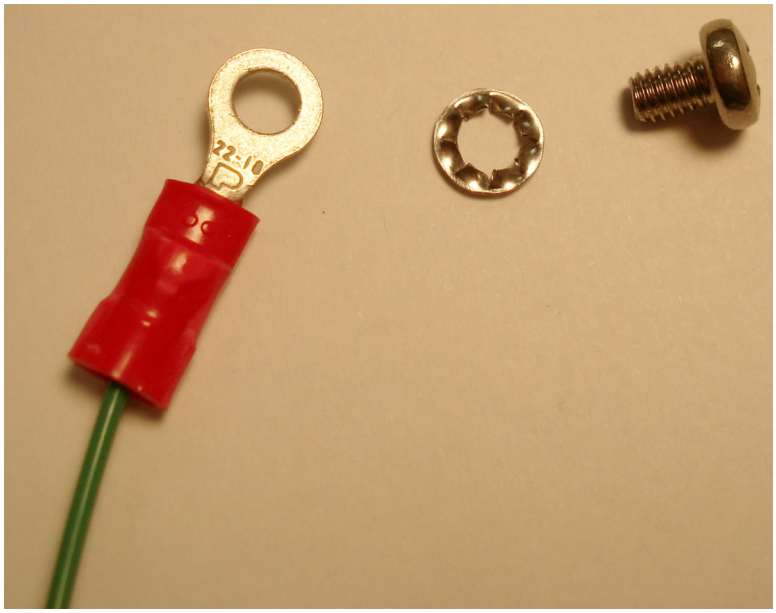
1. Plan the physical installation (for example the power system, proper equipment grounding, and location of the GPS antenna).
2. Install and level the seismometer.

   For more information, refer to the seismometer documentation.

3. Mount the GPS antenna with a good view of the sky and ensure that the antenna cable is installed with sufficient strain relief.

Figure 3-1 Mount the GPS antenna (optional bullet antenna shown)

4. Strip one end of the grounding wire and crimp the grounding lug around the grounding wire.
5. Attach the grounding lug to the grounding hole (see Figure 4-2 on page 19) using the M4x5 screw and the M4 lock washer.



6. Connect the other end of the grounding wire to a grounding point at the site.

   For more information, see Section 4.2 "Grounding a Taurus Installation" on page 18.
7. Connect the seismometer to the Taurus.
8. Ensure that the Taurus is sealed environmentally (see Section 3.2.2 "Environmental Seals" on page 14).
9. Power up the Taurus and start the display screen.

   Connect the power cable to start the Taurus up in the mode it was in before the last shut down. It will take the Taurus a minute or two to boot. While the unit is booting, the display screen will be off and the SuperLED will indicate the status (see Section 14.2 "Introducing the Status LEDs" on page 91).

   Wait 2 minutes after connecting power and then start the display screen by pressing and holding the centre key for about 1 second. It might take a minute for the display to start up.

For more information, see Chapter 4 "Powering and Grounding a Taurus."

10. Ensure that the SuperLED is blinking green before you leave the Taurus.

    When the SuperLED blinks green, this indicates that all systems are operating as configured and no problems are detected. If the SuperLED is blinking yellow or red, use the Status page indicators to help you find the problem (see Section 14.3.2 "Status Details Page" on page 96 for more detailed information on interpreting the status bar colours).

    If the display screen is off, press the centre key for about 1 second and wait for the display to start up. It will open to the Status page.

11. View the information on the Status page to check the operational status of the Taurus.

    a) Verify that the status bar is green.

       A green status bar indicates that the Taurus is ready to capture data. A yellow status bar indicates that the Taurus is acquiring and calculating status information. A red status bar indicates an error condition. The colour of the status bar matches the colour of the SuperLED.

       See Section 14.3.2 "Status Details Page" on page 96 for more detailed information on interpreting the status bar colours.

    b) Verify that waveform images are displayed and that the number of packets is increasing.

3.2.1 Powering and Grounding Considerations

- See Section 19.15 "Power" on page 137 for power specifications and Chapter 4 "Powering and Grounding a Taurus" for information on powering the Taurus.
- See Section 4.2 "Grounding a Taurus Installation" on page 18 and Chapter 20 "Seismometer-Taurus Interconnection" for guidelines on equipment and signal grounding.
- It is recommended that you use the Shutdown option to power down the Controller before disconnecting the power from the Taurus. For more information, see Section 5.2.2 "Shutting Down the Controller" on page 27.

If you disconnect the power while the Controller is running, you might lose data presently cached in the buffer. This can be about 15 seconds of data if the Taurus is running in Communications mode and up to several hours of data if the Taurus is running in Buffered mode, depending on the sample rate, seismic signal and noise, and number of channels configured (for example, typically about 30 minutes of data for 3 channels at 100sps). Also, if the Store is not closed down properly, it might need to perform a lengthy reindexing on the next start-up (see Section 16.1.3 "Reindexing Stores" on page 115).

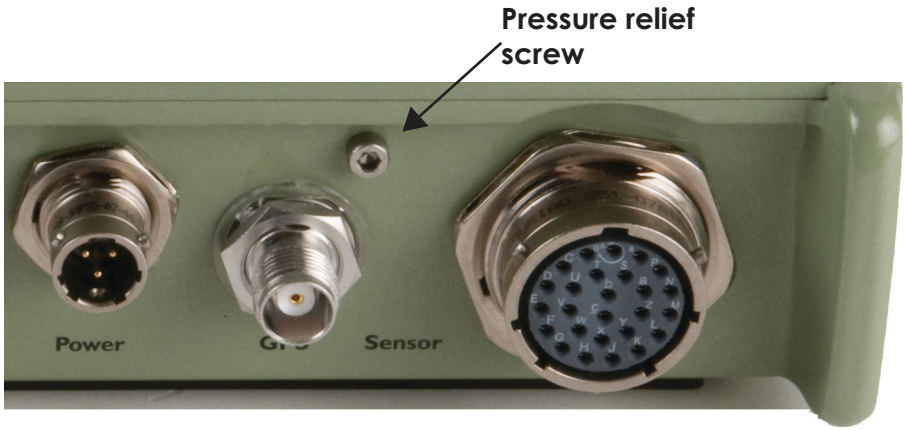
Do not press and hold the centre key on the display screen for more than 4 seconds as this will cause a hard shut down of the Taurus Controller. A hard shut down immediately terminates various processes and might cause detrimental effects.

3.2.2 Environmental Seals

The Taurus can be sealed against dust and moisture. You should confirm the following before you leave a Taurus installation:

- The media door is closed with the doorknob locked and the black plastic lever in the down position.
- All Taurus connectors are either occupied by the appropriate cable connector or are sealed with the optional factory-installed dust caps or equivalent.
- The self-sealing pressure relief screw is torqued to hand tight (Figure 3-2). This screw is a slot head on older models and is a 2.5mm hex Allen key on newer models.

Figure 3-2 Pressure relief screw



3.3 Installing the Taurus CompactFlash Adapter

The Taurus Data Archive feature writes MiniSEED data files and, optionally, SOH data to a CompactFlash card formatted as FAT32, which can easily be transferred to a computer or laptop for immediate analysis.

Before the Taurus Data Archive feature can be enabled, a FAT32 formatted CF card has to be inserted into the CompactFlash slot of the Taurus. If your Taurus currently has an ext3 formatted CompactFlash card in that slot, you need to use the Taurus CompactFlash Adapter to move the ext3 CF card to the IDE media slot so that you can insert an FAT32 CF card into the CompactFlash slot. The Taurus Store is written in ext3 format and the Taurus always has to have a Store even if it is in Communications mode and streaming data.

Refer to the installation instructions included with the Taurus CompactFlash Adapter for information on how to install and use it. For more information, see Section 1.1.2 “Taurus CompactFlash Adapter” on page 4.

3.4 Installing Recording Media

There are three different possible configurations for recording media:

- Option A: Two CompactFlash cards (one formatted as FAT32 and one formatted as ext3)

-OR-

- Option B: One FAT32 CompactFlash card and one IDE hard drive formatted as ext3

-OR-

- Option C: One ext3 CompactFlash card or IDE hard drive formatted as ext3

Option A and B are both used for stand-alone Tauruses because they allow for the recording of MiniSEED and SOH data to a FAT32 CF card in addition to the recording of data to the Taurus Store in the ext3 format. Option A requires the Taurus CompactFlash Adapter. For instructions on how to use the adapter, refer to the documentation included with it.

Option C is used for a networked Taurus because data is streamed to the data acquisition server via the network instead of being written locally and the only media that is needed is for the Taurus Store. The recording media for the Taurus Store has to be in the ext3 format. Although the data is streamed over the network, the Store is still needed because the Taurus buffers data in the Store.

For recording media specifications, see Section 19.6 "Removable Media Data Storage" on page 135.

You can damage the Store or the recording media if you insert or remove the media while the Media Status LED is red or yellow (solid or blinking). Wait until the Media Status LED is green before you replace media. For more information, see Section 14.2 "Introducing the Status LEDs" on page 91.

To install recording media

1. If the Taurus is running in **Communications** mode, shut down the Controller by selecting **Shutdown** on the Shutdown page.

   -OR-

   If the Taurus is running in **Buffered** mode, go to step 2.

2. Open the media door and wait until the Media Status LED is green.

   Air pressure differential inside versus outside the Taurus case (for example, if the Taurus was transported by air) might make the media door difficult to remove. If this occurs, loosen (but do not remove) the pressure relief screw (Figure 3-2 on page 14) to allow the pressure to equalize. Remove the media door and then gently tighten the pressure relief screw (hand-tight is sufficient).

   Do not remove the IDE/CF if the Media Status LED is red or yellow (solid or blinking). For more information, see Section 14.2.3 "Media Status LED" on page 93.

3. Insert recording media as required.

   If you are using dual CompactFlash cards (one formatted as FAT32 and one formatted as ext3), follow the instructions for using the Taurus CompactFlash Adapter that are included with the adapter.

4. Push the media door in place and twist the door knob clockwise to the locked position (horizontal).

   Closing the media door will start the Controller. If you want to start the display screen, press the centre key for about 1 second. The display will start up once the Controller has finished booting.

5. If the media you inserted for the Store was not formatted, you can format it on the Store Tools page.

   For information on how to do this, see Section 16.2.2 "Formatting Recording Media for the Store" on page 117.

   -OR-

   If you inserted formatted media for the Store, the Taurus will

   - Create a new Store using the last configured Store size setting, if the media does not contain a Store.

     -OR-

   - Automatically start adding data to the existing Store (see Section 16.1.1.1 "About Appended Stores" on page 114).

If you do not want to have the new data appended to an existing Store (for example, if it was created on a different Taurus), you can either reformat the media or delete and recreate the existing Store.

Chapter 4
Powering and Grounding a Taurus

4.1 Taurus Power Consumption

Power consumption of the Taurus varies with factors such as the operating mode and GPS receiver duty cycle. (See Section 5.4 "Selecting the Running Mode" on page 31 and Section 19.15 "Power" on page 137 for specifications).

- In Buffered mode, the Taurus will write data to the Store on the recording media at approximately 30 minute intervals (for 3 channels at 100 sps). The average power consumption will typically be 750 mW when using CompactFlash and with the GPS Duty Cycle mode configured to Automatic. Instantaneous power consumption is higher than 750 mW for the minute or two when the data in the Digitizer buffer is being written to the Store. Power consumption will be higher with a higher sample rate since the buffer fills more frequently. Power consumption will be correspondingly lower for lower sample rates.
- In Communications mode, the Controller is running continuously. This consumes more power (about 2.3 W when CompactFlash is used) than Buffered mode.
- The highest power consumption occurs when the Taurus display screen is on and all systems are running (about 3.3 W).

Power consumption as discussed above refers to the Taurus only. Power consumption of peripheral devices, such as the sensor, or devices connected to the NMXbus, serial port, or the External SOH, is in addition to these stated averages.

4.2 Grounding a Taurus Installation

The most appropriate grounding plan will depend on your application and the installation environment. This section outlines some general information you can take into account when planning grounding for a Taurus installation. For more information, see Chapter 20 "Seismometer-Taurus Interconnection."

Figure 4-1 shows the Taurus ground architecture and Figure 4-2 shows where to connect a grounding lug to the Taurus (using an M4 x 5 screw).

Figure 4-1 Taurus ground distribution and architecture

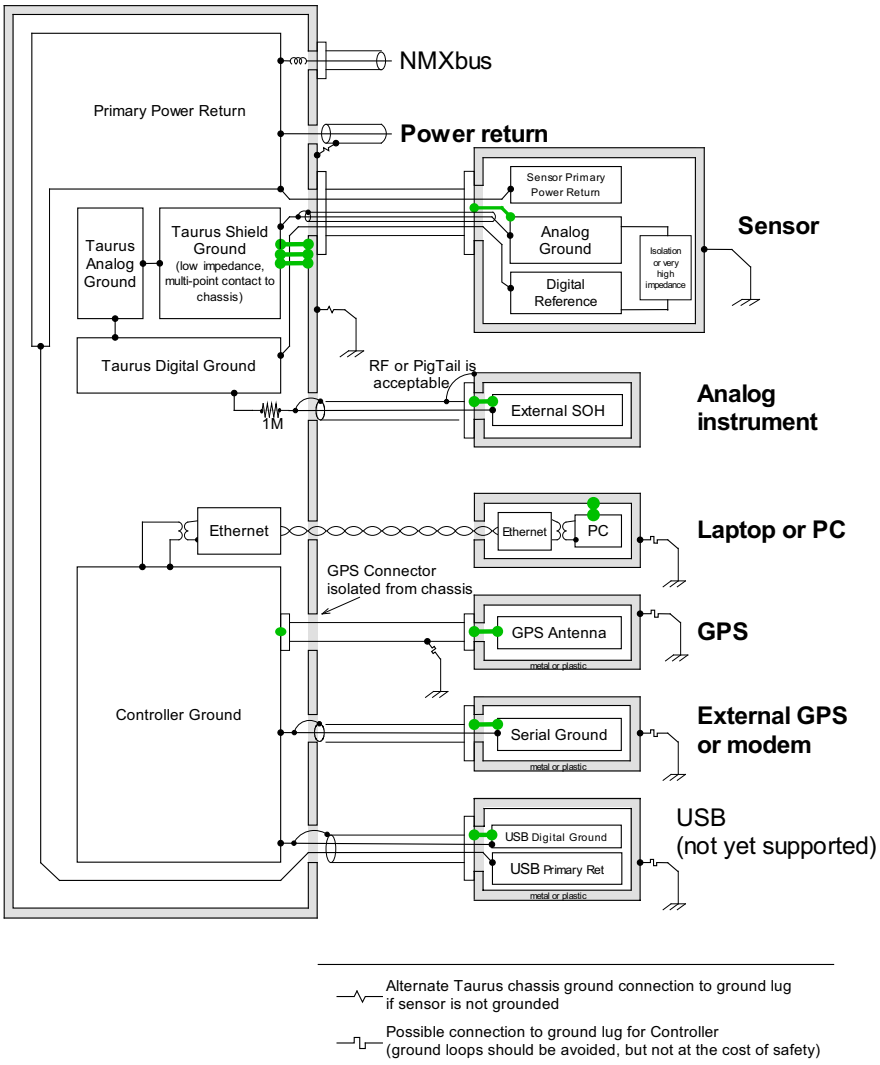


Figure 4-2 Hole for grounding lug screw

The Taurus has chassis ground, analog ground, digital ground, and primary (input power) return. Primary power return is completely isolated from chassis, analog, and digital ground. Sensor power is connected directly to the input power and is thus isolated from digital and analog ground. Chassis (case) ground is connected to the analog ground of the Digitizer subsystem. There is a single point connection from analog ground to the Digitizer subsystem digital ground. The Taurus Controller subsystem is isolated from the Digitizer and has its own Controller ground, which is used for the Serial and USB interfaces. For sensor cables, the chassis ground should be connected to the outer shield of the cable which is connected to the chassis of the sensor. The channel grounds are connected to the channel twisted pair shield. The control lines use digital ground and there must be a digital ground connection to the sensor. Sensor power return is connected to primary ground.

4.2.1 General Considerations

- Power – The Taurus power connector has 3 pins to allow the Taurus to conform to the site grounding system. You can connect the power return pin and ground, but combining grounding and power return in the same conductor limits the site grounding options. The recommended practice is to establish a single ground point for the station and ground everything to that point, which minimizes the chances of ground loops and signal noise created by the power system.
- Peripheral power – The Taurus provides primary power to attached peripheral devices via the Sensor, Serial, and NMXbus connectors. This power is switched to allow devices to be controlled by the user through the Taurus. The Taurus monitors for over-current conditions and will automatically switch off power to a peripheral if excessive current or a short is detected. See Section 19.15 "Power" on page 137 for the typical current limit threshold of each peripheral power. Peripheral power is otherwise unregulated: The voltage provided to the Taurus is passed on to the attached peripherals. The current demand of each attached peripheral and the consequent voltage drop through the Taurus and peripheral cables should be taken into consideration when designing the power system to ensure that sufficient voltage is supplied to each peripheral.

- Sensor – The voltage drop through the Taurus in a typical 12 V system is (1.0 * *peak current draw of the sensor*) + 100 mV. Add to that the voltage drop in the Taurus power cable (*power cable resistance in ohms * peak current of the Taurus and all peripherals*) and the sensor cable (*sensor cable resistance in ohms * peak current of the sensor*) to ensure that the total voltage drop between the Taurus power supply and the sensor does not cause the voltage at the sensor to fall below its required operating voltage. Solutions to problems of excessive voltage drop include heavier gauge cables, shorter cables, and higher voltage power supplies (which lowers the current consumption).

  For example, a 12V system designed to operate down to 10.8V, with a short heavy gauge power cable and a 10m 24 gauge sensor cable (1.75Ω) operating a sensor with a peak current draw of 500mA, could see a voltage drop of 1.0 * 0.500 + 0.100 + 1.75 * 0.500 = 1.425V. When the battery dips to 10.8V, peak current could cause the voltage at the sensor to drop to 10.8 – 1.425 = 9.375V.

- Serial – Similar considerations apply, except that the calculation for net voltage drop in the Taurus is (0.5 * *peak current draw of the peripheral*) + 100mV.

- NMXbus – Similar considerations apply, except that the calculation for net voltage drop in the Taurus is (0.5 * *peak current draw of the peripheral*) + 100mV.

◆ External SOH – When there is a negative input voltage across External SOH values (pins A-G, for example) and if ground is connected to negative on the voltage supply, then an incorrect value appears for SOH. Ensure ground is floating from negative to prevent this error.

◆ GPS antenna – Do not short the GPS connector to the Taurus chassis as this might introduce a ground loop (for example, if the optional metal dust caps are installed, keep any loose caps away from the GPS connector).

  The GPS antenna is on digital ground which has a single point connection to analog ground and analog ground is connected to chassis ground. The GPS TNC connector is fully isolated from the chassis and therefore is isolated from chassis ground. The purpose of this scheme is to avoid a ground loop from digital ground to chassis to analog ground. Accidental momentary connection to the chassis is not a problem, but a permanent connection might create ground loops. Ideally, the GPS antenna is isolated from ground and, in most cases, this is fine because the antenna cable is short.

  In configurations that have long GPS cables and lightning protection, an overall system design approach must be taken which balances the grounding requirements with the protection requirements. This approach requires an understanding of the Taurus grounding, the sensor grounding, power supply grounding, and local site grounding.

4.3 Powering a Taurus

See these sections for related information:

- Section 19.15 "Power" on page 137 for Taurus power specifications.
- Section 4.2 "Grounding a Taurus Installation" on page 18 and Chapter 20 "Seismometer-Taurus Interconnection" for grounding information.
- Section 5.6 "Accessing the Taurus File System via FTP, Telnet, and SSH" on page 34 for Taurus start-up definitions and options.
- Section 9.2 "Controlling Sensors" on page 57 for turning sensor power on and off via the Taurus UI.

It is recommended that you use the Shutdown option to shut down the Controller before disconnecting the power. This will preserve data presently cached in the buffer and will allow the data Store to close gracefully. For more information, see Section 5.2.2 "Shutting Down the Controller" on page 27.

4.3.1 Choosing a Power Supply and Cable

Choose an appropriate power supply for your application. See Section 19.15 "Power" on page 137 for the Taurus power specifications.

- Purchase a power cable.

  -OR-

  Build a power cable using a power connector from the optional Taurus Connector Kit (part number 15170) or equivalent (see Chapter 18 "Connector Pinouts").

4.3.2 Powering Up a Taurus

1. Connect the Taurus to an appropriate 9 to 36V DC power supply (see Chapter 4 "Powering and Grounding a Taurus").

   The Taurus will start booting up and finish in 2 to 3 minutes. Progress is indicated by the LED colour and blink patterns (see Section 14.2 "Introducing the Status LEDs" on page 91) and the boot progress screen.

2. Press and hold the centre key on the keypad for about 1 second to turn on the display screen.

   It will take about 10 to 15 seconds for the display screen to turn on and it opens to the Status page.

If the Store is reindexing while the Taurus is in Buffered mode, the Taurus will not respond to a key press until the reindexing is complete. In this case, you will see a yellow SuperLED and the display might take a very long time to start up after you press the centre key.

4.3.2.1 Bypassing the Power Supply Threshold Settings on Start-Up

If the power supply voltage is not within the configured range, the Taurus will not power up. If this happens, you can power up the Taurus by bypassing the power supply threshold settings on start-up.

To bypass the power supply threshold settings

- Connect the power to the Taurus while the media door is open.

  If the media door is open when power is first connected, the battery voltage level checks are disabled and the Taurus is forced to start up.

Once the Taurus has started, you can reconfigure the voltage thresholds to the appropriate values for your power supply (see Section 4.4 "Configuring Power Manager Settings" on page 22).

4.3.3 Power Cycling a Taurus

The Shutdown option on the Shutdown page only shuts down the Controller. If you need to power cycle other subsystems or undo an applied configuration (Section 6.3 "Undoing Applied Changes" on page 38), you have to power cycle the Taurus:

To power cycle a Taurus

1. Select **Shutdown** on the Shutdown page.
2. Wait until the SuperLED switches to a slow blinking pattern (0.5 seconds on, 5 seconds off), then disconnect the power cable.
3. Reconnect the power cable.

4.4 Configuring Power Manager Settings

The Configuration > Power Manager page provides options to configure power supply settings such as voltage thresholds.

When the external power supply voltage falls below the Low Voltage Disconnect threshold, the Taurus powers off immediately. When the external supply voltage rises above the Low Voltage Reconnect threshold, the Taurus powers up but not before 10 seconds has elapsed since the last shut down. Set the disconnect value so as to properly protect the battery for your power supply and set the reconnect value high enough to prevent the unit from prematurely turning on due to battery rebound. Voltage drops in long power supply cables should also be considered in determining these values.

When the external power supply voltage rises above the High Voltage Disconnect threshold, the Taurus powers off immediately. When the external power supply voltage drops below the High Voltage Reconnect threshold, the Taurus powers up but not before 10 seconds has elapsed since the last shut down.

You can bypass these voltage threshold settings on power up, see Section 4.3.2.1 "Bypassing the Power Supply Threshold Settings on Start-Up" on page 22.

To configure power supply settings

1. Select **Power Manager** on the Configuration page.
2. Enter the appropriate values for your system.

   The default values are for 12 V lead-acid batteries and assume short power cables. To protect your equipment, confirm the appropriate values for your power system and the maximum voltage tolerance of your sensor before setting these values.

The power supply voltage for the Trident 305 is provided by the NMXbus.

Table 4-1 Power supply settings

Setting	Description and Permitted Values
High Voltage Disconnect [mV]	When the external power supply voltage rises above the High Voltage Disconnect threshold, the Taurus powers off immediately. You can specify any integer from 9000 to 36000. The default setting is 36000 mV.
High Voltage Reconnect [mV]	After a High Voltage Disconnect has occurred, if the external power supply voltage drops below the High Voltage Reconnect threshold, the Taurus powers up but not before 10 seconds has elapsed since the last shut down. You can specify any integer between the Low Voltage Reconnect and the High Voltage Disconnect settings. The default setting is 35000 mV. **Note**: If, on initial power up, the supply voltage is higher than the High Voltage Reconnect value, the Taurus will not power up.
Low Voltage Reconnect [mV]	After a Low Voltage Disconnect has occurred, if the external supply voltage rises above the Low Voltage Reconnect threshold, the Taurus powers up but not before 10 seconds has elapsed since the last shut down. You can specify any integer between the Low Voltage Disconnect and the High Voltage Reconnect settings. The default setting is 11800 mV. **Notes:** ◆ Set the reconnect value high enough to prevent the unit from prematurely reconnecting due to battery rebound. ◆ If, on initial power up, the supply voltage is lower than the configured Low Voltage Reconnect value, the Taurus will not power up.
Low Voltage Disconnect [mV]	When the external power supply voltage falls below the Low Voltage Disconnect threshold, the Taurus powers off immediately. You can specify any integer from 9000 to 36000. The default setting is 10500 mV. **Note:** Set the disconnect value so as to properly protect the battery for your power supply.

3. Select **Apply**.
4. Select **Commit**.

Chapter 5
Operating a Taurus

5.1 Using the Taurus User Interface

The Taurus can be configured locally using the colour display screen and integrated browser and/or remotely using any Web browser over a TCP/IP connection. The Taurus user interface provides access to real-time and historic data, GPS status, instrument configuration, and field procedures.

5.1.1 Using a Web Browser

You can access the Taurus user interface using a Web browser over an IP connection. The Taurus must be in either Communications mode or Interactive mode and the network cable must be connected before the Taurus is started. For more information, see Chapter 7 "Configuring Taurus Communications."

You must have cookies enabled in your Web browser to access the Taurus user interface.

We recommend that you use Mozilla®Firefox® version 3.6 or later as your Web browser. Firefox is used by Nanometrics for product verification, and while other modern browsers, such as Google Chrome™ and Apple® Safari®, should work, they are supported on a best-effort basis only.

1. Connect to the Taurus using any of these methods:
   - Use the Ethernet cable (15228) to connect the Taurus to your LAN or to connect your computer directly to the Taurus.
   - Connect to the Taurus using a serial connection.
2. Start the Taurus.

   For information on how to do this, see Section 5.2 "Starting Up and Shutting Down" on page 27.
3. Type the IP address of the Taurus into the Address bar of your browser.

   If you do not know the IP address of the Taurus, you can start the display screen. The IP address is shown on the Status page. If you cannot view the IP address on the Status page of the Taurus display screen, see Section 5.1.1.1 "Troubleshooting: Viewing the IP Address" on page 26.

If you use the Back and Forward buttons of your Web browser to navigate through the Taurus user interface pages, any changes you make will be lost.

