Taurus Seismograph Overview

Geological Survey of Canada
April 29, 2007

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Based on: Taurus FW 2.05.09
Taurus Manual R5

Outline

- Introduction
- Features
- Specifications
- Hardware
- Software
- Using the Taurus
- Apollo Support Utilities

Introduction

What is a Taurus?

- All-in-one, portable seismograph
- 3 channel 24-bit digitizer
  - > 141 dB dynamic range
- CF or ATA disk drive recording media
  - over 2 years of continuous recording
- Low power, 750mW capable
- Embedded Linux OS
- Web browser user interface
- IP communications
- Real-time Data Streaming
- Three extracted data formats

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Taurus in System

Broadband Seismometer
(Trillium 240)

Portable Digital Seismograph
(Taurus)

Ethernet / RS-232
(VSAT, Wi-Fi,
Internet, SLIP, etc.)

Web Browser
Configuration /
Data Retrieval

Data Acquisition Server
(NAQS)

Geophone
(Mark L-4)

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Modes of Operation

- Communications (real-time, configuration):
  - Continuous write to removable media
  - Taurus configuration and data are accessible via ethernet or serial ports
  - Streaming to data acquisition server capable
- Buffered (low power, stand-alone):
  - Stand alone, unattended continuous data recording, no real-time comms.
  - Periodically writes data to removable media when buffer is near full capacity
  - Lowest power consumption
  - Manual activation required for configuration and data extraction

Taurus Features

Taurus Features

- Sensor Input
  - Selectable number of Channels: 0, 1, 2 or 3
  - Selectable Hardware Gain: 0.4, 1, 2, 4 or 8
  - Maximum Input voltage range: 40 V peak-to-peak differential
    - at hardware gain = 0.4
  - Nominal Sensitivity: 1 count / μV
    - at hardware gain = 1
  - Selectable Input Impedance: 43.07kΩ (low) or > 9MΩ (high)

Taurus Features

- Digitizer Performance
  - Dynamic range: > 141 dB
  - Shorted input noise: <1 count RMS (of 24 bits) at 100 sps
  - Sampling rates: 10, 20, 40, 50, 80, 100, 120, 200, 250, 500 sps
  - Software Gain: 0.001 to 100 (user configurable)
  - High Pass Filter: user configurable 0.001 to 1.0 Hz

Taurus Features

- Sensor Support
  - Sensor Types: Active or Passive
  - Sensor Power
    - Supply power passed through (9 – 36VDC)
    - Short circuit protection
    - Configurable: ON / OFF
  - Sensor Detection: configurable
  - Control lines: 6 user configurable
    - Supporting Mass lock/unlock, mass center, cal enable, etc.
  - Mass position monitoring
    - ±10V range
    - Automatic re-centering

Taurus Features

- Sensor Calibration
  - Calibration Signal
    - ramped sine wave
    - pulse signal
    - pseudo-random binary
  - Mode
    - voltage or current
  - Initialization: user interface

Taurus Features

- Timing System
  - Internal VCXO clock disciplined to GPS
  - Timing accuracy < 100 μs
  - GPS Receiver: 12 channels
  - GPS Antenna Options
    - ETEK MA-35 Patch antenna with integrated 5 m cable
    - Trimble Bullet III: 3.3VDC
      - Not compatible with Libra system (5VDC)
  - Duty Cycle: user configurable (automatic or always on)

Taurus Features

- Data Storage
  - Removable media: Compact Flash or 1.8” IDE disk drive
  - Capacity support:
    - CompactFlash: tested up to 4 GB
    - 1.8” IDE hard drive: 20 GB to 60 GB
  - Duration: > 600 days of 3 channels @ 100 sps w/40 GB IDE drive
  - Recording mode: continuous ringbuffer
  - Storage Format
    - Nanometrics STORE (NP packets)
    - Steim (1) Compression
  - Data Extraction: MiniSEED, SEISAN, ASCII

Taurus Features

- Communications
  - Interfaces:
    - 10/100 Base-T Ethernet
      - DHCP / Static
      - Auto-MDIX
    - RS-232 serial
      - SLIP / PPP
  - Protocols:
    - UDP/IP (unicast/multicast)
    - HTTP
    - RS-232 with IP drivers
  - Streaming of multicast NP packets routed to selected default interface