5.1.1.1 Troubleshooting: Viewing the IP Address

If you cannot view the IP address on the Status page of the Taurus display screen, you can access the Taurus by performing the following steps on a laptop running Windows:

1. Ensure that the Internet Protocol (TCP/IP) properties are set to obtain an IP address automatically.
2. Disconnect the laptop from the Local Area Network by unplugging the network cable.
3. Restart the laptop.
4. Connect the Taurus to the laptop using the Ethernet cable.
5. Type the following IP address into the Address bar of your browser: 169.254.2.2
6. Make a note of the IP address that is displayed on the Status page and type that IP address into the Address bar of your browser to access the Taurus.

   If the IP address of the Taurus is not displayed on the Status page, perform the following steps:

   a) Telnet to 169.254.2.2.

   b) Log on and type `ifconfig eth0`.

      The IP address is displayed on the second line (after inet addr).

      Example:

```
taurus_0116$ ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:11:40:02:00:30
          inet addr:10.11.2.51  Bcast:10.255.255.255  Mask:255.255.0.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:361076 errors:6 dropped:0 overruns:0 frame:6
          TX packets:306781 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:43537585 (41.5 MiB)  TX bytes:213367176 (203.4 MiB)
          Base address:0xe00
```

5.1.2 Navigating the Taurus UI pages

The Taurus UI Web pages show real-time status information and provide configuration, data download, and firmware upgrade options. You can access the UI pages using the Taurus display screen and using any Web browser with IP access to the Taurus.

The Taurus Web interface normally refreshes every 5 seconds. The Taurus will detect if a communications link is slow and will reduce the interface refresh rate to attempt to compensate for the link speed.

You can click the Pause automatic refresh button at the top of the Status, Waveform, SOH, Timing, and Sensor pages to stop the page from refreshing automatically.

You can click the Start automatic refresh button to start automatic refreshing again.

5.2 Starting Up and Shutting Down

The Taurus Digitizer, Controller, and timing are started up as soon as you connect power to the Taurus. Typically it takes about 3 minutes for these Taurus systems to finish booting when power is first connected.

About 2 minutes after connecting power to the Taurus, you can start the Taurus display screen:

- Press and hold the centre key for 1 second.

  The display screen will start in about 50 to 90 seconds.

If the supply voltage exceeds either of the configured voltage disconnect settings (that is, it is either lower than the Battery Low value or higher than the Battery High level), the Taurus will not power up. See Section 4.3.2.1 "Bypassing the Power Supply Threshold Settings on Start-Up" on page 22.

5.2.1 Starting the Controller

The Taurus Controller manages operations such as communications and networking, the Taurus display screen and user interface, and the recording media. The Taurus Digitizer operates continuously whether or not the Controller is running. The options on the Shutdown page (such as Restart) and a hard shut down with the centre key apply only to the Controller, they do not affect the Digitizer.

It is possible to do a hard shut down of the Controller by pressing the centre key for about 5 seconds but this is not recommended. A hard shut down will interrupt various processes and might cause detrimental effects, such as causing the Store to require reindexing.

While the Controller is running you have access to the Taurus over an IP connection and applied configuration changes are held in volatile memory (memory that requires power to maintain the stored information). Once the Controller shuts down, you no longer have IP access to the Taurus and any uncommitted changes in the volatile memory for Controller-based functions will be lost.

The Controller will start up when

- You connect power to the Taurus.
- You press the centre key for 1 second.
- The buffer fills up in Buffered mode or when the buffer fills up after a shut down in Communications mode (if the configured media type is installed).

5.2.2 Shutting Down the Controller

The Shutdown option shuts down the Controller gracefully. This does not turn off the Digitizer, which continues to collect and buffer data.

Always ensure the Controller is shut down before removing or inserting recording media. For more information, see Section 16.2.1 "Replacing Recording Media" on page 116.

The time elapsed before the buffer fills depends on factors such as the number of active channels, sample rate, seismic signal and noise, and buffer size.

It is recommended that you use Shutdown to shut down the Controller before disconnecting the power. If you disconnect the power while the Controller is running, you might lose data presently cached in the buffer. This can be about 15 seconds of data if the Taurus is running in Communications mode and up to several hours of data if the Taurus is running in Buffered mode depending on factors such as the sample rate and number of channels configured. Also, if the Store is not closed down properly, it might need to perform a lengthy reindexing on the next start-up (see Section 16.1.3 "Reindexing Stores" on page 115).

To shut down the Controller

1. Select **Shutdown** on the Shutdown page.

   The status LEDs indicate when shut down has completed:

   - The SuperLED has switched to a slow blinking pattern.
   - The Media Status LED is green.
   - The Ethernet Status LED is off.

If the Taurus is in Buffered mode, the Controller will normally be shut down already. If the Controller is running, it is writing buffered data to the media and will shut down automatically when it has finished writing the data. For more information, see Section 5.4 "Selecting the Running Mode" on page 31.

To use Shutdown in Buffered mode, wake the display first (press the centre key for 1 second and wait for the display screen to start) so that you can access the Shutdown option. You might want to do this to ensure any remaining buffered data is written to the recording media before you remove media or power down the Taurus.

It is possible to do a hard shut down of the Controller by pressing the centre key for about 5 seconds but this is not recommended. A hard shut down will interrupt various processes and might cause detrimental effects, such as causing the Store to require reindexing.

5.2.3 Restarting the Controller

You can use the Restart option to reboot the Taurus. The Taurus continues to buffer data during a restart.

To restart the Controller

- Select **Restart** on the Shutdown page.

5.3 Logging On and Off

As a user, you have two ways to access a Taurus (Web browser or Taurus display screen) and you have four options for operating a Taurus:

- Logging on using the *central* user account
- Logging on using the *tech* user account
- Logging on using the *user* user account
- Not logging on

Table 5-1 shows the permissions and roles for each of the different options.

Table 5-1 User roles and permissions

User account name	Default password	Role	Permissions to
central	central	securityAdmin	◆ Configure security ◆ Configure system ◆ Manage data Store and recording media ◆ Command sensor ◆ Download all data types ◆ Restart ◆ Shut down ◆ Upgrade
tech	tech	maintenance	◆ Configure system ◆ Manage data Store and recording media ◆ Command sensor ◆ Download all data types ◆ Restart ◆ Shut down
user	user	operator	◆ Manage data Store and recording media ◆ Command sensor ◆ Download all data types ◆ Restart ◆ Shut down
Not logged on		not defined	◆ Format active media (if unformatted)/switch media on start-up ◆ Command sensor ◆ Download all data types ◆ Restart ◆ Shut down

5.3.1 Logging On

You can log on using a Web browser or the Taurus display screen. If you use the display screen, you have the additional option of performing a Quick Log On (see Section 5.3.1.2 "Quick Log On Using the Display Screen" on page 30.)

5.3.1.1 Standard Log On

1. Select **Log On** from the main menu.
2. Type a user name in the User ID box and the corresponding password in the Password box and click **Log On**. (Web browser)

   -OR-

   1. Select a User ID from the list. (display screen)

2. Select **Keys** and press the centre key.
3. Press the keys to type the corresponding password and select **Done**.
4. Select **Log On**.

If you did not log on successfully, you can go back to the Log On page and try again. There is no limit on the number of log on attempts.

All passwords are case-sensitive.

5.3.1.2 Quick Log On Using the Display Screen

There are two ways to log on using the display screen: Standard and Quick Log On.

You can configure Taurus to use Quick Log On for local authentication. It allows you to log on without having to enter the password for the user account. Quick Log On is only available on the display screen.

Once Quick Log On is configured as the Local Authentication type, the Log On page on the Taurus display screen will give you the option to **Log On as <user>**. For example, if you configured the Quick Log On to use the `central` account, the name of the button is **Log On as central.**

To configure Quick Log On

1. Log on using the *central* user account and open the Configuration > Security page.
2. Select **Quick Log On** from the Local Authentication list and then select the appropriate account from the Quick Log On User ID list.
3. Select **Apply**.
4. Select **Commit**.

To disable the Quick Log On option on the Taurus display screen, repeat steps 1 to 4 and select **Standard** from the Local Authentication list.

5.3.2 Logging Off

We recommend that you log off Taurusbefore you close your Web browser window or when you have finished using the Taurus display screen.

You are automatically logged off if you close your Web browser window or if you are inactive for more than 30 minutes. The Taurus display screen will also turn off automatically.

To log off of the Taurus

1. Click ▼ and select **Log Off** from the main menu. (Web browser)

   -OR-

   Press the top key to open the main menu, press the bottom key to select **Log Off**, and press the centre key. (display screen)
2. Select **Log Off** to confirm that you want to log off.

5.3.3 Changing Passwords

You can change the default passwords of the three user accounts: central, tech, and user. Change the password for any of these accounts at any time, regardless of your current logged on or logged off status.

All passwords are case-sensitive.

To change a password

1. Open the **Log On** page (if you are not logged in) or the **Log Off** page (if you are logged in) and select the **Change Password** link.
2. Type the current user ID in the **User ID** box.
3. Type the current password in the **Current password** box.
4. Type the new password in the **New password** box.

   The new password must be at least 4 alphanumeric characters long. All passwords are case-sensitive.
5. Type the new password in the **Verify new password** box.
6. Select **Save.**

   You will be logged on to that account automatically.

5.3.3.1 Resetting to Default Passwords

If required, you can revert to the default set of passwords listed in Table 5-1 "User roles and permissions" on page 29.

To reset all passwords to the default settings

1. Access the Taurus via telnet or SSH.

   For information on how to do this, see Section 5.6 "Accessing the Taurus File System via FTP, Telnet, and SSH" on page 34.
2. Delete the file /home/apollo/users.txt.
3. Click in the Web browser user interface and select **Shutdown** from the main menu.
4. Click **Restart**.

5.4 Selecting the Running Mode

The running modes are: Communications (default) or Buffered.

In Communications mode, data is written continuously to the data Store and it can also be downloaded or streamed to another device. The Communications mode consumes more power than Buffered mode because the Controller is always on (writing data to the Store), and the Web server is always on (allowing you to continuously communicate with the Taurus via an IP connection).

In Buffered mode, the Taurus buffers the data and wakes the Controller only to write data to the Store when the buffer is full. Buffered mode consumes the least power of the two running modes. An IP connection is not always available in Buffered mode because the Web server is only on for a short period after you enable Buffered mode, and after that, only if you force it to turn on by pressing the centre button on the unit or by using the `curl` command line tool. For information on how to do this, see Section 5.5.1 "Forcing the Web Server to Turn On (Buffered Mode)" on page 33.

The time it takes for the buffer to fill ranges from a few minutes to several hours, depending on the number of active channels, input signal activity, the sample rate, and the size of the buffer (2MB on units with serial number 0353, 0375, 0379 and higher, 1MB on all other units); for example, about 30 minutes for 3 channels at 100sps and 2MB RAM.

Note that the maximum sample rate you can select for buffered mode is 250.

Table 5-2 shows an overview of the differences between Communications mode and Buffered mode:

Table 5-2 Communications mode versus buffered mode

Mode	Web server	Data	Download data?	Stream data?	Power consumption
Communications	Always on	Continuously written to the data Store	Yes	Yes	Highest The Controller is always on
Buffered	Only on for a short period of time after Buffered mode is enabled, or when you manually force it to turn on (see Section 5.5.1 on page 33)	Buffered until the buffer is full and then written to the data Store	Yes* *Only when the Web server is on	No	Lowest The Controller is only on when writing data to the Store

5.4.1 Configuring the Running Mode

To configure the running mode

1. Select **General** on the Configuration page.
2. Select **Communications** from the **Running Mode** list.

   -OR-

   Select **Buffered** from the **Running Mode** list.
3. Select **Apply**.
4. Select **Commit**.

5.5 Setting the UI Timeout

If you have not been actively using the Taurus user interface within a configured period of time, the UI will time out. When the UI times out, the display screen shuts off and, in Buffered mode, the Controller and Web server also shut off.

Table 5-3 shows what happens when the UI times out for each of the running modes. For more information on the running modes, see Section 5.4 "Selecting the Running Mode" on page 31.

Table 5-3 UI timeout impact on the running modes

Mode	Taurus display screen	Controller and Web Server
Communications	Turns off	Stays on
Buffered	Turns off	Turns off

The Web server is required to communicate with the Taurus through an IP connection. Therefore, in Buffered mode, communication with the Taurus cannot be established until the the Web server is manually turned on by pressing the centre button on the Taurus, or by using the curl command line tool. For information on how to do this, see Section 5.5.1 "Forcing the Web Server to Turn On (Buffered Mode)" on page 33.

To set the UI timeout period

1. Select **General** on the Configuration page.
2. Select the number of minutes from the UI Timeout list.
3. Select **Apply**.
4. Select **Commit**.

If you start a data download in Buffered mode, the Controller will run long enough to complete the download and ignore the configured UI timeout if necessary.

5.5.1 Forcing the Web Server to Turn On (Buffered Mode)

In Buffered mode, when the UI Timeout takes effect (see Section 5.5 "Setting the UI Timeout" on page 33) the display screen, Controller, and Web server also shut off. The Web server is required to communicate with the Taurus through an IP connection. Therefore, in Buffered mode, communication with the Taurus cannot be established until the Web server is manually turned on by pressing the centre button on the Taurus, or by using the curl command line tool.

If you do not have physical access to the Taurus, you can remotely force the Web server to start up again by using the curl command line tool.

To remotely force the Web server to turn on

1. Download and install the curl command line tool (this tool will already be installed on most computers running Linux or Unix operating systems).

   You can download curl packages from the following location: http://curl.haxx.se/download/

2. Open a command prompt and type the following:

   ```
   curl -d "" http://<ip address of your Taurus>/keypress
   ```

3. Repeat step 2 until the command has been executed successfully.

   You can write a script to repeatedly invoke this command until it is successful.

   The /keypress URL is only available for a very small period of time (1 to 2 minutes) every Buffered mode cycle. The full cycle can be anywhere from 10 to 60 minutes depending on the sample rate.

4. Connect to your Taurus by typing the IP address into the Address bar of your Web browser.

5.6 Accessing the Taurus File System via FTP, Telnet, and SSH

You can access the Taurus file system via File Transfer Protocol (FTP), telnet, and Secure Shell (SSH; Taurus supports SSH-1 and SSH-2). SSH is included as of Taurus firmware version 2.x. Nanometrics does not provide technical support for use of these protocols. Procedure details will depend on the operating system, the client you are using, and your network set-up.

FTP and telnet are both cleartext protocols, so it is risky to use them across an unsecure network. Where security is an issue it is better to use SSH, which encrypts the entire session. Most UNIX/Linux systems include an SSH client. On Windows, you can install a client such as PuTTY (http://www.chiark.greenend.org.uk/~sgtatham/putty/). PuTTY includes other utilities such as PSFTP (a secure FTP utility).

The Taurus server uses the standard port number for each protocol (FTP port 21, SSH port 22, and telnet port 23).

5.6.1 Logging On as Root

To log on as root

- Log on with the following credentials:
  - User name = *root*
  - Password = *dolphin18*

5.6.1.1 Changing the Root Password

If you are logged on as the user `root`, you can change the root password using the `passwd` command.

If you change the root password and then forget the password, there is no way to recover it. You will no longer be able to log on to the Taurus file system.

Part 2
Configuring a Taurus

- Changing Configuration Settings
- Configuring Taurus Communications
- Configuring the Taurus Digitizer
- Controlling and Configuring Sensors
- Changing General and Channel Naming Settings

Chapter 6
Changing Configuration Settings

Reset, Apply, Commit

- Reset — Undo changes before they are applied.
- Apply — Implement changes before they are committed. If you shut down the Controller before committing your changes they will be lost. For more information, see Section 5.2.2 "Shutting Down the Controller" on page 27.
- Commit — Permanently save changes.

Logging On

To change the configuration settings of a Taurus, you have to be logged on with one of the following user accounts: *tech* or *central*.

6.1 Configuration Pages Tips

- The **Apply**, **Reset**, and **Commit** buttons affect all configuration pages not just the page on which the **Apply**, **Reset**, or **Commit** button was selected.
- Always select the **Previous** button to navigate back through configuration pages to preserve unapplied changes. If you use the Web browser's Back button, unapplied configuration changes are discarded.
- You should only use one Web browser session at a time for configuration changes. For example, if you are running two browsers simultaneously (an external Web browser and the internal browser on the Taurus) and performing configuration changes on both, you must select the **Reset** button on the configuration page each time you switch from one browser to the other.

6.2 Checking Basic Configuration Settings

There are some basic settings you might want to check before making other configuration changes:

- Running mode

  For more information, see Section 5.4 "Selecting the Running Mode" on page 31.
- Number of channels
- Digitizer sample rate
- Channel naming settings

  Downloaded data files will use the network and station definitions as entered on the Channel Naming page.

6.3 Undoing Applied Changes

To undo applied changes, you can

- Manually apply the reverse of the changes that were made

  -OR-

  Restart the subsystem where the applied changes are stored

To undo changes applied to	You have to
Data Retrieval page Data Archive page Data Streaming page Communications page Security page Sensor Library page (all sensors except the active sensor) UI Timeout (General page) Apollo Log Verbosity (General page)	1. Click ▼ and select **Shutdown** from the main menu. (Web browser) -OR- Press the top key to open the main menu, press the bottom key to select **Shutdown**, and press the centre key. (display screen) 2. Select **Restart**.
Calibration page Digitizer page Power Manager page Sensor Library page (active sensor) Timing page Running Mode (General page) SOH Report Interval (General page) ARM Log Verbosity	1. Press the top key to open the main menu, press the bottom key to select **Shutdown**, and press the centre key. 2. Wait until the SuperLED switches to a slow blink pattern (0.5s on, 5s off), then disconnect the power cable. 3. Reconnect the power cable.

6.4 Downloading a Configuration File

You can download all of the configuration settings of a Taurus and save them as a file. You can do this for the default configuration settings but also for custom configuration settings. You can then upload the configuration file and apply the settings to any Taurus.

1. Click ▼ and select **Configuration** from the main menu. (Web browser)
2. Click **Download From Taurus**.
3. Save the .ttl file.

   The format of the Taurus configuration file is Terse RDF Triple Language (Turtle), which is a syntax for the Resource Description Framework (RDF). For information on Turtle, see http://www.w3.org/TeamSubmission/turtle/. For information on RDF, see http://www.w3.org/RDF.

6.5 Uploading a Configuration File

Valid configuration files can be uploaded to a Taurus to replace the existing configuration settings (for example, a configuration file downloaded from another Taurus). The configuration settings are applied automatically when you upload the configuration file.

You must have the configured recording media for the Store installed in the Taurus before you can upload a configuration.

1. Click and select **Configuration** from the main menu. (Web browser)
2. Click **Browse**, find the Taurus configuration file you want to upload (.ttl), and click **Open**.

   The format of the Taurus configuration file is Terse RDF Triple Language (Turtle), which is a syntax for the Resource Description Framework (RDF). For information on Turtle, see http://www.w3.org/TeamSubmission/turtle/. For information on RDF, see http://www.w3.org/RDF.
3. Click **Upload**. The progress bar will indicate the percentage of the file upload that is complete.

   The configuration settings defined in the configuration file are applied automatically after the file has been uploaded. See Section 6.3 "Undoing Applied Changes" on page 38 if you want to revert to the previous configuration settings.
4. If you want to make the uploaded configuration settings permanent, click **Commit**.
5. Click and click **Shutdown** from the main menu.

6.6 Viewing Configuration Change History

The Taurus maintains an audit trail of all configuration changes since the Store was created You can extract this audit trail from the Store as a file and save it on your local computer. The format of the Taurus configuration audit trail file is Terse RDF Triple Language (Turtle), which is a syntax for the Resource Description Framework (RDF). For information on Turtle, see http://www.w3.org/TeamSubmission/turtle/. For information on RDF, see http://www.w3.org/RDF.

You can view the configuration audit trail file to determine the exact state of the configuration for the Taurus at any point since the Store was created. The configuration audit trail file contains configuration data, metadata, and a list of audit trail events. When any of the following occur, they are recorded as events in the audit trail:

- The Store is opened (which includes when the Taurus starts up).
- A configuration change is applied.
- A configuration change is committed.

To download the configuration audit trail file

1. Select **Data Retrieval** from the main menu.
2. If a list is available in the upper, right corner of the page, select the instrument for which you want to retrieve data.

   If your Store references multiple instruments, the Data Retrieval pages will provide a list of instruments in the upper, right corner of the pages. This list allows you to select an individual instrument and form a data retrieval request for that specific instrument. If only the current instrument is referenced in the Store, the list is not present.

3. Click **System configuration** and click **Next**.
4. Select the start time (Month, Day, and Time) and end time (Duration) of the data you want to extract and click **Next**.

   -OR-

   Click the **Show Available Times link** and select a time.

   Review the settings and click **Download**.

   To change the settings; click one of the links to return to the appropriate settings page, change the settings, and then click **Next** to return to the Download page.

   Click **Clear All Choices** to delete all of the current settings and return to the Data Retrieval main page.

5. Click **OK** to save the file to your desktop.

   You can open the .ttl file with any text editor.

Chapter 7
Configuring Taurus Communications

Page:	Configuration > Communications
Log on required:	Yes

7.1 Taurus Networking

You can configure a Taurus for network access via an IP connection over either an Ethernet connection or serial port (SLIP). The Taurus is accessible while it is in Communications mode or before the UI shuts down in Buffered mode (see Section 5.4 "Selecting the Running Mode" on page 31).

7.1.1 Packet Routing

When packets are destined to a location outside of an immediate interface (more than a single hop), a default route is required. A Taurus can have multiple interfaces configured, the Default Interface setting specifies which remote address should be used as the gateway and all packets that are not on an immediate interface will be sent to that gateway:

- Ethernet – The gateway used is the one obtained from the settings specified on the Configuration > Communications > Ethernet page.
- Serial Port 1 – The gateway used is the remote IP address configured on the Configuration > Communications > Serial Port 1 pages.

To set the packet routing default interface

1. Select **Communications** on the Configuration page.
2. Select the default interface from the list.

7.2 Communications over Ethernet

The Taurus provides standard modes for searching for an Ethernet LAN interface. These include DHCP, Link-Local, and Static IP. There is also an option for no Ethernet.

- Use the supplied Ethernet cable (15228) or equivalent to connect the Taurus to your LAN.

7.2.1 Configuring Ethernet Settings

To configure the Ethernet settings for a Taurus

1. Select **Communications** on the Configuration page.
2. Ensure the Default Interface is set to Ethernet.
3. Select the **Ethernet** link.
4. Select an Ethernet mode from the list.

Mode	Description
DHCP	The Taurus searches for a DHCP server to obtain a network address. If a DHCP server is not found, the Taurus will use the Link-Local protocol to acquire an available IP address. **Note:** If DHCP is set as the Ethernet mode, the IP address of the Taurus could change whenever the Taurus reboots (such as after a firmware upgrade).
Link-Local	The Taurus uses trial-and-error testing of the LAN for address conflicts to acquire an available IP address in the Link-Local address space of 169.254.0.0/16.
Static IP	The Taurus uses the Ethernet Static IP Address, Ethernet Static Subnet Mask and Static Default Gateway settings to define its Ethernet interface: • Ethernet Static IP Address – The IP address for the Taurus in the selected network. • Ethernet Static Subnet Mask – Identifies which portion of the IP address is the network ID and which is the host ID. • Static Default Gateway – The IP address of the gateway device for remote network visibility.
None	The Ethernet interface is disabled. This will conserve a small amount of power but will force you to access the Taurus via the display screen and keypad. (This setting is not associated with serial configuration in any way.)

5. Configure the following settings as required:

Setting	Description
Ethernet Static IP Address	The IP address assigned to the Taurus This setting is only applicable if the Ethernet mode is set to Static IP. The default setting is 127.0.0.1.
Ethernet Static Subnet Mask	The network mask for the Taurus static IP address This setting is only applicable if the Ethernet mode is set to Static IP. The default setting is 255.255.0.0.
Static Default Gateway	The default gateway address for the static IP address This setting is only applicable if the Ethernet mode is set to Static IP.

7.3 Communications over Serial Ports

Taurus provides one serial port that can be configured to use SLIP for link control and establishment, with a further option to use TDMA on a SLIP link. The default configuration setting for the port is 9600bps.

Serial Port 1 is a full 9-pin RS232 serial port designed for communication with a computer via a direct connection. Configuration options are on the Configuration > Communications > Serial Port 1 pages.

Table 7-1 Serial port protocols

Protocol	Description
Serial Line IP (SLIP)	A simple IP over serial protocol with very little overhead. The Taurus uses a 1500 byte frame size. Compressed SLIP (CSLIP) – SLIP with TCP/IP header compression. This will decrease the TCP/IP header from 40 bytes to 7 bytes but has no effect on the 28-byte UDP/IP headers.
Unused	The serial port is not used.

7.3.1 Flow Control

When streaming data, a Taurus will automatically reduce the rate at which NP packets are transmitted based on the configured speed of Serial Port 1.

7.3.1.1 Bandwidth Requirement

Even with flow control, the serial link has bandwidth limits which, if exceeded, might affect data availability. When streaming data over a serial port, the following condition must be true:

Number_bytes_required_to_be_sent < *Maximum_number_bytes_that_can_be_sent*

Maximum_number_bytes_that_can_be_sent = *SerialPortSpeed* x 0.90 / 10

Number_bytes_required_to_be_sent = *OutputChannels* x *SampleRate*_Hz x *BytesPerSample* x *PacketOverhead*

PacketOverhead = (51 + 64 x *FramesPerPacket* + 28) / (60 x *FramesPerPacket* – 8)

If this condition is violated, buffers will temporarily allow data streaming without data loss but a data delay might be noticed.

The packet overhead is the combined overhead of the Steim (1), NP, and UDP/IP overheads.

If you are using TDMA over a serial port, remember that the maximum number of bytes that can be sent will be limited additionally by the size of the Taurus TDMA slot.

7.3.2 Configuring a SLIP Direct Connection

The Taurus supports a direct SLIP connection via a serial communication cable or transparent serial modem. This section provides the procedure for configuring the Taurus for a SLIP connection.

To configure a SLIP connection for a Taurus

1. Select **Communications** on the Configuration page.
2. Select the **Serial Port 1** link.
3. Select **SLIP** from the **Mode** list.
4. Select a link speed from the **Speed** list.

   The speed is the transmission rate between the Taurus and a connected serial device. The default is 9600.
5. Set the **Local IP Address** to the IP address of the local Taurus interface for SLIP connections.
6. Set **Remote IP Address** to the IP address of the remote interface for SLIP connections.

   Make sure that the local IP address and the remote IP address are in the same subnet. For example, if the local IP address is set as 192.168.1.1, the remote IP address should also be in the same subnet, such as 192.168.1.2.

   The subnet of the SLIP interface cannot be the same as the subnet of the Ethernet or satellite interface of your Taurus. We recommend that you use a private network address pair that does not match the Ethernet or satellite subnet of your Taurus or workstation computer. If you are using the SLIP connection on your Taurus for an Internet-bound connection, you should use the endpoint addresses specified by your network administrator.
7. Select the **SLIP** link.
8. Select **SLIP** from the **Protocol** list.
9. Select **Apply**.
10. Select **Commit**.
    a) Click **OK** on TCP/IP properties.
    b) Click **OK** on *ComputerName* Properties.
    c) Ensure the Taurus has been powered up and Serial 1 is connected to the COM port.

       The message “All devices are connected” will appear briefly and the connection icon will show up immediately in the system tray.
11. Test the connection by pinging the local IP address configured on Taurus from a command prompt.

7.3.3 Configuring a CSLIP Connection

CSLIP provides minor amounts of compression to the link.

7.3.3.1 Taurus Configuration for CSLIP Connection

To use CSLIP, follow the steps for configuring a SLIP connection (see To configure a SLIP connection for a Taurus on page 44) with the following change:

- For step 8, set the protocol to CSLIP.

7.3.4 Configuring TDMA over SLIP

You can configure Serial Port 1 for TDMA over a SLIP link. This option is typically used to prevent collisions on a serial RF radio link. These links are most commonly used to connect a Taurus to a Cygnus 205 acting as a repeater in a multiple hop acquisition path.

If the Taurus system timing status is not good (status is not Green), data streaming is disabled until timing status is good again. (See Timing on page 104 for a summary of timing statuses and indicators.)

While data streaming is disabled, HTTP access to the Taurus is still available. HTTP access might be erratic, depending on the number of collisions on the link due to any significant shift of the Taurus time slot.

For a network that uses a set of half-duplex links on different frequencies, it is recommended that you configure the radios for priority receive. For low bandwidth links, you can balance transmission efficiency for data transmission and retransmission requests by setting the respective slot proportions to 90% and 10%.

To configure TDMA for a Taurus

1. Select **Communications** on the Configuration page.
2. Ensure the Taurus is configured for a SLIP connection.
3. Select **Serial Port 1**.
4. Select the **TDMA** link.
5. Select the **Enable TDMA** check box.
6. Enter values for the following TDMA settings:

Setting	Description
Frame Length	Enter a number between 1000 and 10000 milliseconds. The default setting is 4000. The TDMA frame length must be set to the same value for all devices sharing the link. This value should be compatible with the minimum slot size for this connection (Section 7.4 "Data Streaming" on page 46).

Setting	Description
Slot Start [%]	The Taurus TDMA slot start position as a percentage of the entire frame Enter an integer from 0 to 99. The default setting is 0. **Note:** The slot start plus slot duration must be less than or equal to 100.
Slot Duration [%]	The Taurus TDMA slot duration as a percentage of the entire frame Enter an integer from 1 to 99. The default setting is 80. **Notes:** ◆ The slot start plus slot duration must be less than or equal to 100. ◆ The minimum slot size is determined by the largest frame that can be transmitted over the serial link. The minimum slot size is determined by the largest frame that can be transmitted over the serial link. The minimum slot size in milliseconds is defined as follows: *minSlotSize = guardTime + ((MTU · bitsPerCharacter · paddingMargin / dataRate) 1000)* For example, with 35ms slot guard time (not configurable to other values in this release), a 530 byte Maximum Transmission Unit (MTU), 10 bits per character (8 data bits, 1 start, 1 stop, no parity), 10% byte stuffing margin, and 9600 bps; the minimum slot size would be as follows: *minimum slot size = 35 + 530 · 10 · 1.1 / 9600 · 1000 = 642 ms*

7.4 Data Streaming

You can stream time series data over either an Ethernet or a Serial Port 1 (SLIP) connection to a destination such as Apollo Server or a NAQSServer. For more information, see Chapter 11 "Streaming and Receiving Data".

7.5 Discovery

A Taurus can be configured to send out small multicast, identification messages to other devices and applications running on the network, such as Apollo Project, Apollo Server, and Antares. Discovery is enabled by default but you can disable it if required by clearing the **Enable Discovery** check box.

Table 7-2 Discovery settings

Setting	Description
Enable Discovery	Select this option to allow the Taurus to send out identification messages to other devices on the network. By default, this option is selected.
IP Address	A valid multicast IP address The first octet must be between 224 and 240, inclusive. Each of the last three octets can be any positive integer from 0 to 255. The default setting is 224.199.71.138.
Port #	The port number used by the Taurus for discovery broadcasts. The default setting is 6776.

Chapter 8
Configuring the Taurus Digitizer

Page:	Configuration > Digitizer
Log on required:	Yes

8.1 Taurus Digitizer

The Taurus Digitizer has three time series data channels that are constantly digitizing data. The data from each of these channels is recorded by the Controller and written to the Store. You can configure general settings for the Taurus Digitizer (such as sample rate, subsampling, and frames per packet) and also timing, front end, and trigger settings.

8.2 Main Digitizer Settings

Table 8-1 Main settings

Setting	Description
Sample rate [Hz]	The number of samples per second in hertz taken from the continuous analog sensor signal by the Taurus Digitizer to make a discrete-time signal. Analog signals connected to the Taurus and Trident 305 are low pass filtered before being sampled at 30 kHz. This data is then low pass filtered and decimated to the configured output sample rate. For more information, see Chapter 21 "Filter Response." The default setting is 100. **Notes**: The valid value ranges for some of the trigger parameters depend on the sample rate, therefore some sample rates might be incompatible with your current trigger settings. 500 sps and 1000 sps are not supported in Buffered mode.
Output channels	The number of time series data channels that are constantly digitizing data. **Note**: The Taurus Digitizer has 3 channels but you can expand the total number of channels supported by a single Taurus from three to six or nine channels by connecting up to two Trident 305s Digitizers.
Enable DC removal	The DC removal filter is a a high pass filter with a configurable low corner frequency. For more information, see Section 21.4 "Digital IIR High Pass Filter" on page 147. Select this option if you want this filter applied to the data. By default, this option is not selected.
DC removal cutoff [Hz]	The DC Removal cutoff refers to the corner frequency of the high pass filter in hertz (the DC Removal filter). All signal frequencies below this are removed. Enter a number between 0.001 and 1.0. The default setting is 0.001.
Frames per packet	The number of standard Steim data frames per packet for transmission and storage of the primary time series data. Smaller packets reduce the streaming latency but will greatly increase the requirements for streaming throughput and data storage. The default setting is 7.

8.3 Taurus Times

A Taurus derives its time frames from GPS time as described in Table 8-2. The times shown on the various pages are updated whenever those page views refresh (typically every 5 seconds unless the refresh rate is reduced to compensate for a slow network link when using a browser).

Table 8-2 Taurus time definitions

Type	Description	Shown on Taurus UI
GPS time	The GPS time provided by the GPS receiver. The Taurus has an algorithm that attempts to correct any time errors that the GPS receiver might have under certain conditions.	Not shown – used as the basis for the derived times described below.
System clock	The current system time according to the Taurus Digitizer. The system clock is resynchronized to GPS Time when the GPS receiver is turned on. For more information, see Section 8.3.1 "System Clock Correction" on page 49.	Timing page > Timing > Report time
Time	The current time according to the Controller (see Section 5.2.1 "Starting the Controller" on page 27 for a description of the Controller). The Controller resynchronizes its time to the system clock continuously when it is running.	◆ Status page > Time ◆ SOH page > Time
Last updated	The system time when the GPS data (including the GPS time) was last updated.	Timing page > GPS Satellites Timing page > GPS Map

8.3.1 System Clock Correction

The system clock is kept close to GPS Time when GPS is available. Even when the GPS receiver is duty cycled and the system clock is free running for a while, the time error is regularly small enough so that it can be smoothly reduced to near-zero levels by running the clock slightly off-frequency until perfectly resynchronized. The time module is in Fine Lock if the time error (which is the difference between the system clock and GPS Time) remains small. If a time error develops that is larger than a preset limit, the time module goes into Coarse Lock which steers the clock back faster.

Large time errors might develop if the system clock is left free running without the GPS receiver active for a prolonged period of time. The magnitude of the error is dependent on the length of time the GPS was unlocked (or otherwise unavailable) and the stability of the ambient temperature of the Taurus. In these cases, the clock steering described above would take too long and a system clock correction is necessary. This eliminates a large part of the error instantly, after which the error can be driven small using the steering mechanism. The system clock correction introduces a discontinuity in the Taurus time frame because time appears to be "jumping" by a predefined amount.

8.3.1.1 System Clock Correction Options

There are three options for configuring how the Taurus will correct the system clock time: Discard Samples, Slow Coarse Lock, and No Alignment. You can set these options on the Configuration > Digitizer > Timing page. Table 8-3 provides a description of the three options and explains the advantages and disadvantages of each.

Table 8-3 System clock correction options

Option	Description	Advantages	Disadvantages
Discard samples	A time correction is performed in a multiple of 100 µs when the time error between the Taurus and GPS time exceeds 100 µs. To preserve data quality, the FIR filters buffers are flushed of their samples and the FIR filtering is disabled for a few hardware samples, so that the first output sample occurs on a UTC aligned multiple of the output sample period.	All output samples are UTC aligned. Very low maximum time error (100 µs) between the Taurus and GPS time. Very little time is spent in the coarse lock mode so that the time error between the Taurus and GPS time is brought under 1.25µs very quickly.	Hardware samples are discarded during a time correction so the last sample before the time correction is not one sample period before the first sample afterwards. A gap in data slightly larger than the FIR filter period is introduced. For example, when sampling at 100Hz, the FIR filter period is 36254 hardware samples or 1.2084667 seconds. This results in gaps of 1.21 seconds.

Table 8-3 System clock correction options

Option	Description	Advantages	Disadvantages
Slow coarse lock	A time correction is performed in a multiple of the output sample period when the time error between the Taurus and GPS time is greater than 2/3 the output sample period. For example, for a100 Hz sample rate, the time correction is performed in multiples of 10ms when the time error exceeds 6.67ms. Before digitizing has started, the time corrections are performed in multiples of 100µs to minimize the time error.	All output samples are UTC aligned. Fewer time corrections are performed in this mode than any other because the threshold is much higher. No hardware samples are discarded during a time correction so that the last sample before the time correction is still exactly one sample period before the first sample afterwards.	Might require several hours in coarse lock mode to slowly correct some time errors, especially when using low primary sample rates. Time errors of up to 6.66ms between the Taurus and GPS time might occur when sampling at 100Hz. Might not be suitable on an NMXBus with multiple Digitizers where simultaneous sampling of all channels is required at all times.
No alignment	A time correction is performed in a multiple of 100µs when the time error between the Taurus and GPS disciplined clock exceeds 100 µs. When first starting to digitize, after powering on or after a reboot, the output samples are UTC aligned.	Very low maximum time error (100 µs) between the Taurus and GPS time. Very little time is spent in the coarse lock mode so that time error between the Taurus and GPS time is brought under 1.25µs very quickly. No hardware samples are discarded during a time correction, so that the last sample before the time correction is still exactly one sample period before the first sample afterwards.	UTC alignment is not preserved after a time correction, therefore the actual phase of the output samples in the output sample interval is not always the same. For example, when sampling at 100Hz after performing a time correction of -1.1ms, the first sample output in each second is time stamped as xx.0089 instead of xx.0000. Not suitable for networks where simultaneous sampling is required.

8.3.1.2 System Clock Battery Backup

The Taurus system clock has a battery backup for power outages. The battery can hold its charge and keep the current system time for approximately three months. If you plug it back into a power source after three months, the Taurus will display the date as 1970 and the system clock battery will need to be recharged.

You can recharge the system clock battery by keeping the Taurus plugged into a power source. The battery will be fully recharged after 4 days. To acquire the current system time, you have to connect the GPS antenna to the Taurus. The Taurus will automatically acquire the current system time when it locks to the GPS.

8.3.2 Digitizer Timing Settings

Table 8-4 Timing settings

Setting	Description
Resynchronization mode	Defines how the Taurus makes a time error correction: ◆ Discard Samples ◆ Slow Coarse Lock ◆ No Alignment The default resynchronization mode is Discard Samples.
Require good time	Select this option if you want good time quality (that is, GPS lock) to be required before the Taurus starts digitizing data. By default, this option is not selected.

8.4 Digitizer Front End Settings

Table 8-5 Front end settings

Setting	Description
Input range, diff p-to-p [V]	The input voltage ranges represent the differential between the sensor positive and negative signal inputs, in volts peak-to-peak. The maximum input range is 40 volts peak-to-peak. This represents the case of a differential input signal that at one peak has +10 V on the positive input and –10 V on the negative input (20 V peak). At the other peak, the differential input is –20 V, for a peak-to-peak input range of 40 V. • If you want to accurately measure full-scale sensor activity, the input range of the sensor must be greater than the maximum output level of the sensor. However, if the sensor has a very large dynamic range and the Input Range is set to a large value (to capture full-scale movement), accuracy will be lost when measuring very weak seismic signals. • If you want to accurately measure very weak seismic signals, the input range of the sensor must be set to a small enough value to accurately digitize weak signals. If strong seismic events occur that exceed the configured range, these signals will be clipped. Increased sensitivity (lower input ranges) also tend to increase overall data volume. For example, a 3-channel 100 sps configuration might generate 3000 bps of sampled data. If the same system is reconfigured with much greater sensitivity, the increased signal activity might cause the average data throughput to rise to 6000 bps or more. The default setting is 40. **Note:** An input range of 40 V_{pp} is not supported when both high input impedance and normal common mode range are selected.

Table 8-5 Front end settings

Setting	Description
Input impedance	Low input impedance mode (43.07kΩ) has the best immunity to noise pickup and is the preferred mode when using active sensors. High input impedance mode (>9MΩ) is provided for use with some passive sensors that require a damping load shunt resistor which is higher than the Taurus low input impedance. If the required load resistor is lower than the Taurus input impedance, you can use the Taurus in low impedance mode by choosing a shunt resistor that, in parallel with the Taurus input impedance, achieves the desired load shunt value. Alternatively, you can put the Taurus in high input impedance mode to use the load shunt resistor value specified by the passive sensor directly. In low input impedance mode, the Taurus input impedance forms a voltage divider with the output impedance of the source signal so that a 436Ω source, for example, would result in a 1% decrease in signal amplitude at the Digitizer. The exact signal amplitude is as follows: $Taurus\ Input = R_i / (R_s + R_i) \cdot Sensor\ Output$ where R_i is the Taurus input impedance and R_s is the total source impedance (both sides of the differential source output plus both conductors of the sensor-to-digitizer cable). The voltage divider effect is negligible when using high input impedance mode, where attenuation is less than 0.1% for source impedance up to 9kΩ. The default setting is Low. **Note:** High input impedance is not supported when both normal common mode range and an input range of $40V_{pp}$ are selected.
Common mode range	In normal common mode, the rejection range is ±0.78 V and the clip level for ground-referenced single-ended signals is ±1.56 V. In extended common mode, the rejection range is ±1.8 V and the clip level for ground-referenced single-ended signals is ±3.6 V. This is provided for use with sensors that have single-ended outputs referenced to ground or where unusually high common mode signals must be rejected. This mode consumes approximately 40 mW of additional power. The default setting is Normal. **Note:** Normal common mode range is not supported when both high input impedance and an input range of $40V_{pp}$ are selected.
Enable dither	The Enable Dither option adds a very small random signal to the input signal of the Digitizer at an amplitude low enough that the dynamic range of the Digitizer is not reduced. This is done to virtually eliminate so-called idle tones. Idle tones are a phenomenon that might occur only when the input is held to zero (or pure DC) so that the least significant bit of the Digitizer output can flip around in a quasi-periodic pattern. Idle tones seen on Taurus when dither is turned off have virtually no energy, are not indicative of a malfunction, and are not present when recording real data. Selecting the Enable Dither option consumes approximately 10 mW of additional power. By default, this option is not selected.

Table 8-5 Front end settings

Setting	Description
Software gain	You can set the Digitizer gain to attenuate or amplify the sensor input signal to a level that will optimize the use of the Digitizer dynamic range. After the Taurus digitizes the signal, it multiplies the amplitude by the software gain value. The default setting is 1.0 (that is, no change in amplitude). This setting can be used to adjust the sensitivity of a station to match a desired value. For example, if a specific site has a sensitivity of 0.8 cnt/(nm/s^2) and you want all stations in the network to have a sensitivity of 1 cnt/(nm/s^2) you can set the Software Gain in this station to 1.25. You can normalize the sensitivity of each station by adjusting the Software Gain or you can choose to create a different baseband response file (a seed.rsp file) for each station and use this file during data analysis at the central site. Enter a number between 0.001 and 100.
Enable hard clip	A sigma-delta convertor output can transition sharply overscale if the input signal is near or exceeds the full scale input range, creating spikes in the output (that can also transition down into the range). The Enable Hard Clip option cuts off the spikes that exceed the expected full scale limit by replacing samples that are over-scale with the specified limit. The effect of the Digitizer output spiking at full scale might still be evident even with hard clipping on as these spikes can also transition down within the normal operating range of the Digitizer even though the input is at or above full scale. By default, this option is not selected.

8.5 Digitizer Trigger Settings

Set the detector and filter settings as appropriate for your site and application using the options on the Configuration > Digitizer > Triggers pages.

The Taurus can be configured to detect events using a LTA/STA trigger algorithm on one or more of the 3 primary time series data channels. You can define a trigger algorithm for each channel and enable or disable trigger detection for any channel. Each time series channel is associated with the same detector type identifier: channel 1, detector 1; channel 2, detector 2; and channel 3, detector 3. Each channel will filter the data using the trigger band-pass input filter before passing data to the detector.

Trigger information can also be extracted to a .csv file or streamed in the NP format (for more information, see Section 15.2 "Extracting State of Health Data" on page 109 or Section 11.1 "Streaming Data in the NP Format Using UDP or HTTP" on page 71).

You can enable triggers for inactive channels (see the Output Channels setting) although there will not be any associated data for any triggers that are detected. This could be used to define event information for a Time Series By Event retrieval on a different Taurus.

- Ensure that DC is filtered out for trigger detection. If you do not have the DC Removal filter enabled for your seismic channels, you must include a high pass filter in the trigger input filter.
- The valid value ranges for some of the settings depend on the primary sample rate (see Table 8-6 "Input filter settings" on page 54 and Table 8-7 "Detector settings" on page 55).

- Ensure that the Trigger on ratios are not so high that they will prevent events from ever triggering. The Trigger On Ratio setting is on the Configuration > Digitizer > Triggers > Detector *n* page.
- Ensure that the input range is configured so that the channels will not clip on signals for which triggers are expected to be detected. The Input Range setting is configured on the Configuration > Digitizer > Front End page.
- If you want to simulate an amplitude threshold trigger, you can use a short STA time constant and a long LTA time constant.

There are various external sources of information on defining trigger parameters in general. For example, the New Manual of Seismological Observatory Practice (IASPEI 2002) provides an excellent discussion of this topic.

8.5.1 Trigger Packets

The Taurus creates a trigger channel with a data packet for the start and end of each trigger detected. The trigger end packet is identical to the trigger start packet except that it includes the duration. You can extract the trigger data as SOH information to a `.csv` file (see Section 15.2 "Extracting State of Health Data" on page 109) or stream it in the NP format (see Section 11.1 "Streaming Data in the NP Format Using UDP or HTTP" on page 71). A trigger packet contains the following information:

- Trigger start time
- Trigger duration in ns (only in trigger end packet)
- Channel and detector identification
- STA at trigger detection
- LTA at trigger detection
- Votes

8.5.2 Input Filter

The trigger input filter is applied to the time series data at the primary sample rate before it is used for Detectors 1, 2, and 3.

Table 8-6 Input filter settings

Setting	Description
High pass order	The order of the high pass filter Select a number from 0 to 5. The default setting is 0. **Note:** The High pass order plus the low pass order has to be ≤ 5.
High pass frequency [Hz]	The 3dB corner frequency in hertz of the high pass filter Enter a decimal number where $0.000001 < \frac{f}{sampleRate} < 0.499999$. The default setting is 0.001.
Low pass order	The order of the low pass filter Select a number from 0 to 5. The default setting is 0. **Note:** The Low pass order plus the high pass order has to be ≤ 5.

Table 8-6 Input filter settings

Setting	Description
Low pass frequency [Hz]	The 3dB corner frequency of the low pass filter Enter a decimal number where $0.000001 < \frac{f}{sampleRate} < 0.499999$. The default setting is 1.0.

8.5.3 Detectors

You can configure a trigger detector for each of the enabled primary channels:

- Detector 1 = Channel 1
- Detector 2 = Channel 2
- Detector 3 = Channel 3

Table 8-7 Detector settings

Setting	Description
Enable channel *n*	Select this option to enable a detector for the channel. By default, this check box is not selected.
STA time constant *n* [s]	The short term average time constant (TC) in seconds Choose a value longer than a few periods of a typical expected seismic signal of interest, shorter than expected durations of events of interest, and not so short that excessive false triggers are generated by non-seismic noise spikes near the site.) Enter a decimal number where $0.000001 < \frac{\left(\frac{1}{2\pi \cdot TC}\right)}{sampleRate} < 0.499999$. The default setting is 1.
LTA time constant *n* [s]	The long term average time constant (TC) in seconds Choose a value long enough to encompass at least several cycles of typical non-seismic, irregular noise for the site. Enter a decimal number where $0.000001 < \frac{\left(\frac{1}{2\pi \cdot TC}\right)}{sampleRate} < 0.499999$. The default setting is 5.
Trigger on ratio *n*	The STA/LTA threshold above which the associated channel is triggered. Choose a value low enough to be sensitive to events of interest but high enough to minimize false triggers. Enter a decimal number where 0 < *Trigger Off Ratio* < *Trigger On Ratio*. The default setting is 5.
Trigger off ratio *n*	The STA/LTA threshold below which the associated channel trigger is switched off. Choose a value low enough to encompass the coda waves for events of interest but high enough to terminate the trigger reasonably. The trigger terminates either when the Trigger Off Ratio is achieved or when the Maximum Duration has expired. Enter a decimal number where 0 < *Trigger Off Ratio* < *Trigger On Ratio*. The default setting is 1.

Table 8-7 Detector settings

Setting	Description
Maximum duration *n* [s]	The maximum duration in seconds of a trigger After this time period has expired, the trigger is ended even if the Trigger Off Ratio has not been achieved. Enter a decimal number from 0.001 to 3600. The default setting is 3600.
Latch LTA *n*	If you select this option, the LTA is held at the value when the channel triggered and is not updated while the channel is triggered. If you do not select this option, the LTA continues to be calculated and updated while the channel is triggered. In both cases, the trigger terminates either when the Trigger Off Ratio is achieved or when the Maximum Duration has expired. By default, this option is selected.
Votes *n*	The number of votes assigned to each channel that it can cast towards getting an event triggered. You can enter any number between 0 and 100. The higher the number of votes, the greater the impact that the channel has on event triggering. To ensure proper event triggering, you should give zero votes to a channel that you do not want to affect the event triggering at all and a lower number of votes to channels at noisy stations. The default setting is 10.

Chapter 9
Controlling and Configuring Sensors

Page:	Configuration > Calibration Configuration > Sensor Library
Log on required:	Yes

9.1 Sensor Configuration Considerations

Before a sensor can be calibrated, the Taurus must be properly configured for the installed sensor.

1. Configure the Taurus for the installed sensor either by selecting a default sensor configuration or by creating a new one.
2. Go to the Configuration > Calibration page and configure the
   - Type of calibration.
   - Waveform parameters.
   - Channels to be calibrated.

9.2 Controlling Sensors

You can control some aspects of sensor operation using the buttons on the Sensor page:

- Not all buttons are visible for all sensor types.
- Specific sensor control line settings are required to make some of the buttons visible.

Buttons	Description	Sensor control line setting
	Shows the settings for the sensor. You can change the settings of all custom sensors but you cannot change the settings of any of the default sensor configurations. **Note:** This button is located beside the sensor name, at the top of the screen.	None required
	Opens the Web interface for the Nanometrics smart sensor (see Section 9.4 "Detecting a Nanometrics Smart Sensor" on page 61). This button is displayed to the left of the sensor name when a Trillium smart sensor is connected. **Warning:** The Web interface of Nanometrics smart sensors should not be accessed when the highest quality seismic signal is desired as communication with the sensor can cause low levels of noise on the analog output signals of the sensor.	None required

Buttons	Description	Sensor control line setting
	Click to discover a newly connected and configured Nanometrics smart sensor (see Section 9.4 "Detecting a Nanometrics Smart Sensor" on page 61).	None required
Centre	Centres all masses. **Note:** This option can only be used for sensors that support remote mass centring (for example, Trillium 240 and Trillium 120PA).	One sensor control line must be set to Mass Centre.
Lock	Locks all masses.	One sensor control line must be set to Mass Lock.
Unlock	Unlocks all masses.	One sensor control line must be set to Mass Unlock.
	Turns the power to the sensor on and off. When you turn the sensor on, the Taurus supply voltage is passed through to the sensor power pin (see Chapter 18 "Connector Pinouts"). **Note:** For sensors that require regulated power, an appropriate DC/DC convertor must be built into the sensor cable.	None required
	Starts the calibration of the sensor. The sensor is calibrated based on the settings configured on the Configuration > Calibration page.	One or more sensor control lines must be set to Cal Enable.
	Stops the calibration of the sensor.	One or more sensor control lines must be set to Cal Enable.
	Shows the settings for the sensor calibration. You can change these settings as required. **Note:** This button is located beside the Stop calibration button .	One or more sensor control lines must be set to Cal Enable.
SP	Sets the sensor to Short Period mode. By default, the sensor is set to Long Period mode. **Notes:** When a sensor is in Short Period mode, the button changes to LP and you can use it to put the sensor in Long Period mode.	One sensor control line must be set to one of the following: • SP/LP On=SP • SP/LP On=LP
UVW	Sets the orientation of the sensor elements to UVW (raw axis output) mode. The calibration is run separately on each channel in this mode. By default, the sensor is set to XYZ mode. **Note:** When a sensor is in UVW mode, the button changes to XYZ and you can use it to put the sensor in XYZ mode.	One sensor control line must be set to one of the following: • XYZ/UVW On=XYZ • XYZ/UVW On=UVW

9.3 Configuring Sensors

The Taurus ships with default sensor configurations that you can use as the configuration for your sensors. These default sensor configurations are listed on the Sensor Library page (Configuration > Sensor Library):

A sensor configuration contains the mode, power, voltage, sensitivity, control line, and calibration settings for a sensor. You can select the blue, hyperlinked name of a sensor configuration to view its settings. You cannot edit the settings of any of the default sensor configurations but you can edit the settings of any custom sensor configurations or create a copy of one of the default sensor configurations and edit it. For more information, see Section 9.3.1 "Editing Custom Sensor Configurations" on page 59.

The sensor configuration that is currently active is shown beside the name of the Taurus (or Trident) at the top of the Sensor Library page.