Taurus Features

- State-Of-Health
  - Instrument SOH: voltage, current, mass position, GPS status, temperature
  - User SOH: 4 external user accessible SOH channels (12 bit, digitized)
  - Logging: configuration changes, software messages

Taurus Features

- Access Levels
  - User accounts have password protection
  - Authorization model defines roles with various levels of access and associates each User account with a particular role
  - Default accounts:
    - Highest Access Level: Username=central, Password=central
    - Medium Access Level: Username=tech, Password=tech
    - Default Access Level: Username=user, Password=user

Taurus Features

- Power
  - Input range: 9 to 36 V DC.
  - Fuseless design with user configurable low and high voltage disconnect
  - Reverse polarity and short circuit protection
  - Power Consumption:
    - Ultra low: 0.750W @ 12V, buffered mode with CF
    - Low: 0.800W @ 12V, buffered mode with IDE hard drive
    - Mid: 2.3W @ 12V, communications mode with CF (ethernet or serial)
    - High: 3.3W @ 12V, communications mode with IDE hard drive, display active

Taurus Specifications

Mechanical Specifications

- Machined aluminum case construction
- Weight: 1.8 kg
- 3.5” Colour LCD (320 x 240)
- IP-67 Compliant (with connector caps on)
- Multi-colour status indicator LEDs
- Scratch and chip resistant finishing
- Keyed connectors to prevent incorrect cable plug-in

Environmental Specifications

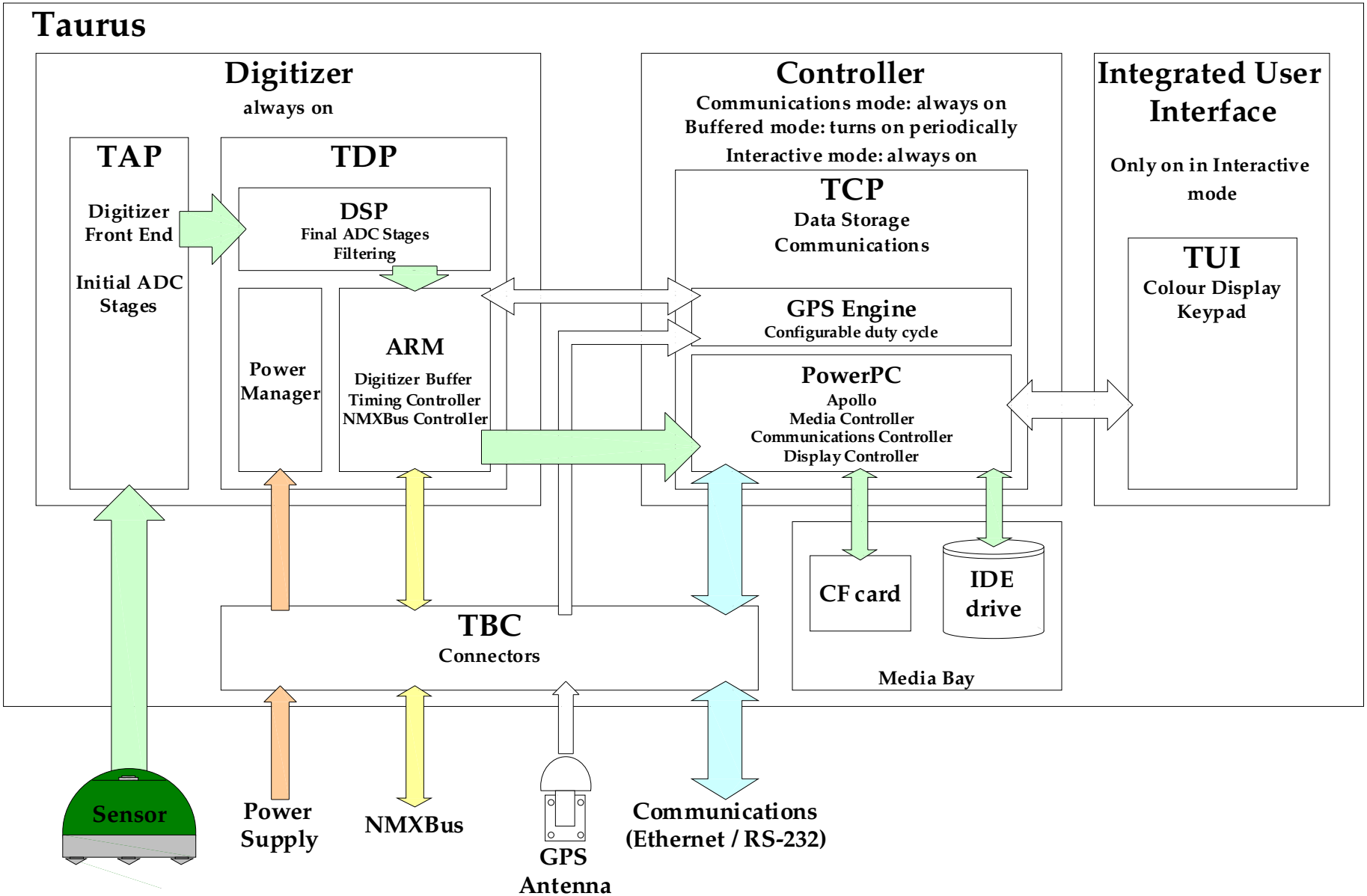
- Operating Temperatures (w/o insulation)
  - With CompactFlash card: -20° C to 60° C
  - With IDE hard drive: 5° C to 55° C
- Storage Temperature:
  - -40° C to 70° C
- Humidity:
  - With media door closed: 0-100% non-condensing
  - With media door open: under 90%
- Operating Altitude:
  - With CompactFlash card: No limit
  - With IDE hard drive: -60m to 3000m