You can change the active sensor configuration by selecting a new sensor configuration from the list. You can select, create, edit, and delete sensor configurations on the Configuration > Sensor Library pages.

9.3.1 Editing Custom Sensor Configurations

You can edit the settings of any custom sensor configuration you create.

To edit a custom sensor configuration

1. Select **Sensor Library** on the Configuration page.
2. Select the name of the custom sensor configuration you want to edit.
3. Edit the following settings as required:

Setting	Description
Sensor Name	The name of the sensor configuration. This is the name that appears on the Sensor Library page.
SP/LP Mode	The default operating mode of the sensor: short period (SP) or long period (LP).
XYZ/UVW Mode	The default orientation of the sensor elements: XYZ or UVW UVW indicates a symmetric triaxial seismometer.
Calibration Mode	The calibration signal mode: Voltage or Current. Refer to your sensor manual for information on which signal mode you should choose.
Needs Power	Select this option if the sensor needs power (active sensors). Do not select it for passive sensors that do not require power.
Sensitivity Units	Refer to your sensor manual for the appropriate value: V/(m/s) or V/(m/s^2).
Sensitivity Value	Refer to your sensor manual for this value.

9.3.2 Configuring Sensor Control Lines

The default values are for a Trillium Compact seismometer. Refer to your sensor manual for the appropriate values for your seismometer.

Table 9-1 Sensor control line settings

Setting	Default Setting
Assert (On) Level	The assert line level
Deassert (Off) Level	The deassert line level
Positive Voltage Level	+5V **Note:** The tolerance of these voltage levels is +/-10%.
Pulse Duration [s]	The control pulse duration in seconds
Control Line 1 (pin H)	XYZ/UVW On=UVW
Control Line 2 (pin W)	SP/LP On=SP
Control Line 3 (pin G)	Unused Deassert
Control Line 4 (pin Z)	Ch 1 Cal Enable **Note:** If you selected Current as the Calibration Mode (see Section 9.3.1 "Editing Custom Sensor Configurations" on page 59, this control line will not be available for any other configuration option. It will be reserved for calibration current return.
Control Line 5 (pin c)	Ch 2 Cal Enable **Note:** See note for Control line 4 (pin Z).
Control Line 6 (pin Y)	Ch 3 Cal Enable **Note:** See note for Control line 4 (pin Z).

9.3.3 Configuring Auto Mass Centring Options

You can configure the Auto Mass Centring options to initiate mass centring attempts when sensor mass positions reach off-centre thresholds. You can set thresholds for a delayed or an immediate recentring attempt (yellow and red thresholds respectively) and set the number of retries and retry intervals to achieve centred masses. You must have a control line configured for Mass Centre and have at least one of the following thresholds enabled:

- Auto Centre on Yellow – The Taurus will initiate mass centring when any axis has been above the Yellow Threshold for more than the Yellow Holdoff Time. If all axes drop below the Yellow threshold during holdoff time, then the holdoff time is cancelled.
- Auto Centre on Red – The Taurus will initiate mass centring 1 minute after any axis exceeds the Red Threshold.

Each mass centring attempt is comprised of the configured number of retries at the configured retry interval. Retries will be attempted until all axes are below the yellow threshold or until the number of retries per Auto Centre have been executed.

You can only configure Auto Mass Centring options for the following Nanometrics seismometers: Trillium 120PA and Trillium 240.

The Sensor page shows the status of the mass position (see Section 9.2 "Controlling Sensors" on page 57).

Table 9-2 Mass auto-centring settings

Setting	Description
Red Threshold [V]	The minimum voltage level used to indicate that the mass position is out of range. Mass centring is initiated one minute after this level is crossed for any sensing element. The threshold range is from negative to positive, for example 1 indicates –1 to +1. Enter a number that is equal to or higher than 0.001 and greater than the yellow threshold (if used). **Note:** If you use both the red and the yellow thresholds, ensure that you set the yellow threshold as the lower mass position limit and the red threshold as the higher mass position limit (red >= yellow).
Auto-Centre on Red	Select this option if you want the Taurus to initiate mass centring when the Red Threshold is crossed. By default, this option is not selected.
Yellow Threshold [V]	The minimum voltage level used to indicate that the mass position is marginal. Mass centring is initiated after the Yellow Holdoff Time has expired. The threshold range is from negative to positive: for example, 1 indicates –1 to +1. Enter a number that is equal to or higher than 0.001 and lower than the red threshold (if used).
Auto-Centre on Yellow	Select this option if you want the Taurus to initiate mass centring when the Yellow Holdoff Time expires. By default, this option is not selected.
Yellow Holdoff Time [h]	The number of hours the Taurus waits when any mass position voltage is higher than the yellow threshold but lower than the red threshold before initiating mass centring. Enter a number between 0.1 and 72.
Retries per Auto-Centre	The maximum number of attempts the Taurus makes to centre the masses. Enter an integer between 0 and 20.
Retry Interval [min]	The number of minutes the Taurus waits between trying to automatically centre the masses again. Enter an integer between 1 and 20.

9.4 Detecting a Nanometrics Smart Sensor

When you connect a Nanometrics smart sensor, such as a Trillium Compact or Titan, and configure it through the **Sensor Library** (see Section 9.3 "Configuring Sensors" on page 59), you can easily detect it, load the sensor details, and create a portal into its Web interface using the **Discover** button on the **Sensor** page. After connecting and configuring the sensor, simply click the **Discover** button and the Nanometrics smart sensor details will load. Click the sensor icon to the left of the sensor name to open the Web interface for the sensor.

The Web interface of Nanometrics smart sensors should not be accessed when the highest quality seismic signal is desired as communication with the sensor can cause low levels of noise on the analog output signals of the sensor.

9.5 Configuring Sensor Calibration

You can configure the settings that are used to calibrate the sensor on the Configuration > Calibration page.

(1) If you selected Current as the Calibration Mode (see step 3 of Section 9.3.1 "Editing Custom Sensor Configurations" on page 59), control lines 4, 5, and 6 will not be available for any other configuration option. They will be reserved for calibration current return.

(2) If a sensor has one calibration enable line and multiple calibration signal inputs (for example, STS-2), you might have to reconfigure the calibration channel each time to calibrate a different channel, depending on the cable design.

To ensure that the sensor calibration is configured properly, the cable design should be taken into consideration.

To configure sensor calibration settings

1. Select **Calibration** on the Configuration page.

You can also select the Configure calibration button on the Sensor page to view and edit the calibration settings.

2. Configure the following settings as required:

Setting	Description
Calibration name	The name of the calibration This name appears in the configuration change history file that you can download. For more information, see Section 6.6 "Viewing Configuration Change History" on page 39.
Calibration type	The type of calibration signal generated by the Taurus: Sine, Pulse, or PRB. The default setting is Sine.
Attenuation	The value used to attenuate the calibration signal. You can use attenuation to select the range when lower amplitude signals are desired. For example, a more accurate 5 mV signal is generated by selecting attenuation of 1000 and amplitude 5V, rather than attenuation of 1 and amplitude 0.005 V. The default setting is 1.
Amplitude	The amplitude of the calibration signal in volts or amperes The units depend on the configured Calibration Mode (Voltage or Current). You can enter a value up to 5.0 V or 60 mA. If taken as a single-ended output (for example, between pin N (SEN_CAL1+) and pin V (DGND), the calibration circuit can provide a signal with a maximum amplitude of 4.5 V. The default setting is 0.1. **Notes:** ◆ Ensure that you choose a value low enough that the signal will not clip. If you have configured the Calibration Mode as Voltage, ensure that you know the calibration coil resistance. ◆ See step 3 of Section 9.3.1 "Editing Custom Sensor Configurations" on page 59 for information on how to configure the Calibration Mode.

Setting	Description
Wait time [s]	The length of time in seconds that the Taurus waits after the calibration coil has been enabled before it starts the calibration signal. The default setting is 0.
Ramp duration [s]	The length of time in seconds the Taurus uses to bring the signal amplitude up to and down from the configured amplitude using a sine squared ramp. The default setting is 0. **Note:** The ramp duration is usually set to 0 for pulse and PRB signals.
Duration [s]	The length of time in seconds during which the Taurus applies the full amplitude calibration signal to the sensor at the configured amplitude. The default setting is 60.
Sine frequency [Hz]	The sine signal frequency in hertz Enter a number between 0.01000 and 50.0000. The default setting is 1.0. **Note:** This setting is ignored for pulse and PRB signals.
Pulse duration [ms]	The pulse signal width in milliseconds. The default setting is 1000. **Note:** This setting is ignored for sine and PRB signals.
PRB pulse width	The PRB (Pseudo-Random Binary) signal unit pulse width in milliseconds The default setting is 1000. **Note:** This setting is ignored for pulse and sine signals.
Enable channel 1	Select this option if you want channel 1 enabled for calibration.
Enable channel 2	Select this option if you want channel 2 enabled for calibration.
Enable channel 3	Select this option if you want channel 3 enabled for calibration.

9.5.1 Performing a Calibration

To calibrate a sensor

1. Click and select **Sensor** from the main menu. (Web browser)

   -OR-

   Press the keys to open the main menu and select the **Sensor** page. (display screen)

2. Select the Start calibration button .

   The time it takes a calibration to run depends on the calibration settings. The total run time consists of the wait time + ramp duration + duration. For example, if wait time is set as 120 seconds, ramp duration is set as 120 seconds, and duration is set as 120 seconds, then the total calibration run time is 360 seconds. For more information, see Section 9.5 "Configuring Sensor Calibration" on page 62.

3. If required, you can stop the calibration before it has finished running by selecting the Stop calibration button .

Chapter 10

Changing General and Channel Naming Settings

Page:	Configuration > General Configuration > Channel Naming
Log on required:	Yes

10.1 Changing General Taurus Settings

Table 10-1 General settings

Setting	Description
Running Mode	The operating mode of the Taurus For more information, see Section 5.4 "Selecting the Running Mode" on page 31.
SOH Report Interval [s]	The SOH sampling rate in seconds, including some internal SOH and the four External SOH channels Enter an integer from 5 to 3600. The default setting is 60.
ARM Log Verbosity	The level of detail of the ARM log: ◆ Info – All errors, warnings, and minimal system status information ◆ Verbose – All error, warnings, and more detailed system status information ◆ Debug – All errors, warnings, and extensive system status information The default setting is Info. **Note:** You should only select Debug as the logging level if you were instructed to do so by Nanometrics Technical Support.
GPS Duty Cycle Mode	The GPS receiver duty cycle ◆ Always On – Always On will use approximately an additional 200mW but will provide the most accurate timing. Since GPS time is always available, System Time can always be kept close to UTC such that the time error of the Taurus is typically not more than a few microseconds. ◆ Automatic – Automatic is the most efficient setting for Taurus power consumption. The duty cycling strategy is that the GPS receiver is switched on until fine lock is reached in the system clock then switched off until the estimated time uncertainty reaches a predefined limit such that the expected time error is still less than the 100µs specification. The uncertainty estimate is based on clock drift and temperature measurements. ◆ Every 10 minutes | Every 30 minutes – You can use a constant duty cycle, either every 10 minutes or every 30 minutes. You should verify that the time error does not exceed your requirements when the GPS receiver is switched back on after these time intervals. Use the GPS Time SOH file to inspect the time error. The default setting is Automatic.

Table 10-1 General settings (Continued)

Setting	Description
Minimum Tridents	The minimum number of Tridents that the Taurus expects to detect. **Note:** If the number of detected Tridents is less than this value, both the Tridents status bar on the Status Details page and the SuperLED are red.
Retrieval Mark	The date and time the last data was retrieved by Apollo Project for a Field Archive project. Apollo Project automatically stores this date in the Taurus after it retrieves data for a Field Archive project and uses it as the starting point for a future data download. The Retrieval Mark box is blank if Apollo Project has not been used to download data from a Taurus for a Field Archive project. You can delete the date if you want Apollo Project to download all of the data from the start of the project the next time you run a Field Archive project. You can also change the date if you only want data downloaded from a specific point in time. **Note:** This setting is only used by Apollo Project for Field Archive projects. If you do not use Apollo Project or Field Archive projects, you can ignore this setting. For more information on data retrieval and Field Archive projects, see the Apollo Project User Guide.
UI Timeout [min]	The time delay in minutes before the Taurus shuts down the display screen and, when in Buffered mode, before the Controller, including the Web server, shuts down. The default setting is 10. **Note**: This setting is overridden by UI activity and data downloads as described in Section 5.5 "Setting the UI Timeout" on page 33.
UI Auto Refresh	Select this option to allow the UI to refresh automatically. By default, this option is selected.
Apollo Log Verbosity	The level of detail of the Apollo log: ◆ Info – All errors, warnings, and minimal system status information ◆ Verbose – All error, warnings, and more detailed system status information ◆ Debug – All errors, warnings, and extensive system status information The default setting is Info. **Note:** You should only select Debug as the logging level if you were instructed to do so by Nanometrics Technical Support.

10.2 Configuring Channel Naming Settings

The channel naming settings are used by the Taurus for two different purposes:

- Data Archiving/Data Retrieval – The channel naming settings are used in the file headings and default file names for all types of archived/retrieved data. They act as labels to help you identify the data. For more information, see Chapter 12 "Recording MiniSEED and SOH Data Files" and Chapter 13 "Retrieving Time Series Data from the Store".
- Filtered Streaming – When you configure the Taurus to stream data, you have the option to define an SCNL-based filter to limit what channels are streamed. The Taurus refers to the channel naming settings when it performs the filtering. For more information, see Chapter 11 "Streaming and Receiving Data".

You can also change the channel naming settings for a specific data extraction by selecting the **Choose Channel Naming** link on the Data Retrieval pages. For more information, see Chapter 13 "Retrieving Time Series Data from the Store".

10.2.1 Changing the Channel Naming Settings

1. Select **Channel Naming** from the Configuration page.
2. Change the following settings for the Taurus as required:

Setting	Description
Network code	A two character alphanumeric code that represents the network that the Taurus belongs to. The default network code is XX.
Station code	A five character alphanumeric code that represents the station where the Taurus is located. **Note:** If you specify a station name other than the default name (STN01), it is displayed in the upper, right corner of the page next to the Taurus serial number (ID). Example: A0737 ID: 737 The default station code is STN01.
Time series location code (1-3)	A two character alphanumeric code that represents the location of the Taurus and up to two attached Trident 305s. The location code is optional and this field is blank by default.
Channel *n* code	A three character alphanumeric code that represents each of the time series data channels. The default channel codes are as follows: ◆ Channel 1 – HHZ ◆ Channel 2 – HHN ◆ Channel 3 – HHE
Taurus SOH code	A two character alphanumeric code for the location and a three character alphanumeric code for the channel that represents the SOH for the Taurus. The two codes have to be separated by a dot. Example: D0.SOH The default SOH codes are as follows: ◆ Taurus – D0.SOH ◆ First attached Trident 305 – D1. SOH ◆ Second attached Trident 305 – D2.SOH

3. If applicable, select the links at the bottom of the Channel Naming page to define the channel naming settings for the attached Trident 305s.

   The default channel codes for the Trident 305s are as follows:
   - Channel 4 – HNZ
   - Channel 5 – HNN
   - Channel 6 – HNE
   - Channel 7 – HLZ
   - Channel 8 – HLN
   - Channel 9 – HLE

   The default SOH code for the first attached Trident 305 is D1. SOH and the default SOH code for the second attached Trident 305 is D2.S0H.

4. Select **Apply**.

5. Select **Commit** when you have finished defining the Channel Naming settings for all applicable devices.

Part 3

Streaming, Receiving, Recording, and Retrieving Data

Chapter 11
Streaming and Receiving Data

Page:	Configuration > Data Streaming Configuration > NP UDP Receiving
Log on required:	Yes

11.1 Streaming Data in the NP Format Using UDP or HTTP

You can configure the Taurus to stream time-series data, SOH data, triggers, and alerts to one or more data acquisition servers, such as Apollo Server. The data is streamed in the NP format using a User Datagram Protocol (UDP) socket or a Hypertext Transfer Protocol (HTTP).

To stream data in the NP format

1. Select **Data Streaming** on the Configuration page.
2. Select **NP UDP Streaming**.

   -OR-

   Select **NP HTTP Streaming.**
3. Select the New Item button to create a new streamer.

   You can create and configure an unlimited number of streamers.

4. Configure the following settings as required:

Setting	Description
Name	The name of the streamer This name appears on the NP UDP Streaming/NP HTTP Streaming page and you can select the name to edit the settings of the streamer.
Enable	Select this option to enable the streamer to stream data. By default, this check box is not selected.
Stream time series	Select this option to stream time series data.
Stream environmental SOH	Select this option to stream environmental SOH data. Environmental SOH for the Taurus includes the following data: • Voltages • Temperature • External SOH • Sensor SOH • Timing information
Stream system SOH	Select this option to stream system SOH data. System SOH for the Taurus includes the following data: • Store statistics • Data acquisition statistics
Stream triggers	Select this option to stream triggers. You can configure trigger settings by selecting Configuration > Digitizer > Triggers. For more information, see Section 8.5 "Digitizer Trigger Settings" on page 53.
Stream alerts	Select this option to stream alerts generated by the Taurus for events such as start-ups, shut downs, and major errors. Alert messages include a time stamp and a brief description and you can view them on the Alerts page.

Setting	Description
Channel list	After you have selected the type of data you want the Taurus to stream, you have the option to use a filter to specify exactly which channels the Taurus streams. The filter is a comma-separated list of the SCNL (Station, Channel, Network, and Location) names of the channels you want streamed. The network, station, location, and channel codes used in the SCNL list are defined in the Channel Naming settings. For more information, see Section 10.2 "Configuring Channel Naming Settings" on page 66. You can use an asterisk (*) to represent one or more characters in a channel name and an exclamation point (!) to exclude a network, station, location, or channel. The exclamation point always has to be placed before the SCNL element that should be excluded. The format for specifying SCNL elements in a filter is NN.SSSSS.LL.CCC, where NN is the network code, SSSSS is the station code, LL is the location code, and CCC is the channel code. The S, C, and N elements must be represented in the filter and each element must be separated by a dot (.). The L (Location) element is optional. Examples: a) Data is streamed for all of the channels in the XX network • XX.*.*.* b) Data is streamed for all of the Z channels in the XX network • XX.*.*.*Z c) Data is streamed for the specified channel • XX.STN01.LO.BHZ d) Data is not streamed for any of the channels in the XX network • !XX.*.*.* e) Data is streamed for all of the channels in the XX network and all of the channels from STN01 in the YY network • XX.*.*.*,YY.STN01.*.* f) All SOH data is streamed for the XX network (if all SOH channels are called SOH) • XX.*.*.SOH **Notes:** ◆ The maximum length of each SCNL element is as follows: • Network name — A two character alphanumeric code. • Station name — A five character alphanumeric code. • Location name — A two character alphanumeric code. • Channel name — A three character alphanumeric code. ◆ If you do not want to filter the data, type an asterisk (*) into the box. A single asterisk means that all available data will be streamed.
IP Address	The valid IP address of the streaming destination in dotted decimal format -OR- A valid multicast IP address The first octet of a valid multicast IP address must be between 224 and 240, inclusive. Each of the last three octets can be any positive integer from 0 to 255. **Note:** The Naqs.ini file must be configured to listen for this multicast address. For more information, see the NAQSServer User Guide.

Setting	Description
Port #	The port number used by Taurus to stream data in the NP format. The default port is 32004. **Note:** If you are streaming to Apollo Server, ensure that the Apollo Server UDP receiver is configured to listen to this port number.
ReTx Strategy	Defines the manner in which requests to retransmit data are prioritized and processed. ◆ First-Come, First-Served – ReTx requests are processed in the order received. ◆ Oldest Data First, with Recent Data Threshold– ReTx requests are processed in chronological order based on the data time (oldest first) except for requests for data newer than the configured ReTx Recent Data Threshold, which are given highest priority. The default setting is Oldest Data First, with Recent Data Threshold.
ReTx Recent Data Threshold [min]	The time in which recent requests should be processed before the oldest requests are processed. The default setting is 5 minutes. **Note:** You only have to configure this setting if you selected Oldest Data First, with Recent Data Threshold as the ReTx Strategy.
Multicast TTL	If the streaming destination address is multicast, you can increase the Time-To-Live (TTL) of the packets by specifying the number of networks (routers) that the packet must cross to reach the destination. For example, if the packets have to cross five networks to reach the destination, you should set the Multicast TTL to 5. **Caution:** All of the routers must support the Time-To-Live feature. In some cases, this feature might be disabled for security reasons (Denial-of-Service attack).

5. Select **Apply**.
6. Configure the following additional settings for the streamer as required and then finish the remainder of the steps in this procedure:
   a) Throttle — Section 11.1.1 on page 75

      The throttle settings allow you to configure the maximum data output of the NP UDP/HTTP streamer, which is useful if you have a low-throughput link.

   b) Short Term Complete — Section 11.1.2 on page 75

      The short term complete settings allow you to configure the number of seconds the NP UDP streamer will wait to receive a missed packet before continuing to send data.

   c) Fragmentation — Section 11.1.3 on page 75

      The fragmentation settings allow you to configure the maximum packet size for routers that do not allow IP fragmentation.
7. Select **Commit** when you have finished configuring the NP UDP/HTTP streamer.

11.1.1 Throttle

If you have a low-throughput link, the throttle settings allow you to configure the maximum data output of the streamer.

Table 11-1 NP Streamer throttle settings

Setting	Description
Enable Throttle	Select this option to set the maximum data output of the NP streamer.
Maximum Throughput [bps]	The maximum throughput in bits per second. The default settings is 38 400 bps.

11.1.2 Short Term Complete

If you want to ensure that the data packets are sent in chronological order, you can configure the streamer to wait a set amount of time for missed packets before sending any more packets.

Table 11-2 NP streamer short term complete settings

Setting	Description
Short term complete enable	Select this option to ensure that the NP streamer sends data in chronological order. If a packet is missed, the streamer will wait up to the set threshold time (**Short Term Complete Threshold [s]**) before sending any more packets. Once the threshold time is crossed, the streamer will send the next available packet and ignore the missed packet if it is received.
Short term complete threshold [s]	The number of seconds the NP UDP streamer will wait to receive a missed packet before continuing to send data. The default is 120 s. **Note:** This threshold value is only used if the **Short term complete enable** option is selected.

11.1.3 Fragmentation

This feature supports data paths with components that block packets larger than a particular threshold. For instance, if you are using a router that does not allow IP fragmentation, the fragmentation settings allow you to configure the maximum packet size.

Table 11-3 NP UDP Streamer fragmentation settings

Setting	Description
Enable Fragmenting	Select this option to set the maximum allowable packet size. If enabled, packets larger than the configured threshold will be broken into smaller packets.
Fragment Size [B]	The maximum packet size in Bytes.
Include CRC	Select this option if you want a cyclic redundancy check performed on each fragment to verify that the data is not corrupted.

11.1.4 Streaming Seismic Data in WIN Format

You can stream seismic data from a Taurus in WIN format.

WIN is a format for multi-channel earthquake waveform data. You can download WIN system code from http://eoc.eri.u-tokyo.ac.jp/WIN/Eindex.html and view instructions at http://eoc.eri.u-tokyo.ac.jp/WIN/show_man_index_en.html.

1. Select **Data Streaming** on the Configuration page.
2. Select **WIN Streaming** and edit the following settings as required:

Setting	Description
Stream WIN Packets	Select this option to stream data in the WIN format. By default, this check box is not selected.
UTC Offset [h]	The amount of time in hours that the time zone used in the WIN packets is offset from Coordinated Universal Time (UTC). The default setting is 9.
IP Address	The valid IP address of the streaming destination in dotted decimal format -OR- A valid multicast IP address The first octet of a valid multicast IP address must be between 224 and 240, inclusive. Each of the last three octets can be any positive integer from 0 to 255.
Port Number	The port number used by Taurus to stream data in the WIN format. The default port is 32005.
Max. Packet Bytes [B]	The maximum number of bytes in each packet The default setting is 1500.

3. Select an **Enable** check box for each of the channels you want to stream data for.
4. Enter a unique decimal or hexadecimal channel number for each enabled channel.

   The default channel number for WIN channel 1 is 0x0001.
5. Select **Apply**.
6. If you want to set the maximum data output of the WIN streamer because of a low-throughput link, select the **Throttle** link and go to step 7.

   -OR-

   Go to step 11.
7. Select the **Enable throttle** check box and enter the maximum throughput in bits per second.
8. Select **Apply**.
9. Select **Commit**.
10. Select **Previous** to return to the configuration page for the WIN streamer.
11. Select **Commit** when you have finished configuring the WIN streamer.

11.2 Acquiring Data in the NP Format

Taurus uses a configurable UDP data receiver to acquire data in the NP format from any Nanometrics data acquisition and communication instrument that uses the NP protocol.

1. Select **NP UDP Receiving** on the Configuration page.
2. Select the New Item button to create a new NP UDP receiver.
3. Change the following settings for the NP UDP receiver as required:

Table 11-4 NP UDP receiver settings

Setting	Description
Name	The unique name of the NP UDP receiver. This name appears on the NP UDP Receiving page and you can select the name to edit the settings of the receiver.
Enable	Select this check box to allow Taurus to acquire data from this receiver. Clear this check box to disable this receiver, stopping data acquisition from this source.
UDP Receiver Address	The IP address of the Taurus computer in dotted decimal format. -OR- A multicast IP address. The first octet of a multicast IP address must be between 224 and 240, inclusive. Each of the last three octets can be any positive integer from 0 to 255.
Port #	The port number used by the source to stream data. The default port is 32004. **Notes:** ◆ The port number used by Taurus to receive data cannot be the same port number that Taurus uses to stream data. ◆ The port number for each NP UDP Receiver must be unique.

4. Select **Apply**.
5. Select **Commit** when you have finished configuring the NP UDP receiver.

Chapter 12
Recording MiniSEED and SOH Data Files

Page:	Configuration > Data Archive
Log on required:	Yes

12.1 Recording MiniSEED and SOH Data

The Taurus Data Archive feature writes MiniSEED data files and, optionally, SOH data to a CompactFlash card formatted as FAT32, which can easily be transferred to a computer or laptop for immediate analysis.

Before this feature can be enabled, a FAT32 formatted CF card has to be inserted into the CompactFlash slot of the Taurus. If your Taurus currently has an ext3 formatted CompactFlash card in that slot, you need to use the Taurus CompactFlash Adapter to move the ext3 CF card to the IDE media slot so that you can insert an FAT32 CF card into the CompactFlash slot. The Taurus Store is written in ext3 format and the Taurus always has to have a Store even if it is in Communications mode and streaming data. For more information on the adapter, see Section 1.1.2 "Taurus CompactFlash Adapter" on page 4.

1. Follow the instructions in Section 3.4 "Installing Recording Media" on page 15 to insert a FAT32 formatted CF card into the CompactFlash media slot in the Taurus.
2. After the media has been installed successfully, select **Data Archive** on the Configuration page.
3. Select the **Enable Data Archive** check box to allow the Taurus to write MiniSEED data files to the FAT32 CF card.

   Each file contains multiple 512-byte MiniSEED records of waveform data for all live channels (1-9) and is stored in a folder named for the month and year it was recorded (YYYYMM). The format of the name of each MiniSEED data file is as follows:

   NE.STN.LO_YYYYMMDD_HHMMSS.miniseed

   The network, station, and location names are defined in the Taurus Channel Naming settings. For more information, see Section 10.2 "Configuring Channel Naming Settings" on page 66.

   Data from attached Trident305s is stored in their own MiniSEED files.
4. Select the amount of data in minutes to be written to each file.

   The number of 512-byte MiniSEED records contained in each file is determined by the duration you select here.
5. Select the number of output files to be generated: one file per channel or one file for all instruments.

The per channel option produces many small files, the all instruments option produces one large file.

6. If you also want SOH data files written to the FAT32 CF card, select the **Include SOH Archive** check box.

   The SOH data files are four separate files: Environment, GPS Time, GPS Satellites, and Instrument. The SOH files are stored in a subfolder of the MiniSEED YYYYMM folder called `soh`.

7. If you selected the option to archive SOH data, select the format for archiving the SOH files: NP Binary or CSV.

   You can use the Nanometrics tool SohConvert to convert NP binary files (.np) to .csv. For more information on SohConvert, contact your Nanometrics sales representative (see Contacting Nanometrics on page 159).

   Archiving SOH data as CSV is time consuming and requires long write cycles when operating in Buffered Mode. As such, considerably more power is consumed than when archiving MiniSEED data alone or when archiving SOH data in the NP binary format.

8. Click **Apply**.

9. Click **Commit**.

   No new files will be written to the CF card once it is full.

   You can monitor the status on the **Data Archive** page (see Section 14.8 "Viewing the Status of the Data Archive" on page 102).

You can also download the data archive files by clicking the link on the Data Retrieval and Data Archive pages or by using FTP. The files are located in `/var/archive`.

Chapter 13

Retrieving Time Series Data from the Store

Page:	Data Retrieval
Log on required:	No

13.1 Retrieving and Accessing Data

The Taurus records all time series data to the Store. You can extract data from the Store using the following data retrieval options:

- Retrieving data from the Store over an IP connection and saving it on your network:
  - Retrieving Time Series Data

    Time series data can be extracted in the following formats: MiniSEED, MiniSEED Sorted, ASCII, SEGY, Seisan, or SAC.
- Accessing Store Files on the Recording Media

One data retrieval request can be run at a time. Any subsequent retrieval requests will be processed when the current download is finished. You can run a data retrieval request at the same time as data is streaming to an acquisition server.

Before you download data, you can view what data is available for download on the Data Availability pages. You can also view a summary of the available data and details about data gaps and time tears. See Section 14.7 "Viewing Data Availability" on page 101 for a description of the Data Availability page options.

13.2 Retrieving Time Series Data

You can retrieve time series data from the Store (either from the Taurus directly or from removed media) by extracting it to a file in the following formats: MiniSEED, MiniSEED Sorted, ASCII, SEG Y, Seisan, or SAC. You have two options for extracting seismic data:

- Section 13.2.1 "Extracting Seismic Data" on page 82
- Section 13.2.2 "Extracting Seismic Data by Event" on page 84

You can also stream time series data from the Taurus to a central acquisition server, for example to write the data to NAQSServer ringbuffers. For more information, see Section 11.1 "Streaming Data in the NP Format Using UDP or HTTP" on page 71.

Trigger information is available as an SOH download (Section 13.3 "Accessing Store Files on the Recording Media" on page 87).

13.2.1 Extracting Seismic Data

You can extract time series data from the Store to a file in the following formats: MiniSEED, MiniSEED Sorted, ASCII, SEG Y, Seisan, or SAC. Before you extract data to the MiniSeed Sorted, SEG Y, Seisan, or SAC format for the first time, you have to install a conversion program on your computer. You are instructed to do this just before you start the download of the data.

To download time series data

1. Select **Data Retrieval** from the main menu.
2. If a list is available in the upper, right corner of the page, select the instrument for which you want to retrieve data.

If your Store references multiple instruments, the Data Retrieval pages will provide a list of instruments in the upper, right corner of the pages. This list allows you to select an individual instrument and form a data retrieval request for that specific instrument. If only the current instrument is referenced in the Store, the list is not present.

3. Click **Time series** and click **Next**.
4. Select one or more channels and click **Next**.
5. Select the start time (Month, Day, and Time) and end time (Duration) of the data you want to extract and click **Next**.

   -OR-

   Click **Show Available Times** and select a time.
6. Click the format you want to extract seismic data in and click **Next**.

The extracted file uses a 512 byte Data Record Length for 4 to 7 frames per packet and a 256 byte Data Record Length for 1 to 3 frames per packet. More than 488MB of data cannot be downloaded in MiniSEED format. Use multiple downloads for quantities of data that exceed 488MB.

Format	Description
MiniSEED	The MiniSEED format is a subformat of the SEED data format. MiniSEED data only contains waveform data: no station or channel metadata is included.
MiniSEED Sorted	The MiniSEED Sorted format is identical to the MiniSEED format in terms of content but the data is divided into blocks (you specify the size) and put into chronological order from oldest to newest.
ASCII	The ASCII format is a plain text file that can be viewed with any text editor.
SEG Y	The SEG Y file format is a standard format developed by the Society of Exploration Geophysicists for storing geophysical data.
Seisan	The Seisan file format is a waveform file that can be used with the SEISAN earthquake analysis software. The extracted files have been tested with Seisan version 8.1.
SAC (binary format)	A waveform file used by the SAC software (see http: www.iris.edu/software/sac/).

7. If you selected MiniSEED or ASCII as the data format, go to step 13.

   -OR-

   If you selected MiniSEED Sorted as the data format, go to step 8.

   -OR-

   If you selected SEG Y as the data format, go to step 10.

   -OR-

   If you selected SAC as the data format, go to step 11.

   -OR-

   If you selected Seisan as the data format, go to step 12.

8. Enter the full file name of the file you want to extract the data to in the File destination box.

   For example:

   C:\TaurusData\Output.seed

   /home/nmx/taurusdata/output.seed

9. Select the block size for each block of data, click **Next**, and go to step 12.

10. Enter the full file name of the file you want to extract the data to in the File destination box, click **Next**, and go to step 12.

    For example:

    C:\TaurusData\Output.sgy or C:\TaurusData\Output.segy

    /home/nmx/taurusdata/output.sgy or /home/nmx/taurusdata/output.segy

11. Enter the full file name of the file you want to extract the data to in the File destination box, click **Next**, and go to step 12.

    For example:

    C:\TaurusData\Output.sac

    /home/nmx/taurusdata/output.sac

12. Click the **Download it** link, follow the instructions in the compressed folder to install the conversion program for the format you selected (MiniSEED Sorted, SEG Y, Seisan, or SAC), and then go to step 13.

13. Review the settings and click **Download**.

    - To change the settings; click one of the links to return to the appropriate settings page, change the settings, and then click **Next** to return to the Download page.
    - Click **Clear All Choices** to delete all of the current settings and return to the Data Retrieval main page.

14. If you selected MiniSEED or ASCII as the data format, save the file.

    You can view the MiniSEED file in any MiniSEED reader and you can view the ASCII file in any text editor.

    -OR-

    If you selected MiniSEED Sorted, SEG Y, Seisan, or SAC as the data format, open the file with the conversion program you installed for that format.

13.2.2 Extracting Seismic Data by Event

You can retrieve seismic data from a Taurus using information from an event list. The event list can be a file that you upload to the Taurus (for example, a list of events from third-party Internet sites) or information for a single event that you enter into a form.

The Taurus calculates arrival times for various phases that are applicable to the event selected. The supported phases include the following: P, S, Pn, Sn, PKiKP, SKiKS, PcP, ScS, PKP, SKS, Pdiff, and Sdiff. Travel time tables are used to calculate the estimated time it takes a seismic wave to travel distance from a seismic event to a specified location. This is used to determine what data to download for a known teleseismic event. The travel time tables used in Taurus are calculated using the Tau algorithm, using the TauP Java Package (http://www.seis.sc.edu). TauP outputs files for any velocity model the user wants. The Taurus uses the IASPEI91 default model, which is commonly used for teleseismic events.

To download time series data by event

1. Select **Data Retrieval** from the main menu.
2. If a list is available in the upper, right corner of the page, select the instrument for which you want to retrieve data.

   If your Store references multiple instruments, the Data Retrieval pages will provide a list of instruments in the upper, right corner of the pages. This list allows you to select an individual instrument and form a data retrieval request for that specific instrument. If only the current instrument is referenced in the Store, the list is not present.

3. Click **Time series by event** and click **Next**.
4. Select one or more channels and click **Next**.
5. Click the type of event list file you want to upload and go to step 6.

   -OR-

   Go to step 10 to manually enter an event.

6. Download the event list file from the linked site and save it to your local computer.

Event List	Steps
IRIS Search - ASCII http://www.iris.edu/quakes/eventsrch.htm	1. Submit a search for the time period you are interested in. 2. Click the **ASCII version** link at the top of the search results page. 3. Save the ASCII version to your local computer. **Note:** An IRIS event list cannot be used with the Network name NE. If the Network name displayed in the Station Info section is NE, select the **Choose Station Info** link to change it.

Event List	Steps
NEIC Epic Search - Compressed http://neic.usgs.gov/neis/epic	1. Select a search area. 2. Click **Compressed File Format** as the output file type. 3. Select the search parameters and click **Submit Search**. 4. Save the .html search results file to your local computer.
NEIC Finger http://neic.usgs.gov/neis/finger/quake.asc	▸ Save the file quake.asc to your local computer.

7. Click **Browse,** select the saved file, and click **Upload**.
8. Click **Next**.
9. Click an event from the list, click **Next,** and go to step 14.
10. Enter a name for the event in the Label box.

    You can enter an ASCII string of any length.
11. Enter the event time as an ASCII string with the following format: *yyyy-MM-dd HH:mm:ss*
12. Enter the location of the event as a comma-separated list of the latitude, longitude, and depth.
13. Click the event once you have filled in the information and then click **Next**.
14. Select the pre-event and post event times and start and end phases.

Option	Description
Pre-event time	Number of seconds of data downloaded before calculated start time
Start phase	Phase when data starts downloading
Post-event time	Number of seconds of data downloaded after the calculated end time
End phase	Phase when data stops downloading

15. Click **Next** to search the Taurus data for the event.

    If there is no data for the selected event, you can search for another event in the currently uploaded list or enter another event by clicking the **Change Event** link.
16. Click the format you want to extract seismic data in and click **Next**.

Format	Description
MiniSEED	The MiniSEED format is a subformat of the SEED data format. MiniSEED data only contains waveform data: no station or channel metadata is included. **Note:** The extracted file uses a 512 byte Data Record Length. More than 488MB of data cannot be downloaded in MiniSEED format. Use multiple downloads for quantities of data that exceed 488MB.
MiniSEED Sorted	The MiniSEED Sorted format is identical to the MiniSEED format in terms of content but the data is divided into blocks (you specify the size) and put into chronological order from oldest to newest.
ASCII	The ASCII format is a plain text file that can be viewed with any text editor.

Format	Description
SEG Y	The SEG Y file format is a standard format developed by the Society of Exploration Geophysicists for storing geophysical data.
Seisan	The Seisan file format is a waveform file that can be used with the SEISAN earthquake analysis software. The extracted files have been tested with Seisan version 8.1. **Note:** The extracted file uses a 512 byte Data Record Length. More than 488MB of data cannot be downloaded in Seisan format. Use multiple downloads for quantities of data that exceed 488MB.
SAC (binary format)	A waveform file used by the SAC software (see http: www.iris.edu/software/sac/).

17. If you selected MiniSEED or ASCII as the data format, go to step 23.

    -OR-

    If you selected MiniSEED Sorted as the data format, go to step 18.

    -OR-

    If you selected SEG Y as the data format, go to step 20.

    -OR-

    If you selected SAC as the data format, go to step 21.

    -OR-

    If you selected Seisan as the data format, go to step 22.

18. Enter the full file name of the file you want to extract the data to in the File destination box.

    For example:

    C:\TaurusData\Output.seed

    /home/nmx/taurusdata/output.seed

19. Select block size for each block of data, click **Next**, and go to step 22.

20. Enter the full file name of the file you want to extract the data to in the File destination box, click **Next**, and go to step 22.

    For example:

    C:\TaurusData\Output.sgy or C:\TaurusData\Output.segy

    /home/nmx/taurusdata/output.sgy or /home/nmx/taurusdata/output.segy

21. Enter the full file name of the file you want to extract the data to in the File destination box, click **Next**, and go to step 22.

    For example:

    C:\TaurusData\Output.sac

    /home/nmx/taurusdata/output.sac

22. Click the **Download it** link, follow the instructions in the compressed folder to install the conversion program for the format you selected (MiniSEED Sorted, SEG Y, Seisan, or SAC), and then go to step 23.

23. Review the settings and click **Download**.
    - To change the settings; click one of the links to return to the appropriate settings page, change the settings, and then click **Next** to return to the Download page.
    - Click **Clear All Choices** to delete all of the current settings and return to the Data Retrieval main page.
24. If you selected MiniSEED or ASCII as the data format, save the file.

    You can view the MiniSEED file in any MiniSEED reader and you can view the ASCII file in any text editor.

    -OR-

    If you selected MiniSEED Sorted, SEG Y, Seisan, or SAC as the data format, open the file with the conversion program you installed for that format.

13.3 Accessing Store Files on the Recording Media

The Taurus Store media are formatted to use the Linux ext3 file system. You can copy the files to your computer from the Taurus via a means such as FTP. You can access and copy the files on removed media with a media reader such as a Nanometrics Hard Drive Reader or a third-party CompactFlash reader.

All of the Store files must be present in the same directory if you want to view or extract data. (For example, on the Taurus media in a media reader connected to your computer, or copied to a directory on your computer).

- You can transfer the files from the Taurus to your computer via a means such as FTP.
  - Ensure FTP is set to binary transfer.
- If you are using a media reader on Linux, note that some Linux versions will not detect a removable hard drive or CompactFlash card if the computer was not booted with the device attached. After booting with the removable hard drive or CF attached, the device can be removed and exchanged for other media which will be detected.
- If you are using a media reader on Windows there are various third-party utilities available for you to access the files directly; for example, Ext2IFS and Explore2fs.
  - Ext2 Installable File System For Windows (Ext2IFS) provides a file system driver to include ext3 volumes as fully accessible drives on Windows file systems, and a control panel item for assigning drive letters to ext3 volumes (http://www.fs-driver.org/index.html).

As of Explore2fs version 1.07 do not drag and drop a 1 GB file from the media as this will allocate 1 GB of shared memory on the computer. Use the File > Save As menu option instead. The Save As option supports saving of multiple files.

  - Explore2fs provides an Explorer-type graphical user interface for reading files and for copying files from an ext3 file system (see http://uranus.it.swin.edu.au/~jn/linux/explore2fs-old.htm for general information, and http://www.chrysocome.net/explore2fs for software updates).

Part 4

Monitoring, Managing, and Upgrading a Taurus

Chapter 14
Monitoring the Operation of a Taurus

Page:	Status Waveform SOH Alerts Data Availability Data Archive Timing Sensor Store Tools System Info
Log on required:	No

14.1 Monitoring the Taurus

You can monitor the status of the Taurus using the status LEDs located on the Taurus and by viewing the status information displayed on various pages of the Taurus user interface.

14.2 Introducing the Status LEDs

The Taurus has 4 status indicator LEDs:

- Two SuperLEDs to indicate overall unit status.

  One is located on the top panel and the other one is on the side panel (see Figure 14-1 "SuperLED locations" on page 92). They both indicate the same thing. The top panel SuperLED is visible when you use the keypad, the side panel SuperLED is useful for monitoring stacked Tauruses.

- An Ethernet Status LED to indicate Ethernet connection status.

- A Media Status LED to indicate whether it is safe to remove or insert recording media.

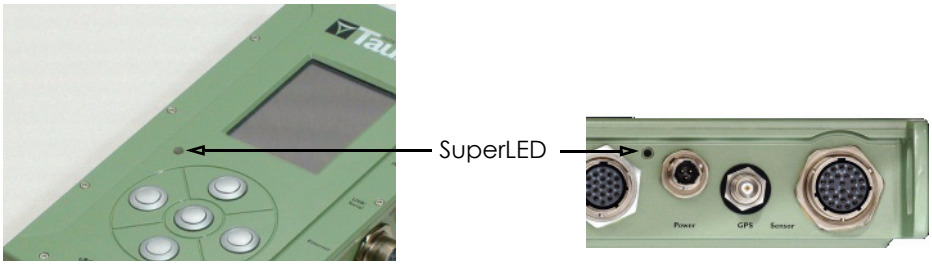
14.2.1 SuperLEDs

Table 14-1 describes the Taurus unit status indicated by the various SuperLED states. The SuperLED uses the following information as inputs: timing status, media door status, store status, sensor status, power manager status, Ethernet networking status, expected Trident 305 connectivity, firmware validity, and configuration status.

Table 14-1 SuperLED states

State	Status
Off	The Taurus has no power.
Slow blink	The Controller is shut down.
Fast blink	Any of the following conditions: ◆ The Taurus is booting (if the power was just connected). ◆ The Controller is booting (for example, after a restart). ◆ The Controller is running. ◆ The Controller is writing data to the media in Buffered mode. The SuperLED colour will vary as Taurus initializes its status information during bootup.
Red (solid, ~5s)	The Taurus is starting to boot immediately after power is connected.
Blinking green	The Taurus meets all the conditions to capture data successfully. For example, the Taurus is digitizing, has recording media, is able to record to media and/or transmit data, has good power, has good timing, and the media door is closed.
Blinking yellow	The Taurus is determining the status of one or more subsystems. This is a temporary state that will change to either blinking green or blinking red. If the Store is reindexing, the SuperLED will be blinking yellow and some UI pages will not be available until reindexing is complete. Reindexing might take a long time, depending on how much data are in the Store. **Caution:** You should not leave a Taurus that is in a Yellow state because it might change to a Red state. You can check the relevant status and configuration pages to identify the problem. You can also view the log files if more detail is required.
Blinking red	There is a fault or condition that prevents the unit from operating properly. You should investigate the problem. Possible problems: GPS/Timing status is not okay, missing recording media, a hardware or software problem, no Ethernet connection.

Figure 14-1 SuperLED locations



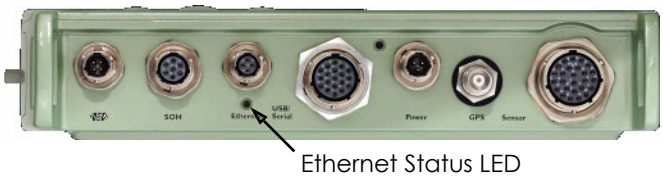
14.2.2 Ethernet Status LED

The Ethernet Status LED on the side panel (Figure 14-2) indicates the status of the Taurus Ethernet connection.

Table 14-2 Ethernet status LED states

State	Ethernet status
Off	The Taurus has no power or the Controller is shut down.
Yellow (solid, ~8s)	The Taurus is starting to boot immediately after power is connected or the Controller is starting.
Fast blinking green	Networking is enabled and a link is established.
Slow blinking green	Networking is not enabled.
Blinking yellow	The Taurus is powering up and running diagnostics.
Blinking red	Networking is configured but there is no link.

Figure 14-2 Ethernet Status LED location



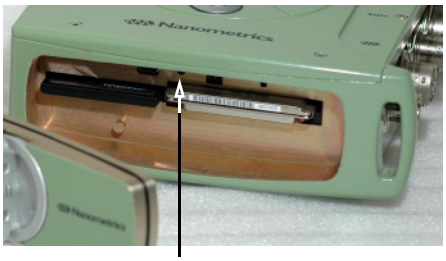
14.2.3 Media Status LED

The Media Status LED inside the media door (see Figure 14-3 "Media Status LED location" on page 94) indicates if it is safe to remove or insert recording media (see Section 16.2.1 "Replacing Recording Media" on page 116).

Table 14-3 Media status LED states

State	Media status
Green	It is safe to remove or insert recording media because the Controller is shut down.
Solid yellow	The Controller will be turned on in 2 minutes because the buffer is full. Do not remove or insert recording media.
Fast blinking yellow	The Controller will be turned on in 30 seconds because the buffer is full. Do not remove or insert recording media.
Red	It is not safe to insert or remove recording media because the Controller is running. **Caution:** You must shut down the Controller before removing or inserting recording media. This does not stop the Digitizer or cause data gaps.

Figure 14-3 Media Status LED location



14.3 Viewing an Overview of the Status of the Taurus

The Status page provides a high-level overview of the current status of the Taurus.

Table 14-4 Status page overview

	Description
Mode	The mode the Taurus is currently running in. For more information, see Section 5.4 "Selecting the Running Mode" on page 31.
Store Time Left/Avg Data Stored	The estimated number of days of recording space remaining in the active Store based on all of the data currently in the Store (and therefore the aggregate sample rate of previously recorded data). Once the Store has reached its configured capacity or has used all of the available space on the media and has started to record over old data, the Store Time Left changes to Avg Data Stored and the value changes to a continuously recalculated average quantity of data in the Store, expressed in units of time.
Store Size	The amount of total storage space used. For more information, see Section 16.1 "Data Stores" on page 113.
IP Address	The current IP address and subnet mask of the Taurus. The IP address is in dotted decimal format and the subnet mask is in mask width format. If the communications interface (Configuration > Communications) is set to Serial Port 1, "(serial)" will follow the IP address.
Time	The current time according to the Controller The Controller resynchronizes its time to the system clock continuously when it is running. For more information, see Section 5.2.1 "Starting the Controller" on page 27.
Voltage	The current power supply level in volts For more information on configuring the power supply, see Section 4.4 "Configuring Power Manager Settings" on page 22.
Power	The average power consumption of the Taurus in watts This includes power consumption of any externally connected devices such as a sensor, serial device, or a device connected to the external SOH.
Packets	The number of data packets recorded to the Store since the Controller was started. For more information, see Section 5.2.1 "Starting the Controller" on page 27.

Table 14-4 Status page overview

	Description
Timing	The current timing uncertainty of the system clock
Status bar	The status bar provides a high-level overview of the overall status of the Taurus. For more information. see Section 14.3.1 "Status Bars" on page 95. The Status Details page is displayed when you select the text on the status bar on the Status page. The Status Details page contains multiple status bars that provide more detailed status information.
Waveform images	Shows the following information for the Taurus and each Trident 305 connected to the Taurus: • Instrument ID (such as Taurus 0838 or Trident 305 0005) • Number of enabled channels at the sample rate (such as 3 at 500sps) • Internal temperature (in degrees Celsius) • Time series data in near real-time for each displayed channel **Notes:** If no Trident 305s are connected to the Taurus, all of the configured output channels of the Taurus are shown. If one or more Trident 305s are connected to the Taurus, then the first enabled channel (the Z channel by default) is shown for the Taurus and for each Trident 305.

14.3.1 Status Bars

The status bar on the Status page is to help you interpret the SuperLED. The colour matches the colour of the SuperLED and a brief text label summarizes the problem.

- A bar with a green background indicates that everything is working properly.
- A bar with a yellow background and with text followed by a question mark indicates Taurus is acquiring status information. This is a temporary state that will change to either Green or Red.

You should not leave a Taurus that is in a Yellow state because it might change to a Red state. You can check the relevant status and configuration pages to identify the problem. You can also view the log files if more detail is required.

- A status bar with a red background indicates an error condition that must be investigated and fixed.

  You can check the relevant status and configuration pages to identify the problem. You can also view the log files if more detail is required.

The Status Details page is displayed when you select the text on the status bar on the Status page. The Status Details page contains multiple status bars that provide more detailed status information. For detailed information about each status bar colour, see Table 14-6 "Timing statuses" on page 97.

Some of the status bars also have links to additional pages (such as Timing, Sensor, and Store Tools) that show additional configuration or status information that can help you identify problems.

14.3.2 Status Details Page

All status bars are yellow when the Taurus is powering up or running diagnostics.

Table 14-5 Status details page overview

Status bar	Description
Timing	The timing status bar indicates the status of the system clock and its inputs and it provides a link to the Timing page. For a description of the timing statuses, see Table 14-6 "Timing statuses" on page 97. **Notes:** ◆ System time starts from zero when the Taurus is powered on and has not been set properly until the time status has been green at least once since power on. ◆ PLL state < Coarse Lock = either Free Running or No Lock
Store	The Store status bar indicates the status of the Store and the active recording media and provides a link to the Store Tools page: ◆ Green colour – The Store is ready for data recording. ◆ Red colour – The Store is missing or corrupt, the media is missing (not installed), or there is not enough free space to accommodate the size that the current Store was configured for. ◆ Yellow colour – The Store is not ready for data recording because it is being reindexed, resized, created, reformatted, or re-created.
Media Door	The media door status bar indicates the status of the media door: ◆ Green colour – The media door is closed. ◆ Red colour – The media door is open. **Note:** The media door should be closed when the Taurus is operating.
Firmware	The Firmware status bar indicates the current status of the firmware and provides a link to the System Info page: ◆ Green colour – The firmware versions are okay. ◆ Red colour – The firmware versions of the subcomponents do not match.
Tridents	The Trident status bar indicates if the Taurus detects all of the Trident 305s that are expected to be connected to the Taurus. You can configure the expected number on the Configuration > General page: ◆ Green colour – The expected number of Tridents is detected. ◆ Red colour – Number of Tridents detected does not match the expected number.
Ethernet	The Ethernet status bar indicates the status of the Ethernet network: ◆ Green colour – Ethernet networking is enabled and a link is established or there is no link and the Taurus is in Buffered mode. ◆ Red colour – Ethernet networking is enabled but there is no link. You can configure Ethernet options on the Configuration > Communications page and on the Configuration > Communications > Ethernet page. **Notes:** ◆ If the Ethernet port has been disabled, the Ethernet status bar is not visible on the Status details page.