Taurus Hardware

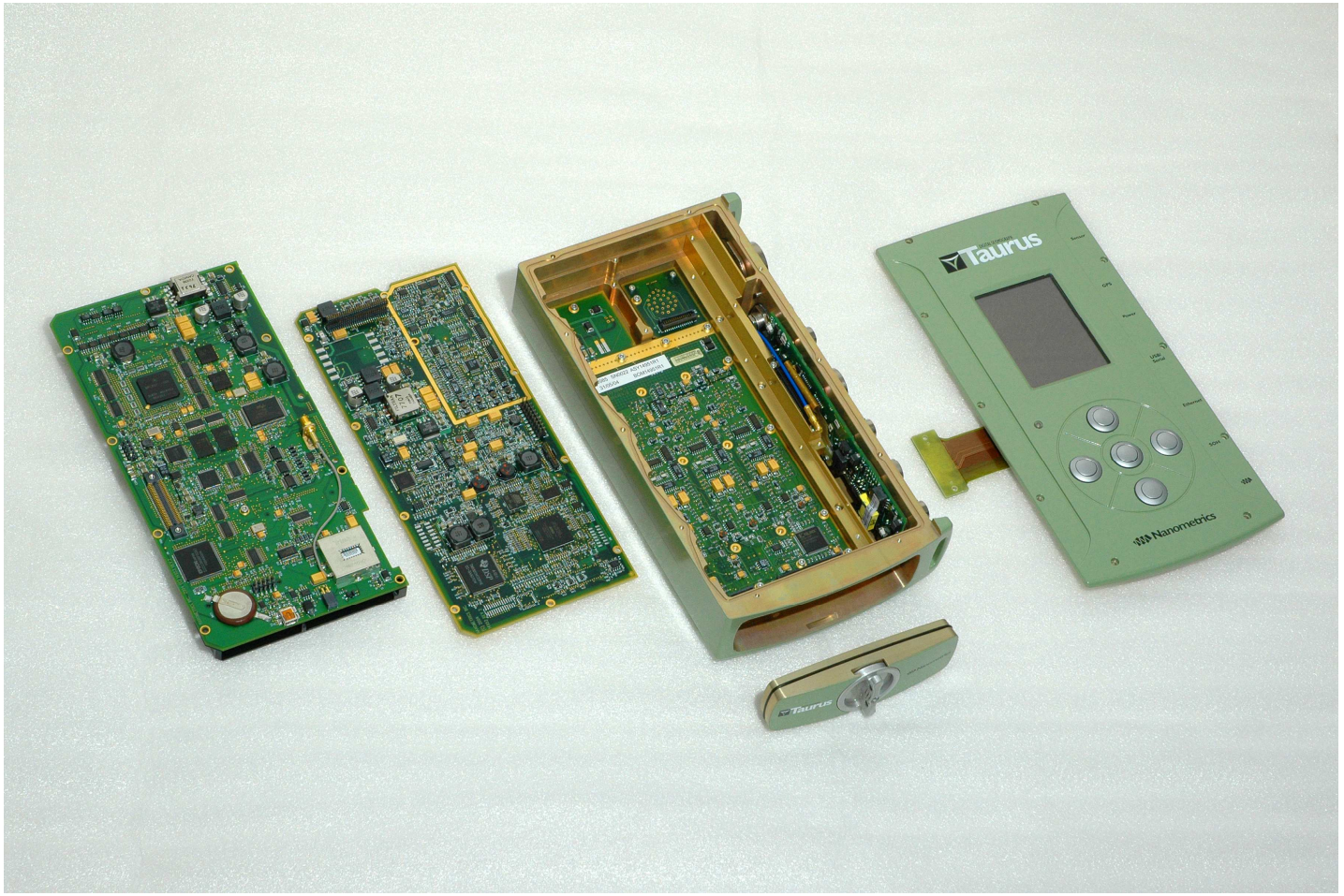
Taurus Components

- Analog Processor (TAP)
  - 3 channels 24-bit data channels
- Digital Processor (TDP)
  - DSP, filtering, GPS engine, timing
- Control Processor (TCP)
  - Linux OS, 128 MB RAM, 64 MB Flash, comms. interface, java based code
- User Interface (TUI)
  - Integrated colour display and keypad
- Backplane (TBC)
  - connectors, internally soldered