Table 14-5 Status details page overview

Status bar	Description
Power	The Power status bar indicates the status of the current draw of external devices: ◆ Green colour – The power usage of external devices is within tolerance. ◆ Red colour – An external device (on either the serial or the sensor connector) has drawn too much current and has been shut off. Sensor power can be turned back on (assuming the fault condition has been fixed) on the Sensor page (see Section 9.2 "Controlling Sensors" on page 57). The Taurus must be power cycled to restore serial power once it has been tripped.
Sensor	The Sensor status bar indicates the sensor power status and provides a link to the Sensor page (see Section 9.2 "Controlling Sensors" on page 57). You can configure sensors on the Configuration > Sensor Library page and you can control and monitor sensors on the Sensor page. ◆ Status: **OK** The sensor is configured as active, is powered, and is drawing the proper current. -OR- The sensor is configured as passive and is not powered. ◆ Status: **No Power** The sensor is configured as active but is not powered. ◆ Status: **Powered** The sensor is configured as passive but is powered. ◆ Status: **SP mode** The sensor is in SP mode. SP mode should only be used when centring the masses in the sensor. Leaving the sensor in SP mode will result in poor data quality.
Config	The config status bar indicates if the latest configuration changes have been committed and provides a link to the Configuration page: ◆ Green colour – Latest configuration changes have been committed. ◆ Red colour – Latest configuration changes have not been committed. Select the **Commit** button on the Configuration page to commit the latest configuration changes.

Table 14-6 Timing statuses

Status	Indicates
Time OK	◆ PLL state has not reached Coarse Lock and Time Uncertainty < 100µs. -OR- ◆ PLL state has reached Coarse Lock or better and Time Error < 100µs.
GPS Init	◆ System time has not been set yet after power on, the GPS is on, the PLL state has not reached Coarse Lock, and the GPS is on for shorter than the initialization time limit.
No Antenna	Antenna open is detected. This is a hardware fault condition even if Taurus time is OK. The Lassen iQ GPS receiver can detect an antenna open condition but the Lassen SQ GPS receiver cannot. If your Taurus uses the Lassen SQ GPS receiver, this status report is not available.
Antenna Short	Antenna short is detected. This is a hardware fault condition even if Taurus time is OK.

Table 14-6 Timing statuses

Status	Indicates
GPS Off	◆ System time has not been set yet after power on and the GPS is off. -OR- ◆ Timing status was green at least once, Time Uncertainty >= 100µs, and GPS is off.
GPS Failed	◆ System time has not been set yet after power on, PLL state has not reached Coarse Lock, and the GPS has been switched on for longer than the initialization time limit. -OR- ◆ Timing status was green at least once, Time Uncertainty >= 100µs, and the GPS is on.
Bad Time	◆ System Time has not been set yet after power on, the GPS is on, PLL state has reached Coarse Lock or better, and Time Error >= 100µs. -OR- ◆ Timing status was Green at least once and PLL state >= Coarse Lock, Time Error >= 100µs.

14.4 Viewing Waveform Data in Near Real Time

The Waveform page shows a waveform in near-real time for each channel with DC offset correction. You can view a single channel at a time or all channels. You can also adjust the scale.

If you have a Trident 305 connected to the Taurus, you can view waveform information for that Trident by selecting the arrow ▼ in the upper, right corner of the Waveform page and selecting the Trident 305 from the list.

Table 14-7 Waveform page overview

	Description
Time	The time scale width in seconds The default setting is 30.
Scale	The amplitude scale in counts The current scale setting is shown on the upper, right corner of the waveform. After about 1 minute from start up of the Controller, the waveform will show AC RMS and DC average. On a single-waveform display, the minimum and maximum values of the visible data are also shown as a numeric value: • S = vertical scale of the channel window • MIN = smallest sample value of the samples • MAX = largest sample value of the samples The default setting is Auto.
Channel	The waveform currently displayed. You can view one waveform at a time (Z, N, or E) or view all channel waveforms simultaneously (All).

14.5 Viewing SOH Information for the Taurus

The Taurus provides you with several options for viewing its state of health information:

- SOH data is recorded to the Store for the 4 External SOH channels and for internal SOH. The SOH page shows a summary of this data for the Taurus at the time shown as described in Table 14-8 "SOH page overview" on page 99.
- If you have enabled the Data Archive feature, you can select the option to have the following SOH data files written as four separate files to the FAT32 CF card: Environment, GPS Time, GPS Satellites, and Instrument. For more information, see Chapter 12 "Recording MiniSEED and SOH Data Files."
- In addition to viewing this information on the SOH page, you can also retrieve it from the Store. For more information, see Chapter 15 "Retrieving Taurus SOH Data from the Store."
- Accessing Store files on the recording media.

  For more information, see Section 13.3 "Accessing Store Files on the Recording Media" on page 87.

If you have a Trident 305 connected to the Taurus, you can view SOH information for that Trident by selecting the arrow ▼ in the upper-right corner of the SOH page and selecting the Trident 305 from the list.

Table 14-8 SOH page overview

	Description
Temperature	The internal temperature of the Taurus, accurate to ±2 °Celsius
Input Voltage	The power supply voltage, accurate to ±0.2V You can configure battery power settings on the Configuration > Power Manager page.
Serial	An estimate of the current drawn by a connected serial device.
NMXbus	An estimate of the current drawn by all of the devices on the NMXbus topology.
Sensor	An estimate of the current drawn by the connected sensor (for sensors that draw more than about 8 mA).
Controller	An estimate of the current drawn by the Taurus Controller.
Digitizer	An estimate of the current drawn by the Taurus Digitizer.
External SOH 1 /2/3/4	The voltage on the specified External SOH connector
Time	The last time the SOH was updated.

14.5.1 Setting the SOH Report Interval

You can specify the interval at which the SOH data is recorded. This setting applies to the 4 External SOH channels and some of the internal SOH. The internal SOH that use this setting include the types listed in the table in Section 15.1 "Retrieving SOH Data" on page 109, except for the types in the row labelled PowerPC, which are not configurable.

To set the SOH report interval

1. Select **General** on the Configuration page.
2. Type a number between 5 and 3600 in the SOH Report Interval box.

   The default setting is 60 seconds.

The SOH information shown on the UI pages is updated every 5 seconds, independent of the SOH Report Interval setting.

14.6 Viewing the Status of the Store

The Store Tools page shows information about the active recording media for the Store (IDE drive or CompactFlash card) and the availability of other media. If you are logged on, you can also view media and Store management options. For more information, see Chapter 16 "Managing the Store and Recording Media."

The options on the Store Tools page can only be used for the recording media for the Store.

Table 14-9 Store tools page overview

	Description
Active Media	The active media type, either IDE (IDE hard drive) or CF (CompactFlash card)
Store Size	The capacity of the active Store This is configured when the Store is created. For more information, see Section 16.1.2 "Deleting and Recreating Stores" on page 115.
CompactFlash/ IDE Available	Indicates if an ext3-formatted recording media is available in the other slot.
Switch Media	Switches the media used for recording data on the Store. For more information, see Section 16.2.3 "Switching Recording to the Other Media for the Store" on page 118.
Format CompactFlash/ IDE	Formats the active media for the Store. For more information, see Section 16.2.2 "Formatting Recording Media for the Store" on page 117.
Reindex Store	Reindexes the Store. For more information, see Section 16.1.3 "Reindexing Stores" on page 115.
Delete Store	Deletes the Store. For more information, see Section 16.1.2 "Deleting and Recreating Stores" on page 115.

14.7 Viewing Data Availability

The Data Availability pages show graphical and text summaries of data availability for all instruments referenced in the Store. If multiple instruments are referenced, a list of instruments is provided in the upper, right corner of the page. This list allows you to select an individual instrument or all instruments. If only the current instrument is referenced in the Store, the list is not present.

For the selected instrument(s), you can view graphical summaries of the time series data availability for each month, week, or day. You can also view text summaries with links to detailed availability information for each band of data. A band is a stream of packets that contains one or more channels. For time series data, each band contains one channel of data. For SOH data, each band contains multiple channels (such as temperature, voltage, and currents). Text summaries are available for both time series data and the other data types (such as SOH).

14.7.1 Month

The Month page shows a calendar summary of time series data availability for the selected month. You can use the green arrows at the top of the page to change the month. If a day had data gaps, you can select it to view the graphical summary for that day.

14.7.2 Week

The Week page shows a graphical summary of the time series data availability for each channel for the selected week. You can use the green arrows at the top of the page to change the week. You can select a date to view the graphical summary for that day.

14.7.3 Day

The Day page shows a graphical summary of the time series data availability for each channel for the selected day. You can use the green arrows at the top of the page to change the day.

14.7.4 Text

There is one Text page for time series data and one for all other data. These pages show data availability and gap information.

A gap can be either a data gap (data packets are missing) or a time tear (a time jump with no missing packets: for example, caused by a time adjustment after an extended GPS reception outage) or both (for example, after the power has been disconnected for an extended period of time).

14.7.4.1 Time Series

The Time Series page shows a text summary of the following:

- The available time ranges of data for each time series channel (band)
- The number of data gaps and time tears
- The quantity of data as both units of time and as the percentage of space used in the Store.

You can select the band name links to view a page showing details about all gaps for that band. Each Times Series Band page shows details about availability for that band. The page shows

- The quantity of data as the percentage of space used in the Store
- The available time range of data
- The number of gaps (includes both data gaps and time tears)
- A list of all gaps that exceed the gap tolerance, with the number of packets missing (if that information is available) and the gap duration

You can select a gap tolerance for this band from the Gap Tolerance list. You can select the **All Channels** link to return to the main Time Series page.

14.7.4.2 Other Bands

Other data types include alert, configuration, log (Apollo, DSP, ARM), SOH, and triggers.

The Other page shows a text summary of the following:

- The available time ranges of data for each time series channel (band)
- The number of data gaps and time tears
- The quantity of data as both units of time and as the percentage of space used in the Store.

You can select the band name links to view a page showing details about all gaps for that band. Each Other Band page shows details about availability for that band. The page shows

- The quantity of data as the percentage of space used in the Store
- The available time range of data
- The number of gaps (includes both data gaps and time tears)
- A list of all gaps that exceed the gap tolerance, with the number of packets missing (if that information is available) and the gap duration

You can select a gap tolerance for this band from the Gap Tolerance list. You can select the **All Channels** link to return to the main Other page.

14.8 Viewing the Status of the Data Archive

The Data Archive page shows information about the status of the data archive and the FAT32 CompactFlash card that the miniSEED and SOH files are written to. For more information, see Chapter 12 "Recording MiniSEED and SOH Data Files".

Table 14-10 Data archive page overview

	Description
Status	The status of the data archive.
Used space	The amount of used space on the CF card.
Available space	The amount of available space on the CF card. **Note**: The data is not overwritten so no data can be written to the media once it becomes full.

14.9 Monitoring Sensor Operation

The Sensor page shows the following near real-time information about your sensor:

- The mass position of each component and the automatic mass centre voltage thresholds as configured on the Auto Mass Centring page. For more information, see Section 9.3.3 "Configuring Auto Mass Centring Options" on page 60.

This information can also be extracted to an Environment SOH file (see Section 15.2 "Extracting State of Health Data" on page 109).

- For active sensors, an estimate of the sensor power consumption is shown on the Sensor page.

  The estimated power consumption is accurate to about ±15% for sensors that draw more than 100 mW. A sensor status bar and a power status bar are also shown on the main Status page (see Section 14.3.2 "Status Details Page" on page 96).

- System sensitivity is calculated using the sensor sensitivity value from the Configuration > Sensor Library > *Sensor Name* page and the input range and software gain from the Configuration > Digitizer > Front End page.

  It is expressed in counts per unit of velocity or acceleration based on the sensitivity units defined on the Configuration > Sensor Library > *Sensor Name* page.

- A waveform of the sensor output for each channel with scaling options and waveform selection options as described in Section 14.4 "Viewing Waveform Data in Near Real Time" on page 98.

If you have a Trident 305 connected to the Taurus, you can view sensor information for that Trident 305 by selecting the arrow ▼ in the upper, right corner of the Sensor page and selecting the Trident 305 from the list.

14.10 Viewing the Status of the System Clock, GPS Receiver, and GPS Satellites

The Timing pages show the status of the system clock, GPS receiver, and GPS satellites; including a visual summary of the GPS satellite status in the form of a GPS map. There is a corresponding Timing status bar on the Status Details page (see Section 14.3.2 "Status Details Page" on page 96). You can configure GPS and timing options on the Configuration > Digitizer > Timing page (see 8.3.2 "Digitizer Timing Settings" on page 51).

You can download timing SOH information as .csv files (see Section 15.2 "Extracting State of Health Data" on page 109).

14.10.1 Timing

Table 14-11 Timing page overview

	Description
Report time	The current time of the system clock For more information, see Table 8-2 "Taurus time definitions" on page 48.
PLL state	The current status of the Phase Locked Loop (PLL) control system used to acquire the GPS signal The possible statuses are as follows: • Free running — The system clock is not being synchronized with GPS time • Fine lock — Small time corrections are being performed to synchronize the system clock with the GPS time, which is provided by the GPS receiver • Coarse lock — Large time corrections are being performed to synchronize the system clock with the GPS time, which is provided by the GPS receiver
Uncertainty	Uncertainty of report time (system time)
Time error	The amount of time the report time (system time) differs from GPS Time For more information, see Table 8-2 "Taurus time definitions" on page 48.
DAC count	The value used to calculate the time base.
Status	The satellite tracking status of the GPS receiver The possible statuses are as follows: • Off - The GPS receiver is off. • Doing fixes — The GPS receiver is doing position fixes. • No GPS time — The GPS receiver does not have GPS time yet. • Need to initialize — The GPS receiver needs to initialize. • PDOP too high — The PDOP is too high, which means that the GPS receiver will not generate a position calculation. • No satellites — The GPS receiver has not found any usable satellites. • One satellite — The GPS receiver has only found one usable satellite. • Two satellites — The GPS receiver has only found two usable satellites. • Three satellites — The GPS receiver has only found three usable satellites. • Satellites unusable — The chosen satellites are unusable for position calculation.
Satellites used	The number of satellites currently used by the GPS receiver for determining time and position.
PDOP	Position Dilution of Precision A standard estimate of the GPS position precision based on the geometry of the visible satellites. A lower value indicates a more precise position calculation. The GPS receiver will not generate a solution if the PDOP is too high.
TDOP	Time Dilution of Precision A standard estimate of the GPS time precision based on the geometry of the visible satellites. A lower value indicates a more precise position calculation.
Location	The current latitude, longitude, and elevation of the Taurus.

14.10.2 GPS Satellites

Table 14-12 GPS satellites page overview

	Description
PRN	The Pseudo-Random Noise code used to identify each satellite.
Status	The signal acquisition status of that channel of the GPS receiver
Elev	The elevation angle of the satellite in degrees The elevation ranges from 0° to 90° (0° is parallel to the surface of the earth).
Azim	The azimuth of the satellite in degrees, measured clockwise from true north.
Signal	The strength of the signal in antenna measurement units (AMU) An AMU is a measure of signal to noise ratio. The conversion formula is as follows: $C/N_0 = 27 + 20\log10(\ SNR[\ AMUs\ ]\ )$
Last updated	The system time when the GPS receiver last updated the information (for more information, see Table 8-2 "Taurus time definitions" on page 48).

14.10.3 GPS Map

Table 14-13 GPS map page overview

	Description
PDOP	Position Dilution of Precision A standard estimate of the GPS position precision based on the geometry of the visible satellites. A lower value indicates a more precise position calculation. The GPS receiver will not generate a position calculation if the PDOP is too high.
TDOP	Time Dilution of Precision A standard estimate of the GPS time precision based on the geometry of the visible satellites. A lower value indicates a more precise position calculation.
GPS satellite sky plot	The sky plot shows the positions of the GPS satellites, labelled with Pseudo-Random Noise codes, and a graph of the received signal strength of each satellite in antenna measurement units.
Last updated	The system time when the GPS receiver last updated the information (for more information, see Table 8-2 "Taurus time definitions" on page 48).
GPS state	The tracking status of the GPS receiver
Location	The current latitude, longitude, and elevation of the Taurus

14.11 Viewing the Configuration History

The Taurus maintains an audit trail of configuration changes made since the Store was created. For more information, see Section 6.6 "Viewing Configuration Change History" on page 39.

14.12 Viewing System Information

The System Info pages show the firmware and hardware version information for the Taurus.

- Firmware page – Shows the version of the Taurus firmware that is installed and the version information for each of the firmware components.

  If you are using a Web browser to view this page, you can also download the firmware and hardware information as a text file (see Section 14.12.1 "Downloading Taurus System Information" on page 106).

- Hardware page – Shows the serial number (where applicable) and version information for each of the Taurus subcomponents.

If you have a Trident 305 connected to the Taurus, you can view system information for that Trident by selecting the arrow ▼ in the upper, right corner of the System Info page and selecting the Trident 305 from the list.

14.12.1 Downloading Taurus System Information

You can download the firmware and hardware information for the Taurus as a Terse RDF Triple Language (Turtle) file and save it on your local computer.

To download the system information file

1. Select **System Info** from the main menu.
2. If a list is available in the upper, right corner of the page, select the instrument for which you want to retrieve the system information.

If your Store references multiple instruments, the System Info pages will provide a list of instruments in the upper, right corner of the pages. This list allows you to select an individual instrument and request the system information for that specific instrument. If only the current instrument is referenced in the Store, the list is not present.

3. Click the **Download** link on the Firmware tab.
4. Click **OK** to save the file to your desktop.

   You can open the .ttl file with any text editor.

14.13 Viewing System Logs and Alert Messages

The Taurus system logs provide operation messages to the configured levels of detail. System logs are recorded to the Store.

The Alerts pages show a list of occurrences such as start-ups, shut downs, and major errors. Alert messages include a time stamp and a brief description. You can use these message time stamps as reference points for searching through system logs for events that generated an alert.

14.13.1 Downloading System Log Files

If required for troubleshooting purposes, you can view and download system log files for the unit.

To download the log files

1. Click and select **Data Retrieval** from the main menu on a Web browser.
2. Click the **Download Log Files** link.
3. Click a log file to view it.

   -OR-

   Right-click a log file to save it locally.

If required, you can change the level of logging. For more information, see Section 10.1 "Changing General Taurus Settings" on page 65.

Chapter 15
Retrieving Taurus SOH Data from the Store

Page:	Data Retrieval
Log on required:	No

15.1 Retrieving SOH Data

The Taurus records all SOH data to the Store. You can extract SOH data from the Store using the following data retrieval options:

- Retrieving data from the Store over an IP connection and saving it on your network.
- Accessing Store files on the recording media.

  For more information, see Section 13.3 "Accessing Store Files on the Recording Media" on page 87.

One data retrieval request can be run at a time. Any subsequent retrieval requests will be processed when the current download is finished. You can run a data retrieval request at the same time as data is streaming to an acquisition server.

If you have enabled the Data Archive feature, you can also select the option to have the following SOH data files written as four separate files to the FAT32 CF card: Environment, GPS Time, GPS Satellites, and Instrument. For more information, see Chapter 12 "Recording MiniSEED and SOH Data Files."

15.2 Extracting State of Health Data

You can extract various types of SOH data from the Store to a comma-separated values file (.csv) on your local computer. Use the pages of the data retrieval wizard to download data for predefined groups of SOH data, or to download an individual SOH data channel, such as Media Bay Door State.

1. Select **Data Retrieval** from the main menu.
2. If a list is available in the upper, right corner of the page, select the instrument for which you want to retrieve data.

   If your Store references multiple instruments, the Data Retrieval pages will provide a list of instruments in the upper, right corner of the pages. This list allows you to select an individual instrument and form a data retrieval request for that specific instrument. If only the current instrument is referenced in the Store, the list is not present.

3. Click **State of health** and click **Next**.

4. Select the SOH data group from the list (see the table below for details on the contents of each predefined SOH group) that you want to extract from and go to step 7

   -OR-

   If you want to extract specific types of SOH data, go to step 5.

Predefined SOH group	SOH data
GPS Time	◆ Time in longsecs format (the number of UTC seconds since 1970-01-01) ◆ UTC time in yyyy-mm-dd hh:mm:ss:ms format ◆ Latitude (°) ◆ Longitude (°) ◆ GPS receiver status ◆ Number of satellites used ◆ PDOP ◆ TDOP ◆ System clock phase lock ◆ Time uncertainty (ns) ◆ DAC count ◆ Time error (ns)
GPS Satellites	◆ Time in longsecs format (the number of UTC seconds since 1970-01-01) ◆ UTC time in yyyy-mm-dd hh:mm:ss:ms format For each satellite ◆ Acquisition type ◆ Azimuth (°) ◆ Elevation (°) ◆ PRN code ◆ Signal level (AMU)
Environment SOH	◆ Time in longsecs format (the number of UTC seconds since 1970-01-01) ◆ UTC time in yyyy-mm-dd hh:mm:ss:ms format ◆ External SOH Voltage 1 input (V) ◆ External SOH Voltage 2 input (V) ◆ External SOH Voltage 3 input (V) ◆ External SOH Voltage 4 input (V) ◆ Sensor SOH Voltage 1 (V) ◆ Sensor SOH Voltage 2 (V) ◆ Sensor SOH Voltage 3 (V)

Predefined SOH group	SOH data
Instrument	◆ Time in longsecs format (the number of UTC seconds since 1970-01-01) ◆ UTC time in yyyy-mm-dd hh:mm:ss:ms format ◆ Supply voltage (mV) ◆ Temperature (°C) ◆ NMXbus current (mA) ◆ Sensor current (mA) ◆ Serial port current (mA) ◆ Controller current (mA) ◆ Digitizer current (mA)
PowerPC	◆ Time in longsecs format (the number of UTC seconds since 1970-01-01) ◆ UTC time in yyyy-mm-dd hh:mm:ss:ms format ◆ Ethernet status ◆ Packets
Acquisition	The Acquisition group provides SOH information about the acquisition rates and telemetry of the transmitted data. This group includes information such as the following: • The number of packets received, missed, requested, or re-requested. • The number of gaps in the data. • The maximum and minimum latency of packets. • The amount of missed time.

5. Select **User Selected** from the list, select a specific type of SOH data from the Available SOH Channels list, and click **Add** to add it to the Selected SOH Channels list.

   For example, if you only want to extract Trigger SOH data, then add Trigger Entry to the Selected SOH Channels list and go to step 7.

6. Repeat step 5 until you have added all of the specific SOH data you want to extract.

7. Click **Next**.

8. Select the start time (Month, Day, and Time) and end time (Duration) of the data you want to extract and click **Next**.

   -OR-

   Click **Show Available Times** and select a time.

9. Review the settings and click **Download**.

   ▸ To change the settings; click one of the links in the **Current Choices** section to return to the appropriate settings page, change the settings, and then click **Next** to return to the Download page.

   ▸ Click **Clear All Choices** to delete all of the current settings and return to the Data Retrieval main page.

Chapter 16

Managing the Store and Recording Media

Page:	Store Tools (for media formatted as ext3)
Log on required:	Yes

16.1 Data Stores

Data is put into Nanometrics Protocol packets (NP packets). The Taurus buffers the NP packets for all data types and writes them to a Store on removable media formatted as ext3 (a CompactFlash card or an IDE hard drive). A data Store contains time series, state of health (SOH), log data, metadata, and configuration data.

A Store works as a ring buffer. It will wrap around when it is full and record over the oldest data while preserving all data types.

A single Store can encompass many files, each being up to 1 GB in size. This is transparent when using the Store on the Taurus, but is relevant if you are planning to copy a Store to your computer because you must copy all files for that Store if you want to extract data later on.

You might notice that some of the files are very small. This is because the Store files allocate disk space as required.

A single recording media can contain multiple Stores although this is not recommended. For more information, see Section 16.1.1.1 "About Appended Stores" on page 114.

16.1.1 Creating Stores

The Taurus will either create a Store automatically or prompt you to create one.

- The Taurus creates a Store automatically after formatting a new media in the active media slot (see Section 16.2.2.1 "Formatting Unformatted Media" on page 118).
- The Taurus prompts you to create a new Store
  - After it deletes the currently active Store (see Section 16.1.2 "Deleting and Recreating Stores" on page 115)
  - When it switches to the media in the other media slot after formatting that media (see Section 16.2.3 "Switching Recording to the Other Media for the Store" on page 118)

If you insert a used media that is already formatted to the Linux file system ext3 but does not contain a Store, the Taurus will need at least 200 MB of free space on the media to create a Store. If the Taurus creates a Store automatically, it will use the last Store capacity setting from the Taurus configuration when it creates the new Store. It will set the Store capacity to 90% of the maximum space on the media if the last Store configuration was set to Full. If the last Store configuration was for a specific capacity (for example, 800MB), the Taurus will create a Store of that capacity if there is sufficient space on the media.

If the last configured Store size was 1GB (1024 MB) on CF and the current media is a 1GB CF, there still will not be sufficient space after deleting all files or formatting the media because the Taurus will require some of the space for other operations.

If there is insufficient space on the media (less than 200 MB), the Status page displays a Status Error and the Status Detail page shows the error Not Enough Space or No Store. The Store Tools page provides more details about why the error occurred. If there is insufficient space on the media, you have the following options:

- Switch to the other media if it is available.

  You can then log on, switch media, and create a Store with a capacity from the list of available options.

- Delete files from the small media to free up sufficient space.
- Format the small media.

Formatting will destroy all data and partition information on the media.

16.1.1.1 About Appended Stores

If you insert media that contains a Store previously created on the same Taurus (the Store ID contains the Taurus serial number where the Store was originally created), the Taurus will append data to the existing Store. If there is more than one Store on the media, the Taurus will append to the Store identified by its own serial number if it exists. Otherwise, the Taurus will append data to a randomly chose Store.

It is recommended that you do not use existing Stores created on other Tauruses. You can insert media with existing Stores and then either delete the existing Stores or format the media and create a new Store to record data from the current Taurus (see Section 16.1.2 "Deleting and Recreating Stores" on page 115 or Section 16.2.2.2 "Formatting Previously Formatted Media" on page 118).

If you do use a combined Store, note the following:

- A Store incorporates the serial number of the Taurus on which it was created as a means of identifying that Store. The file names will use the original Taurus serial number.
- The original data channels in that Store remain intact until the Store wraps. When the Store wraps, the oldest data is always removed first regardless of which Taurus created that data.
- The Month page will never display 100% data availability if you select **All Instruments** from the list in the upper, right corner of the Data Availability page.

16.1.2 Deleting and Recreating Stores

You can delete the active Store (the Store that is currently in use) and recreate it.

When you delete a Store, all data in the Store is permanently deleted.

1. Select **Store Tools** from the main menu.
2. Select **Delete Store**.
3. Select the Store capacity of the new Store that will be created from the Store Size list.

   The list of options is based on the available space on the media. The option Full will use all available space on the media.
4. Select **Destroy & Recreate Store** to delete the current Store and create a new one with the capacity you selected in step 3.

16.1.3 Reindexing Stores

If the Taurus is not shut down properly (using the Shutdown page) before the power is disconnected, the Store might need to be reindexed. If this is the case, the Taurus will automatically reindex the Store on start-up.

If you think that some of the recorded data in the Store is missing from the Data Availability lists, you can manually reindex the Store. When you reindex the Store, the index within the Store is recalculated and synchronized with the actual data that is available.

Reindexing might take a long time depending on how much data is in the Store. Data will continue to be generated during reindexing and will not be lost. You will not be able to perform any other operations that involve the Store at the same time.

1. Select **Reindex Store** from the Store Tools page.
2. Select **Yes** to confirm that you want to reindex the Store.

16.2 Recording Media

Taurus removable recording media options include a 1.8" ATA hard disk drive (IDE hard drive) and a CompactFlash card (CF) (see Section 19.6 "Removable Media Data Storage" on page 135 for specifications) or two CF cards (one formatted as ext3 and one as FAT32) if the Taurus CompactFlash Adapter is used. The recording media is accessible via the media door.

Hard drives can be damaged permanently if they are operated at altitudes or temperatures beyond specified high and low limits. Do not operate the Taurus if it is at an altitude or unit temperature outside the specified ranges for the installed media type. SanDisk Extreme CompactFlash cards can be used across the full operating environmental range of the Taurus. See Section 19.16 "Environmental" on page 138 for the operating range specifications.

16.2.1 Replacing Recording Media

You can damage the Store or the recording media if you insert or remove the media while the Media Status LED is red or yellow (solid or blinking). Wait until the Media Status LED is green before you replace media. For more information, see Section 14.2 "Introducing the Status LEDs" on page 91.

The Taurus continues to collect and buffer data while the Controller is shut down. The Controller starts up again when you close the media door. If you want to preserve all of the buffered data, replace the media and close the media door before the data buffer fills. The time elapsed before the buffer fills will range from a few minutes to several hours, depending on factors including the number of active channels, sample rate, seismic signal and noise, and buffer size.

The buffer size for Tauruses with serial numbers 353, 375, and 379 and higher is 2 MB. The buffer size for all other Tauruses is 1 MB.

The buffer size for a Trident305 is 2 MB.

1. If the Taurus is running in **Communications** mode, shut down the Controller by selecting **Shutdown** on the Shutdown page.

   -OR-

   If the Taurus is running in **Buffered** mode, go to step 2.

2. Open the media door.

   Air pressure differential inside versus outside the Taurus case (for example, if the Taurus was transported by air) might make the media door difficult to remove. If this occurs, loosen (but do not remove) the pressure relief screw (Figure 3-2 on page 14) to allow the pressure to equalize. Remove the media door and then gently tighten the pressure relief screw (hand-tight is sufficient).

3. Check that the Media Status LED status is green.

   Do not remove the IDE/CF if the Media Status LED is red or yellow (solid or blinking). For more information, see Section 14.2.3 "Media Status LED" on page 93.

4. Pull on the end of the media to remove it and insert the replacement media.

5. Push the media door in place and twist the door knob clockwise to the locked position (horizontal).

   Closing the media door will start the Controller. If you want to start the display screen, press the centre key for about 1 second. The display screen will start up once the Controller has finished booting.

If you replaced the media for the Store (ext3 format), the options are as follows:

- If the active media contains a Store, the Taurus will append data to that Store automatically. If the Store was created on a different Taurus, is recommended that you delete the existing Store and create a new one (Section 16.1.2 "Deleting and Recreating Stores" on page 115).
- If the Store media is not formatted to ext3, you can format it and create a new Store (Section 16.2.2 "Formatting Recording Media for the Store" on page 117).
- If the active Store media is formatted to ext3 but does not yet contain a Store, the Taurus will create one automatically using the last Store configuration settings (see Section 16.1.1 "Creating Stores" on page 113).

16.2.2 Formatting Recording Media for the Store

The options on the Store Tools page can only be used for the recording media for the Store.

You can use the Taurus to format media for the Store from a different file system format to ext3 and to reformat used media that is already formatted to ext3. The procedure you use depends on whether one or both media types are inserted in the Taurus, which media is the active one, and whether the media is already formatted to ext3 (see Table 16-1 "Media formatting options" on page 117). The active media is the one the Taurus is currently configured to use for recording data.

Formatting will destroy all existing data and partition information on the media. The Taurus will create two directories on the media immediately after completing the formatting: /mnt/mediaType/logs and /mnt/mediaType/Store.

Table 16-1 Media formatting options

Media installed	Formatting option
One formatted, active media for the Store	You cannot format the active media if it is already formatted. Note: If you want to reuse the media, you can delete the Store on it and recreate it. For more information, see Section 16.1.2 "Deleting and Recreating Stores" on page 115.
One formatted, inactive media for the Store	You can format the inactive media whether or not it is already formatted.
Two formatted media for the Store (one active, one inactive)	You cannot format the active media if it is already formatted but you can format the inactive media. To format the currently active media, switch the media to the other media first. For information on how to do this, see Section 16.2.3 "Switching Recording to the Other Media for the Store" on page 118.
Unformatted media for the Store	You can use the format media options on the Store Tools page to format unformatted, inserted media.

16.2.2.1 Formatting Unformatted Media

When the Taurus detects unformatted media for the Store, it will indicate on the Store Tools page that the media does not exist or is not formatted and will provide the options to format, switch, reindex, and delete the media depending on the media status.

1. Select **Store Tools** from the main menu.
2. Select **Format *MediaType*** for the media you want to format.
   - If this is the currently active media type, the Taurus will format the media and create a Store using the last Store configuration settings (see Section 16.1.1 "Creating Stores" on page 113). The Taurus will start recording to it automatically.
   - If this is the currently inactive media type, the Taurus leaves it as the inactive media after formatting it. If you want to record to the currently inactive media, you can switch the media after formatting is complete (see Section 16.2.3 "Switching Recording to the Other Media for the Store" on page 118).
3. Select **Yes** on the confirmation page.

16.2.2.2 Formatting Previously Formatted Media

When the Taurus detects formatted media in the active slot for the Store, it will show the Store size and Store space used. When it detects formatted media in the inactive slot, it will indicate that the media is available. Options to format, switch, reindex, and delete the media are available depending on the media status.

If a media is already formatted to ext3, you can only reformat it if it is inactive. If you want to reformat the active media, you can install both media types, switch to the other media, and then reformat. For information on how to do this, see Section 16.2.3 "Switching Recording to the Other Media for the Store" on page 118.

If you want to reuse a media with an old Store and do not need to reformat it, you can delete the Store and recreate it (see Section 16.1.2 "Deleting and Recreating Stores" on page 115).

1. Select **Store Tools** from the main menu.
2. Select **Format *MediaType***.
3. Select **Yes** on the confirmation page.

If you select the option to switch media after formatting is completed (see Section 16.2.3 "Switching Recording to the Other Media for the Store" on page 118), you will be prompted to select the new Store capacity from the list of available options.

16.2.3 Switching Recording to the Other Media for the Store

If you have recording media for the Store (ext3 format) installed in both slots, you have the option to switch to the inactive media if it is already formatted.

1. Select **Store Tools** from the main menu.
2. Select **Switch Media**.
3. Select **Yes** on the confirmation page

Chapter 17
Upgrading Taurus Firmware

Page:	Upgrade
Log on required:	Yes

17.1 Before You Upgrade

- Contact Technical Support to obtain the Taurus firmware upgrade files (.tgz) and save them to the computer you will use to upgrade the Taurus. You will require Internet access to obtain the firmware files. For more information, see Contacting Technical Support on page 159.
- Ensure that the Taurus is connected to a local network (LAN) using the supplied Ethernet cable or equivalent.
- Make sure that the computer you will use to upgrade the Taurus has a Web browser and access to the local network.

We recommend that you use Mozilla®Firefox® 3.6 or later as your Web browser. Firefox is used by Nanometrics for product verification, and while other modern browsers, such as Google Chrome™ and Apple® Safari®, should work, they are supported on a best-effort basis only.

- Verify that the Taurus is running in Communications mode.

  For more information, see Section 5.4 "Selecting the Running Mode" on page 31.
- Verify that the Ethernet mode is set to **Static IP** to ensure that the IP address of the Taurus does not change when it reboots after the firmware upgrade.

  For more information, see Section 7.2.1 "Configuring Ethernet Settings" on page 42.
- If you want to upgrade the firmware for a Trident 305, make sure it is connected to the Taurus and properly configured. The Taurus 3.x firmware file contains the firmware for the Trident 305. For more information, see Section 17.4 "Upgrading a Trident 305" on page 123.
- We strongly recommend that you back up the data on all media that you used with Taurus version 2.x and then delete the Stores on those media. This ensures that a new Store with the new version 3.x features is created at next use.

- Verify that the Power Manager partition of a version 2.x Taurus is set to **Default Active** by performing the following steps:
  1. Type **http://*TaurusIPaddress*:8080** into a Web browser

     For example, 10.15.2.46:8080
  2. Click **ARM Firmware Page**.
  3. Click **Power Manager Firmware**.

     Either partition A or B should display **Default Active** in the **Attribute** column. If anything other than Default Active is displayed, click **Set Default**. After a few minutes, Default Active will appear in the Attribute column for the partition.
  4. Restart the Taurus.

17.2 Upgrading from Version 2.x to Version 3.x

Upgrading a version 2.x Taurus to version 3.x is a two-step process that involves first upgrading to version 2.07. Version 2.07 is a firmware release that prepares the Taurus files and subsystems for the change to the version 3.x architecture.

If you do not intend to upgrade to version 3.x, do not install version 2.07. Version 2.07 is an intermediary release that is only intended to act as a preparatory tool for your upgrade to version 3.x.

17.2.1 Upgrading from Version 2.06 or Earlier to Version 2.07

1. Log on and select **Upgrade** from the main menu.
2. Click **Browse**, select the **taurus-release-2.07.02.tgz** file you downloaded, and click **Open**.
3. Click **Upload.**

   Uploading the file over a LAN might time out if you are using a proxy server to connect to the Internet. If this happens, you can change network settings to bypass the proxy server for local addresses.

   The message "Upload Successful" will be displayed in red when the file has finished uploading.
4. Ensure that **taurus-release-2.07.02.tgz** is selected in the list and click **Install** to install the firmware and restart the Taurus using the new firmware.

   The Taurus will install the firmware and then reboot automatically.
5. After the Taurus has rebooted, clear your Web browser's temporary files (cache) before you access the Taurus user interface over an IP connection.
6. Proceed immediately to the upgrade to version 3.x. See Section 17.2.2 "Upgrading from Version 2.07 to Version 3.x" on page 121 for instructions.

17.2.2 Upgrading from Version 2.07 to Version 3.x

1. Log on and select **Store Tools** from the main menu and click **Delete Store**.
2. Select **100** from the Store Size list and click **Destroy & Recreate Store** to delete the current Store.

   You will delete this newly created Store again after the upgrade and create a new version 3.x Store.
3. After the new Store has been created, click ▼ and select **Upgrade** from the main menu.
4. Click **Browse**, select the **taurus-release-3.x.x.tgz** file you downloaded, and click **Open**.
5. Click **Upload.**

   Uploading the file over a LAN might time out if you are using a proxy server to connect to the Internet. If this happens, you can change network settings to bypass the proxy server for local addresses.

   The message "Upload Successful" will be displayed in red when the file has finished uploading.
6. Ensure that **taurus-release-3.x.x.tgz** is selected in the list and click **Install** to install the firmware and restart the Taurus using the new firmware.

   The Taurus will install the firmware and then reboot automatically.

   Once the firmware is installed and the Taurus has rebooted, the new firmware is active but it is not yet the default. You can run the Taurus with the active firmware but it will revert to the default firmware after a reboot. Steps 8 to 10 show you how to set the active firmware as the default firmware.

   You can view the active and default firmware versions on the Upgrade page.
7. After the Taurus has rebooted, clear your Web browser's temporary files (cache) before you access the Taurus user interface over an IP connection.
8. Log on and select **Upgrade** from the main menu.
9. Click **Commit** to set the currently running version of the firmware as the default firmware.
10. Click **Continue** when the message "Done commit" appears.

    Active Version and Default Version should now display the current firmware version.
11. Click ▼ and select **Store Tools** from the main menu and click **Delete Store**.
12. Select the desired Store capacity for the new Store from the list and click **Destroy & Recreate Store** to delete the current version 2.x Store and create a new version 3.x Store.

    The version 2.x Taurus has now been upgraded to version 3.x.

To maximize the amount of free space on the storage media, you can select a firmware upgrade file in the Taurus Release list on the Upgrade page and click **Delete** to remove it from the Taurus.

17.3 Upgrading from Version 3.x to Version 3.x

When you install new firmware, the Taurus reboots and uses that new firmware as the active firmware. However, the next time the Taurus reboots it will revert to the default firmware. You can change this by setting the new firmware as the default after you install it. The following steps explain how to install new firmware and set it as the default.

1. Log on and select **Status** from the main menu.
2. Verify that the Taurus is running in Communications mode.

   For more information, see Section 5.4 "Selecting the Running Mode" on page 31.
3. Verify that the Ethernet mode is set to **Static IP** to ensure that the IP address of the Taurus does not change when it reboots after the firmware upgrade.

   For more information, see Section 7.2.1 "Configuring Ethernet Settings" on page 42.
4. Click ▼ and select **Upgrade** from the main menu.
5. Click **Browse**, select the .tgz file you downloaded, and click **Open**.
6. Click **Upload.**

Uploading the file over a LAN might time out if you are using a proxy server to connect to the Internet. If this happens, you can change network settings to bypass the proxy server for local addresses.

7. Ensure that the firmware version you want to install is selected in the list and click **Install** to install the firmware and restart the Taurus using the new firmware.

   The Taurus will install the firmware and then reboot automatically.

Once the firmware is installed and the Taurus has rebooted, the new firmware is active but it is not yet the default. You can run the Taurus with the active firmware but it will revert to the default firmware after a reboot. Steps 9 to 11 show you how to set the active firmware as the default firmware.

You can view the active and default firmware versions on the Upgrade page.

8. After the Taurus has rebooted, clear your Web browser's temporary files (cache) before you access the Taurus user interface over an IP connection.
9. Click ▼ and select **Upgrade** from the main menu.
10. Type *central* in the User ID box and the corresponding password in the Password box and click **Log On**.
11. Click **Commit** to set the currently running version of the firmware as the default firmware.

To maximize the amount of free space on the storage media, you can select a firmware upgrade file in the Taurus Release list on the Upgrade page and click **Delete** to remove it from the Taurus.

You can also click **Revert** on the Upgrade page to reboot the Taurus and run it with the default version of the firmware.

17.4 Upgrading a Trident 305

Before you can upgrade a Trident 305 attached to a Taurus, the Taurus must be upgraded to version 3.3.14 or later.

1. Log on and select **Upgrade** from the main menu of the Taurus that the Trident 305 is attached to.
2. Type the serial number of the Trident 305 in the **Manual Trident S/N** box.
3. Click **Install**.

   In a few minutes, a screen that shows the progress of the Trident 305 upgrade will appear.

   When the installation has completed, the Taurus will automatically reboot.
4. After the Taurus has rebooted, click ▼ and select **Log On** from the main menu.
5. Type *central* in the User ID box and the corresponding password in the Password box and click **Log On**.
6. Click **Commit**.
7. Click **Continue** when the message "Done commit" appears in the Commit process screen.

To maximize the amount of free space on the storage media, you can select a firmware upgrade file in the Taurus Release list on the Upgrade page and click **Delete** to remove it from the Taurus.

Part 5
Hardware Reference

- Specifications
- Connector Pinouts
- Seismometer-Taurus Interconnection
- Filter Response

Chapter 18
Connector Pinouts

This chapter includes front face views of the Taurus connector receptacles and connector pinout descriptions. See Section 19.13 "Connectors" on page 136 for connector specifications.

The 4-pin connector above the IDE drive slot is for factory use only. It is not described in this User Guide.

18.1 Sensor

Figure 18-1 Sensor connector receptacle

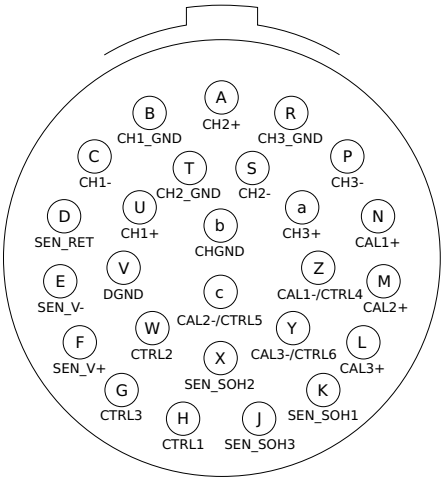


Table 18-1 Sensor connector pinout

Pin	Name	Function	Details
U	CH1+	Channel 1 input	±20V, differential
C	CH1–		
B	CH1_GND	Channel 1 ground/shield	Connected to shield ground
A	CH2+	Channel 2 input	±20V, differential
S	CH2–		
T	CH2_GND	Channel 2 ground/shield	Connected to shield ground
a	CH3+	Channel 3 input	±20V, differential
P	CH3–		
R	CH3_GND	Channel 3 ground/shield	Connected to shield ground
K	SEN_SOH1	Sensor state of health input signals	±10V, single-ended Referenced to DGND
X	SEN_SOH2		
J	SEN_SOH3		
H	SEN_CTRL1	Sensor control signal outputs	0V / 5V / 12V / high impedance Referenced to DGND
W	SEN_CTRL2		
G	SEN_CTRL3		
N	SEN_CAL1+	Sensor calibration signal outputs	±4.5V single ended Referenced to DGND in voltage mode and to CAL*n*– in current mode
M	SEN_CAL2+		
L	SEN_CAL3+		
Z	CAL1–/CTRL4	Sensor calibration signal return/ Sensor control signal outputs	Calibration signal return, or 0V / 5V / 12V / high impedance Referenced to DGND
c	CAL2–/CTRL5		
Y	CAL3–/CTRL6		
V	DGND	Digital ground	Digital ground
F	SEN_V+	Sensor power supply	Filtered, unregulated voltage
E	SEN_V–	Reserved for future use	N/C
D	SEN_RTN	Sensor power return	Switched, overcurrent protected
b	CHGND	Chassis	

18.2 GPS Antenna

Figure 18-2 GPS antenna connector

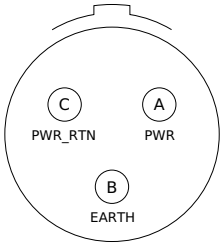
receptacle

Table 18-2 GPS antenna connector pinout

Pin	Function
A	GPS antenna signal and power
Shell	GPS ground, isolated from Taurus chassis

18.3 Power

Figure 18-3 Power connector



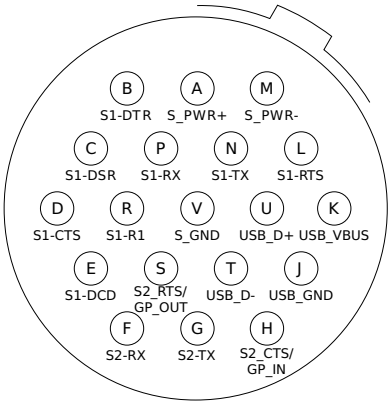
receptacle

Table 18-3 Power connector pinout

Pin	Function
A	Raw (battery) power in (9V to 36V DC)
B	Raw power supply earth
C	Raw power return

18.4 Serial/USB

Figure 18-4 Serial/USB connector



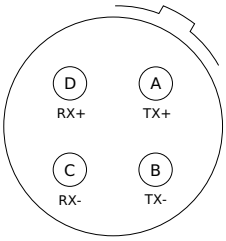
receptacle

Table 18-4 Serial/USB connector pinout

Pin	Name	Function	Details
P	S1-RX	Serial Port 1 receive	RS-232
N	S1-TX	Serial Port 1 transmit	RS-232
L	S1-RTS	Serial Port 1 RTS	RS-232
D	S1-CTS	Serial Port 1 CTS	RS-232
B	S1-DTR	Serial Port 1 DTR	RS-232
C	S1-DSR	Serial Port 1 DSR	RS-232
E	S1-DCD	Serial Port 1 carrier detect	RS-232
R	S1-RI	Serial Port 1 ring indicator	RS-232
V	S_GND	Serial Port ground	
F	S2-RX	Serial Port 2 receive	RS-232
G	S2-TX	Serial Port 2 transmit	RS-232
H	S2-CTS/GP_IN	Serial Port 2 CTS /General purpose input	RS-232
S	S2-RTS/GP_OUT	Serial Port 2 RTS /General purpose output	RS-232
U	USB_D+	Host USB data+	
T	USB_D-	Host USB data –	
K	USB_VBUS	USB power	5V, 100mA
J	USB_GND	USB ground	
A	S_PWR+	Power for serial devices	Filtered, unregulated voltage, referenced to S_PWR–
M	S_PWR–	Power return	Switched, overcurrent protected

18.5 Ethernet

Figure 18-5 Ethernet connector



receptacle

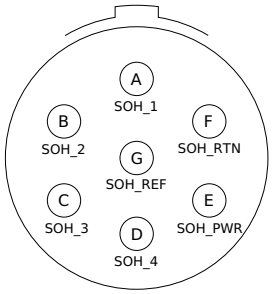
Table 18-5 Ethernet connector pinout

Pin	Function
A	Ethernet MTL-3 Transmit +
B	Ethernet MTL-3 Transmit –
C	Ethernet MTL-3 Receive –
D	Ethernet MTL-3 Receive +

18.6 External SOH

When there is a negative input voltage across External SOH values (pins A-G, for example) and if ground is connected to negative on the voltage supply, then an incorrect value appears for SOH. Ensure ground is floating from negative to prevent this error.

Figure 18-6 External SOH connector



receptacle

Table 18-6 External SOH connector pinout

Pin	Function	Details
A	External SOH Port 1	±2.5V DC, referenced to pin G (SOH_REF)
B	External SOH Port 2	
C	External SOH Port 3	
D	External SOH Port 4	
G	External SOH reference	
E	External SOH power	3.3V, 10mA
F	External SOH power return	

18.7 NMXbus

Figure 18-7 NMXbus connector receptacle

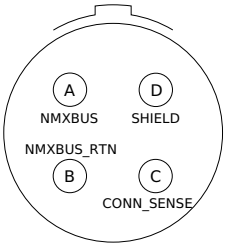


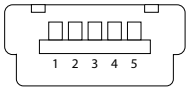
Table 18-7 NMXbus connector pinout

Pin	Function
A	NMXbus power and signal; filtered, unregulated voltage
B	NMXbus power and signal return, switched, overcurrent protected
C	NMXbus cable connection sense, referenced to NMXBUS_RTN
D	NMXbus cable shield

18.8 USB

This connector description refers to the mini USB connector socket in the media bay.

Figure 18-8 USB connector



receptacle

Table 18-8 USB connector pinout

Pin	Function	Details
1	Standard USB power	+5V DC, 100mA
2	Data –	
3	Data +	
4	On-The-Go Sense	
5	USB ground	

Chapter 19
Specifications

19.1 Sensor Input

Channels	3
Sampling	Simultaneous
Hardware gain selection	Software configurable 0.4, 1, 2, 4, 8
Peak-to-peak input voltage range	40V, 16V, 8V, 4V, 2V
Maximum input voltage range	$40V_{pp}$ differential (at hardware gain = 0.4)
Maximum single-ended voltage	±1.56V, $3.12V_{pp}$ or ±3.6V, $7.2V_{pp}$ These limits apply to all gain settings.
Maximum common mode signal	±0.78V, $1.56V_{pp}$ or ±1.8V, $3.6V_{pp}$ These limits apply to all gain settings.
Nominal sensitivity	1 count/µV (at hardware gain = 1)
Input impedance	Selectable low impedance (43.07kΩ ±0.2%) or high impedance (> 9MΩ)

19.2 Digitizer Performance

Type	Proprietary high order sigma-delta
Digital filter	140 dB attenuation at Nyquist frequency
Filter type	Linear phase (consult factory for other options)
Dynamic range	> 141dB (maximum sine wave above shorted input level) at 100sps
Shorted input noise	< 1 counts RMS (of 24 bits) at 100sps
Sample rates	10, 20, 40, 50, 80, 100, 120, 200, 250, 500, 1000 sps
Software gain	User configurable 0.001 to 100
High pass filter	User configurable 0.001 to 1.0Hz

19.3 Sensor Support

Sensor types	Broadband active and short period passive
Control lines	6 Typically used for Cal enable, mass centre, and mass lock/unlock. The following assert/deassert levels can be configured: ◆ Assert (On): High Z, Zero, Positive (5V, 12V) ◆ Deassert (Off): High Z, Zero, Positive (5V, 12V)
Mass position	Mass position monitoring, ±10V range
Sensor power	◆ Supply power pass-through to sensor (9V to 36V DC) ◆ Protected against short circuit ◆ Sensor power can be switched on/off from the user interface
Calibration signal	◆ Ramped sine wave (Sine) ◆ Pseudo-random binary (PRB) ◆ Pulse signal (Pulse)
Calibration control	User interface (local or remote)
Calibration mode	Voltage or current

19.4 Timing Subsystem

Timing system	Internal VCXO clock disciplined to GPS
Timing accuracy	<100µs
GPS receiver	Internal 8 channel or 12 channel
GPS antenna	External active antenna; 3.3V, 100mW
Duty cycle	Software configurable

19.5 State-Of-Health (SOH)

Continuously recorded SOH	See Section 15.2 "Extracting State of Health Data" on page 109. ◆ Instrument ◆ Environment ◆ GPS time ◆ GPS satellites ◆ PowerPC
External SOH	4 analog SOH channels (12-bit, digitized), available for user-defined purposes
Configuration	Configuration audit trail
Log file	All software-generated log messages are stored with the data

19.6 Removable Media Data Storage

Media options	Dual Removable CompactFlash – SanDisk Extreme® Series: • One CF in Linux ext3 format (Store files) • One CF in FAT32 format (MiniSEED and SOH files) -OR- Removable CompactFlash – SanDisk Extreme® Series and 1.8" IDE disk drive – 20GB to 60GB

19.7 Recording Data in Store

Media	Removable ext3 CompactFlash card or IDE hard drive
File system	Linux ext3
Recording mode	Continuous ring buffer (overwrites oldest data)
Storage format	Nanometrics Store Extraction to MiniSEED, MiniSEED Sorted, ASCII, SEGY, Seisan, or SAC

19.8 Recording MiniSEED and SOH Files

Media	Removable CompactFlash – SanDisk Extreme® Series
File system	FAT32 CompactFlash readable on standard USB flash card reader
Recording mode	Continuous ring buffer (overwrites oldest data)
Storage format	MiniSEED files NP Binary files (SOH) CSV files (SOH)

19.9 Data Retrieval

Media exchange	Removable IDE hard drive or ext3 CompactFlash card
Download interfaces	10/100Base-T Ethernet, serial

19.10 Real-time Data Communication

Interfaces	◆ 10/100Base-T Ethernet ◆ RS-232 serial. Port 1 has all RS-232 signals; Port 2 has Rx, Tx, RTS, CTS
Protocols	◆ UDP/IP unicast/multicast ◆ HTTP (POST and GET) ◆ RS-232 serial with IP drivers

19.11 Integrated User Interface

LEDs	System status (tri-colour), Ethernet communication status, media write status
Colour display	240x320 colour graphics LCD display with backlight 3.5" diagonal
Input device	5-key navigation control for internal browser

19.12 Software

Operating system	Embedded Linux
Applications software	Nanometrics Apollo Data Acquisition Server with Web interface

19.13 Connectors

Sensor	26-socket, shell size 16, MIL-C-26482 Series 1 Mating connector MS3116J16-26P
GPS	TNC female Mating connector TNC male
Power	3-pin, shell size 8, MIL-C-26482 Series 1 Mating connector MS3116J8-3S
USB/Serial	19-socket, shell size 14, insert position W, MIL-C-26482 Series 1 Mating connector MS3116J14-19PW
Ethernet	4-socket, shell size 8, insert position W, MIL-C-26482 Series 1 Mating connector MS3116J8-4PW
SOH	7-socket, shell size 10, MIL-C-26482 Series 1 Mating connector MS3116J10-7P
NMXbus	4-pin, shell size 8, MIL-C-26482 Series 1 Mating connector MS3116J8-4S
USB	Mini USB Type AB socket Mating connector mini USB Type A or Type B plug

19.14 Ports

Ethernet	10/100Base-T port for remote configuration and IP packet forwarding
Serial	◆ Serial Port 1: Rx, Tx, RTS, CTS, DTR, DSR, CD, RI ◆ Serial device power (pass through supply voltage)
External state-of-health	◆ 4 user-defined 12-bit channels ◆ Data rate: configurable, options up to 1 sample per 5 seconds ◆ Input range for each channel: ±2.0V DC • Uncalibrated accuracy: (maximum offset error ±0.07V, maximum gain error 2%) or (maximum error ±0.11V from –2V DC to +2V DC) ◆ SOH power: 3.3V DC regulated, 10mA maximum

19.15 Power

Supply input voltage	9V to 36V DC
Power consumption (average typical)	Typical configurations: ◆ Buffered mode: 12V, 3-channel at 100sps, <100µsec timing precision: • ~750mW recording to CF card • ~800mW recording to IDE hard drive ◆ Communications mode: 12V, 3-channel at 100sps, <100µsec timing precision, real-time Ethernet or serial communication: • ~2.3W continuous recording to CF card ◆ All systems operational including colour graphics display screen: • ~3.3W continuous recording to IDE hard drive In any mode: ◆ For common mode range configured to Extended, add 40mW. ◆ For GPS configured to Always On, add 200mW.
Protection	Configurable low voltage disconnect and restart, reverse battery and overvoltage protection, short circuit and overcurrent protected by resettable electronic circuit breakers.
Isolation	Supply power is isolated from signal ground
Earth	Predrilled hole for M4 x 5 earth lug screw
Low/high voltage disconnect	Software configurable
Peripheral power output	Typical over-current limit threshold ◆ Sensor (SEN_V+, SEN_RTN): 1000mA ◆ NMX Bus (NMXBUS, NMXBUS_RTN): 1000mA ◆ Serial (S_PWR+, S_PWR–): 750mA

19.16 Environmental

Operating temperature	For CompactFlash recording option: ◆ –20°C to 60°C For IDE disk drive recording option: ◆ 5°C to 55°C
Storage temperature	–40°C to 70°C
Humidity	0 to 100% non-condensing with media door closed, under 90% with media door open
Operating altitude	◆ For IDE hard drive, –60m to 3000m (–200 feet to 10000 feet) ◆ SanDisk Extreme Series CompactFlash card, no limit
Dimensions	Width = 147mm, Length= 264mm, Depth = 60mm
Weight	1.8 kg
Construction	Machined aluminum case
Weather resistance	IP67 with the following conditions met ◆ Media door is closed. ◆ Connectors are either in use or sealed with the optional factory-installed dust caps or equivalent. ◆ Self-sealing pressure relief screw is torqued to hand-tight (about 1N·m or 9lb·in).

19.17 Regulatory Compliance

Emissions	EN55022:1998 / CISPR22:1997 (modified); FCC Part 15:2004, Subpart B, Class A
Immunity	EN55024:1998 / CISPR24:1997 (modified)

Chapter 20
Seismometer-Taurus Interconnection

This chapter describes considerations and requirements for connecting the Taurus to a seismometer using the Nanometrics Trillium seismometers as an example. The principles apply in general to connecting high-performance seismometers to high-resolution Digitizers.

The Taurus is designed for best dynamic range performance when used with seismometers with differential outputs. For more information, see Section 20.5 "Taurus Operation with Single-Ended Inputs" on page 144.

20.1 Circuit Description

20.1.1 Taurus

High-resolution Digitizers will always have differential input circuits; however, they will differ in their input impedance, RF suppression, and common-mode rejection. It is also important to determine whether or not the power supply is isolated.

The Taurus input stage has an input impedance of 43.07 kΩ (low impedance mode) or 9.4 MΩ (high impedance mode). It has a typical common-mode range of approximately ±0.78 V (Normal) or ±1.8 V (Extended) with respect to the case.

The front end is designed with excellent RF suppression so that the Taurus can be operated in the presence of radios and cell phones through the use of properly designed cables. The Taurus power supply is completely isolated from the rest of the electronics and the case.

The Taurus also provides state-of-health inputs and control, calibration, and sensor power outputs.

20.1.2 Sensors

High-performance active sensors always have differential output stages. Other active sensors sometimes have single-ended output stages. Passive seismometers have an isolated output coil. Active sensor power supplies can be isolated or not.

The Trillium 240 seismometer output is a balanced differential output with a clip level of 16V peak-to-peak and an output impedance of 300Ω (150Ω each output). The Trillium seismometers power supply is completely isolated from the rest of the electronics and the case.

The Trillium seismometers also provide mass position outputs and a calibration input. For the Trillium 40 seismometer, active-low control inputs have three purposes: to act as calibration enable inputs, to configure the output signals (UVW or XYZ), and to select the short or long period frequency response. For the Trillium 120P seismometer, these inputs are active-high.

20.2 Shielding

Sensor cables must be designed for good EMI shielding. This is most easily accomplished using double-shielded twisted-pair cables as shown in Figure 20-1 "Typical passive sensor cable design" on page 141 and Figure 20-2 "Typical active sensor cable design" on page 142.

The twisted-pair cables provide magnetic shielding:

- The inner shield grounded at the Taurus provides good electric field shielding
- The continuous outer shield provides good high-frequency RF shielding.

  The outer shield must be earthed for safety.

For optimal RF shielding, the outer shield should make a continuous connection with the shells of the connectors at both ends.

20.3 Grounding

20.3.1 General Considerations

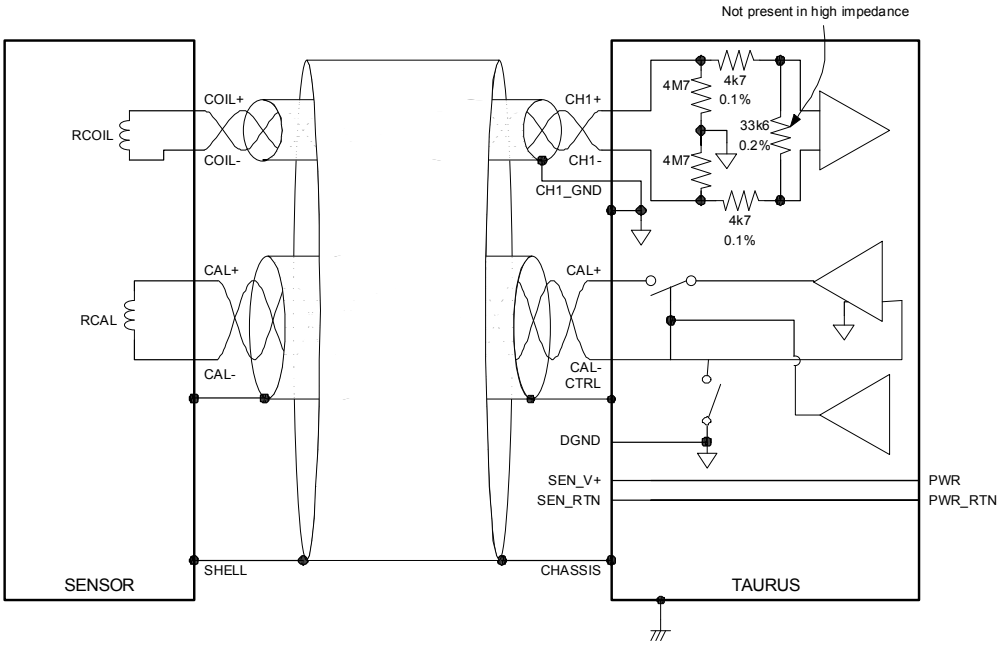
The Taurus and sensor cases must always have a low-resistance path to ground for safety. However, directly earthing both instruments will result in a ground loop. When the Taurus and sensor are far apart, the differences in ground potential will cause spurious signals to appear unless the loop is broken. The solution is to earth the Taurus case and isolate the sensor case or to isolate the Taurus case and earth the sensor case.

Usually the simplest solution is to earth the Taurus as shown in Figure 20-1 "Typical passive sensor cable design" on page 141 and Figure 20-2 "Typical active sensor cable design" on page 142. A hole pre-drilled for an M4 x 5 screw is provided on the side of the Taurus case for this purpose (see Figure 4-2 "Hole for grounding lug screw" on page 19). The Trillium seismometers have stainless steel adjustable feet, which when mounted directly onto dry rock or concrete provide a high resistance to ground. In wet environments, it might be necessary to mount the sensor on a plate of glass embedded in sand or to earth the sensor and isolate the Taurus case. Some sensors might have no chassis connection at the connector. In this case, the sensor and Taurus must be earthed separately.

20.3.2 Passive Sensors

For a passive sensor, connect the output and calibration coils as shown in Figure 20-1 and Table 20-1.

Figure 20-1 Typical passive sensor cable design



The 4.7 MΩ input resistors at the input of the Taurus ensure that the common-mode voltage is negligible.

Table 20-1 Typical passive sensor wiring list

From			To			Colour	Run
Connector	**Pin***	**Name**	**Connector**	**Pin**	**Name**		
P1		COIL+	P2	U	CH1+	RED	1
P1		COIL–	P2	C	CH1–	BLK	1
			P2	B	CH1_GND	DRAIN	1
P1		CAL+	P2	N	SEN_CAL1+	WHT	2
P1		CAL–	P2	Z	CAL1–/CTRL4	BLK	2
P1		SHELL	P2	b	CHGND	DRAIN	2
P1		SHELL	P2	b	CHGND	BRAID	

* Pinout depends on the passive sensor that is selected.

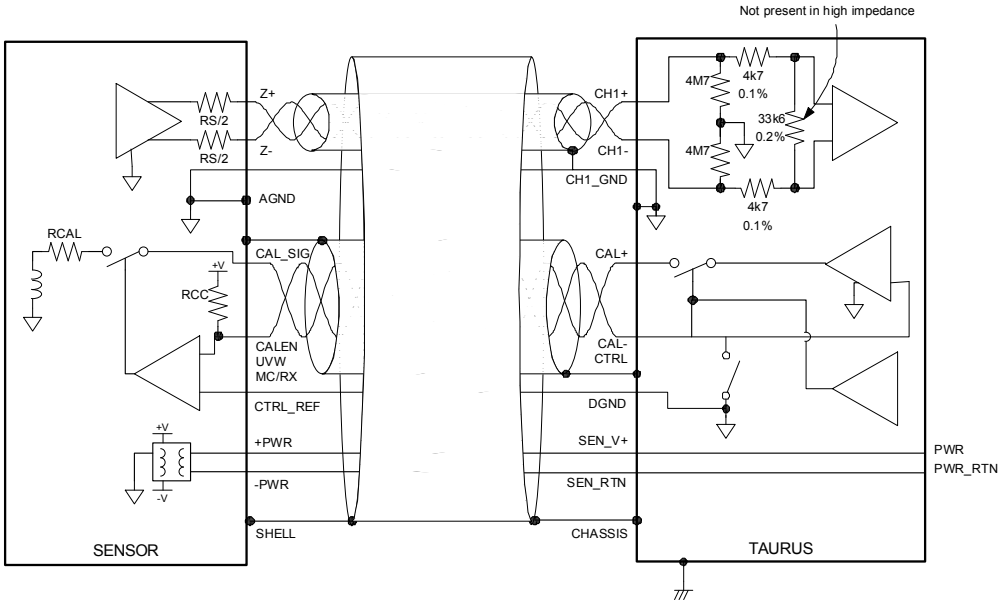
In Table 20-1, P1 is the sensor connector and P2 is the Taurus connector. The Colour and Run columns are used to indicate which signals are paired together and how the shields are connected.
DRAIN refers to the drain wire of the shield of the twisted pair indicated in the Run column and BRAID refers to the overall braided shield of the cable.

20.3.3 Active Sensors

Figure 20-2 shows a typical cable design for an active sensor with a differential output. Only one channel is shown and the mass position state-of-health connections have been omitted.

A typical wiring list is given in Table 20-2. Pinouts given are for the Trillium seismometer and the Taurus.

Figure 20-2 Typical active sensor cable design



When the sensor or Taurus power supplies are isolated, there is nothing to constrain the common-mode voltage of the sensor outputs with respect to the Taurus ground. For optimal shielding performance, the Taurus channel grounds are connected to the drain wires of the inner shields at one end of the cable only. Therefore, it is of critical importance that the analog ground of the sensor (AGND) is connected separately to the analog ground of the Taurus (CH1_GND). The other two Taurus channel grounds (CH2_GND and CH3_GND) should only be connected to their respective shield drain wires and not to AGND.

The control signal reference (CTRL_REF) serves as the reference voltage for all of the Trillium sensor control signals (U_CALEN, V_CALEN, W_CALEN, UVW and MC). This should be connected to the appropriate ground for the control signal outputs on the Taurus. In the case of the Taurus, this is the digital ground (DGND).

Table 20-2 Typical active sensor wiring list

From			To			Colour*	Run
Connector	Pin	Name	Connector	Pin	Name		
P1	L	Z+/W+	P2	U	CH1+	RED	1
P1	M	Z–/W–	P2	C	CH1–	BLK	1
			P2	B	CH1_GND	DRAIN	1
P1	N	Y+/V+	P2	A	CH2+	WHT	2
P1	A	Y–/V–	P2	S	CH2–	BLK	2

Table 20-2 Typical active sensor wiring list (Continued)

From			To			Colour*	Run
Connector	Pin	Name	Connector	Pin	Name		
			P2	T	CH2_GND	DRAIN	2
P1	P	X+/U+	P2	a	CH3+	GRN	3
P1	B	X–/U–	P2	P	CH3–	BLK	3
			P2	R	CH3_GND	DRAIN	3
P1	T	CAL_SIG	P2	N	CAL1+	BLU	4
P1	U	W_CALEN	P2	Z	CAL1–/CTRL4	BLK	4
P1		SHELL	P2		SHELL	DRAIN	4
P1	J	V_CALEN	P2	c	CAL2–/CTRL5	YEL	5
P1	K	U_CALEN	P2	Y	CAL3–/CTRL6	BLK	5
P1		SHELL	P2		SHELL	DRAIN	5
P1	S	W_MP	P2	K	SEN_SOH1	BRN	6
P1	F	V_MP	P2	X	SEN_SOH2	BLK	6
P1		SHELL	P2		SHELL	DRAIN	6
P1	E	U_MP	P2	J	SEN_SOH3	ORG	7
P1	V	AGND	P2	B	CH1 GND	BLK	7
P1		SHELL	P2		SHELL	DRAIN	7
P1	H	+PWR	P2	F	SEN_V+	RED	8
P1	G	–PWR	P2	D	SEN_RTN	WHT	8
P1		SHELL	P2		SHELL	DRAIN	8
P1	D	UVW/TX	P2	H	CTRL1	RED	9
P1	C	MC/RX	P2	W	CTRL2	GRN	9
P1	R	CTRL_REF	P2	V	DGND	DRAIN	9
P1		SHELL	P2	b	CHGND	BRAID	
P2	N	CAL1+	P2	M	CAL2+		
P2	M	CAL2+	P2	L	CAL3+		

* Depends on cable type: This example shows Nanometrics cable 13050-x.

In Table 20-2, P1 is the sensor connector and P2 is the Taurus connector. The Colour and Run columns are used to indicate which signals are paired together and how the shields are connected.

DRAIN refers to the drain wire of the shield of the twisted pair indicated in the Run column and BRAID refers to the overall braided shield of the cable.

20.4 Other Considerations

Some other factors to consider when designing sensor cables are as follows:

- Ensure that the cable length does not cause the sensor requirements for capacitive loading to be exceeded.
- Ensure that the cable is not so long that the peak current requirement of the sensor results in a voltage drop that is so large that the power supply input voltage is below the minimum required at the sensor.
- Ensure that the cable is watertight.
- Check the cable electrically after assembly. In particular, ensure that the individual and overall shields are not shorted together unless so specified.
- Make sure cables are labelled with correct drawing numbers and revisions.
- Make sure the Taurus is configured so that the default states of the control lines put the sensor in the state you want it to be in.

20.5 Taurus Operation with Single-Ended Inputs

The Taurus is designed for best dynamic range performance when used with sensors with differential outputs. Over a limited voltage range, common-mode signal components induced into the input cable are rejected (for example, unwanted noise). However, common-mode signals greater than ±0.78 V (with respect to chassis ground) cause distortion. The maximum single-ended signal before distortion, V_{max}, is computed from the maximum common-mode voltage, $V_{cm_{max}}$, using:

$$V_{max} = 2 \times V_{cm_{max}} = 2 \times 0.78 = 1.56\text{V}$$

The common-mode range can be extended to ±1.8 V.

20.5.1 Input Range and Gain for a Single-Ended Signal

A single-ended signal can be considered as the sum of differential (dif) and common-mode (CM) signals.

Assume (V_{CM}) is the common-mode input, to both positive and negative terminals, and $V_{dif}/2$ and $(-V_{dif})/2$ are the differential inputs. If these are the components of a single-ended signal and the negative terminal is connected to ground return, then $V_{CM} + (-V_{dif}/2) = 0$. Therefore, $V_{CM} = V_{dif}/2$.

At the positive terminal, with $V_{CM} + V_{dif}/2$ referred to ground, the differential input is $(V_{CM} + V_{dif}/2) - (V_{CM} + ((-V_{dif})/2)) = V_{dif}$.

Therefore, gain to a single-ended signal is the same for differential and the common-mode component is half of the single-ended input.

Chapter 21
Filter Response

21.1 Response Overview

Analog signals connected to the Taurus and Trident 305 are low pass filtered before being sampled at 30 kHz. This data is then low pass filtered and decimated to the configured output sample rate. The output bandwidth of the primary sample rate data will always be 40% of the output sample rate. The 40% value is the point at which the designed high end of the passband starts rolling off.

The low frequency response is also configurable using an optional DC removal filter. With the filter disabled, the response is to DC (0 Hz). With the filter enabled, it will be applied to both output sample rates and can be configured to a frequency in the range 0.001 to 1 Hz.

21.2 Analog Low Pass Anti-alias Filter

The analog anti-alias filter is a first order low pass filter, with a corner frequency that is dependent on whether the Digitizer input impedance is set to low impedance (Low-Z) or high impedance (High-Z).

21.2.1 Transfer Function

$$F(s) = \frac{1}{R \cdot C \cdot s + 1}$$

where

- s is the complex angular frequency
- $C = 1.0 \times 10^{-8}\mathrm{F}$
- $R = \dfrac{1}{\dfrac{1}{33600} + \dfrac{1}{(9600 + Z)}}\Omega$ for low impedance mode
- $R = (9600 + Z)\Omega$ for high impedance mode
- Z is the output impedance of the sensor

21.2.2 Corner Frequency

The corner frequency f_0 is therefore

$$f_0 = \frac{1}{2\pi RC}\text{Hz}$$

If the sensor output impedance is negligible, then

- f_0 = 2132Hz in low impedance mode
- f_0 = 1659Hz in high impedance mode

21.3 Digital FIR Low Pass Filters

A 3 or 4 stage digital low pass FIR (Finite Impulse Response) filter is used to filter and decimate the 30 kHz input data to the sample rate.

21.3.1 Transfer Function

$$y(n) = \sum_{i=0}^{N-1} c(i) \cdot x(n-i)$$

where

- $y(n)$ is the output sample
- $x(n-i)$ is an input sample
- $c(i)$ is a FIR coefficient
- N is the number of coefficients

21.3.2 FIR Filter Stages

Table 21-1 shows the number of coefficients and decimation for each filter stage for all sample rates as well as the cumulative filter delay. Compensation for this filter delay has already been applied to the sample times produced by the Digitizer. The list of filter coefficients for each filter stage can be obtained from the FIR_filter_coefficients.zip file.

Table 21-1 Stages for sample rate filters

Primary sample rate	Filter parameter	Stage				Cumulative filter delay (in seconds)
		1	2	3	4	
10	# of coefficients	213	177	113	223	6.172200
	decimation	20	15	5	2	
20	# of coefficients	165	187	113	223	3.104233
	decimation	15	10	5	2	
40	# of coefficients	177	71	113	223	1.547933
	decimation	15	5	5	2	
50	# of coefficients	203	245	223	—	1.194700
	decimation	20	15	2	—	
80	# of coefficients	165	63	497	—	0.638233
	decimation	15	5	5	—	
100	# of coefficients	165	187	223	—	0.604233
	decimation	15	10	2	—	
120	# of coefficients	59	69	113	223	0.515800
	decimation	5	5	5	2	
200	# of coefficients	173	95	223	—	0.303867
	decimation	15	5	2	—	
250	# of coefficients	187	73	223	—	0.243100
	decimation	15	4	2	—	
500	# of coefficients	123	65	223	—	0.123700
	decimation	10	3	2	—	
1000	# of coefficients	63	55	223	—	0.061033
	decimation	5	3	2	—	

21.4 Digital IIR High Pass Filter

An optional first order digital high pass IIR (Infinite Impulse Response) filter is used to remove a DC offset from the output data. Each output sample rate has its own filter using the common configuration. DC removal, when enabled, is applied after the digital FIR filtering used to produce the data at the output sample rates.

21.4.1 Transfer Function

$$y(n) = K \cdot [x(n) - x(n-1)] + F_1 \cdot y(n-1)$$

where

- $y(n)$ is the current output sample
- K is the filter gain
- $x(n)$ is the current input sample
- $x(n-i)$ is the previous input sample
- F_1 is the filter coefficient
- $y(n-i)$ is the previous output sample

21.4.1.1 Coefficients

The following coefficients are calculated at runtime for each filter:

$$F_1 = \frac{1 - \left(\frac{\pi \cdot f}{F_S}\right)}{1 + \left(\frac{\pi \cdot f}{F_S}\right)}$$

$$K = \frac{1}{1 + \left(\frac{\pi \cdot f}{F_S}\right)}$$

where

- F_S is the output sample rate
- f is the configured -3 dB corner frequency of the filter

The time constant (*TC*) of the filter can be calculated as follows:

$$TC = \frac{1}{2\pi \cdot f}$$

Appendix A
Glossary

A.1 Glossary of Abbreviations and Terms

A

AC
: Alternating Current

ADC
: Analog to Digital Converter

AGND
: Analog Ground

AMU
: Antenna Measurement Unit

ASCII
: American Standard Code for Information Interchange

ATA
: Advanced Technology Attachment

AWG
: American Wire Gauge

C

CF
: CompactFlash

CD
: Carrier Detect

CHGND
: Chassis Ground

CRC
: Cyclic Redundancy Check

CTS
: Clear to Send

D

DAC

Digital to Analog Converter

DC

Direct Current

DGND

Digital Ground

DHCP

Dynamic Host Configuration Protocol

DSR

Data Set Ready

DTR

Data Terminal Ready

E

ext3

The file system commonly used by the Linux operation system.

F

FIR

Finite Impulse Response

FTP

File Transfer Protocol

G

GNSS

Global Navigation Satellite Systems

GPS

Global Positioning System

H

HTTP

Hypertext Transfer Protocol

I

ID

Identification

IDE

Integrated Device Electronics

IIR

Infinite Impulse Response

IP

Internet Protocol

L

LAN

Local Area Network

LED

Light Emitting Diode

LP

Long Period

LTA

Long Term Averaging

N

NEIC

National Earthquake Information Center

P

PLL

Phase Locked Loop

PRB

Pseudo-Random Binary

R

RF

Radio Frequency

RI

Request for Information

RMA

Return Merchandise Authorization

RMS

Root Mean Square

RTS

Request to Send

Rx

Receive

S

SAC

Seismic Analysis Code

A waveform file used by the SAC software (see http: www.iris.edu/software/sac/).

SEED

Standard for the Exchange of Earthquake Data

SEG Y

A file format developed by the Society of Exploration Geophysicists for storing geophysical data.

SLIP

Serial Line Internet Protocol

SOH

State-Of-Health

SP

Short Period

STA

Short Term Averaging

T

TCP/IP

Transmission Control Protocol/Internet Protocol

TDMA

Time Division Multiple Access

TNC

Threaded Neill-Concelman

A type of connector on the GPS antenna.

TTL

Time-To-Live

Tx

Transmit

U

UDP

User Datagram Protocol

UI

User Interface

URL

Uniform Resource Locator

USB

Universal Serial Bus

UTC

Universal Time Coordinated

A.2 List of Unit Abbreviations and Symbols

Table A-1 provides a list of unit abbreviations and symbols commonly used in Nanometrics documentation.

Table A-1 Unit abbreviations and symbols

Abbreviation or Symbol	Definition	Abbreviation or Symbol	Definition
°	degree	lb	pound
µ	micro	m	metre
Ω	ohm	m/s	metre per second
A	ampere	m/s^2	metre per second, squared
AC	alternating current	mA	milliampere
b	bit	MB	megabyte
B	byte	MΩ	megaohm
bps	bits per second	mi.	mile
C	Celsius	mL	millilitre
cm	centimetre	mm	millimetre
dB	decibel	ms	millisecond
DC	direct current	MTU	maximum transmission unit
F	farad	mV	millivolt
ft.	foot	mW	milliwatt
g	gram	N	Newton
g	gravity	nF	nanofarad
GB	gigabyte	ns	nanosecond
Hz	hertz	rad	radian
in.	inch	rad/s	radian per second
KB	kilobyte	s	second
kg	kilogram	sps	samples per second
kHz	kilohertz	U	rack unit
kΩ	kiloohm	V	volt
kW	kilowatt	Vpp	Volts peak-to-peak
L	litre	W	watt

Appendix B
Free Software Information

Taurus Portable Seismograph software is distributed with free software that is protected by other licenses. A list of this free software and their respective licensing information is available on the Nanometrics Web site: http://www.nanometrics.ca/products/licences

B.1 Apache Licence Information

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