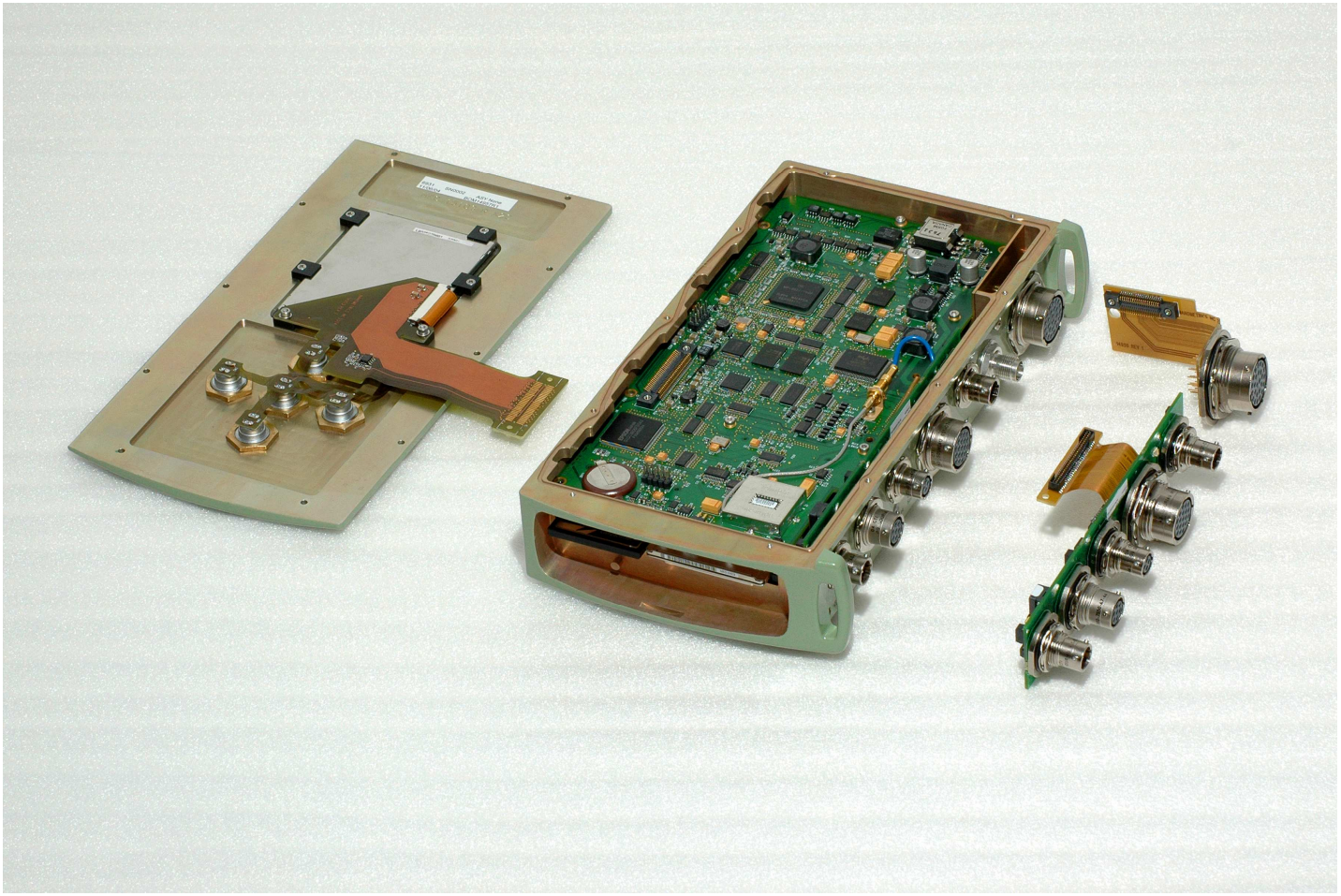
Taurus Architecture



Taurus Components



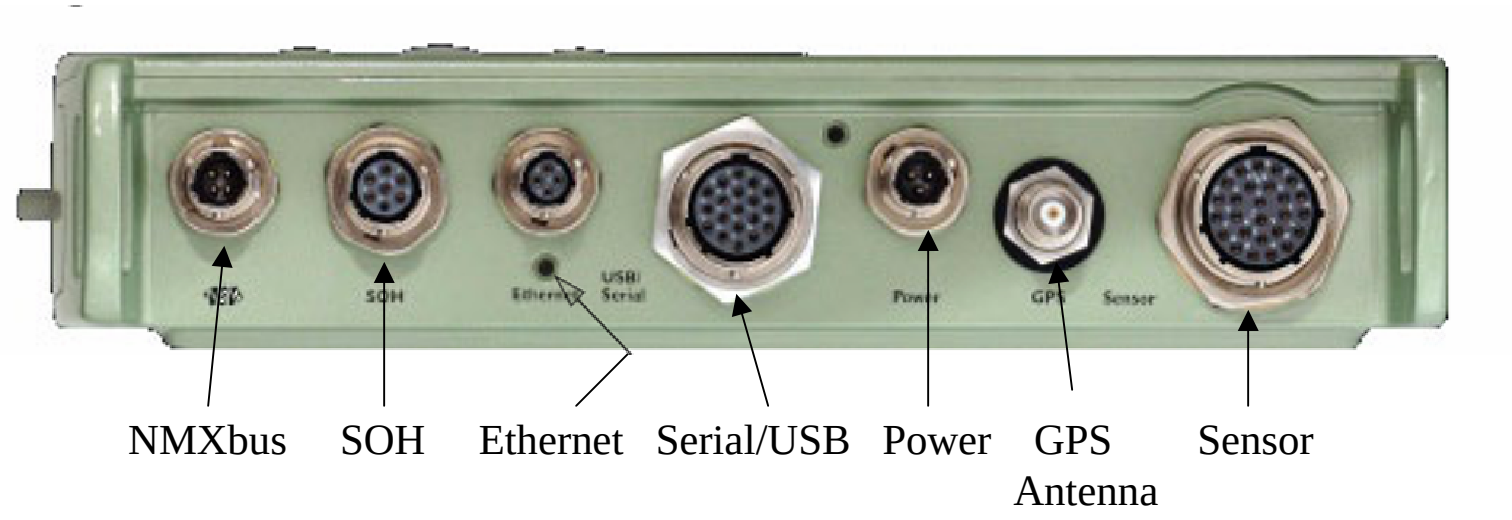
Taurus Components



Connectors

- 7 external MIL spec connectors.
- 1 internal, behind the media door.
- All connectors are keyed and are different in sizes.
- No duplicate connectors.

Connector Overview…



Status LEDs

- 4 status LEDs
  - 2 for Unit Status
    - SuperLED
  - 1 for Ethernet connection / activity
    - EtherLED
  - 1 for Media Access status
    - MediaLED

SuperLED

States:

- ○ Off – Taurus is powered off.
- ● Solid Red – Taurus is booting up.

Normal conditions to capture data:

- Fast Blinking Green – Comms. Mode
- Slow Blinking Green – Buffered Mode.

Busy condition:

- Fast Blinking Yellow - boot up, sub system init, etc.

Warning / Fault conditions:

- Fast Blinking Red – Comms Mode, door, batt, media, GPS
- Slow Blinking Red – Buffered Mode, door, batt, media, GPS

EtherLED

- States:
  - Off – controller is powered down
  - Solid Yellow – controller is booting (~8 seconds)
  - Fast Blinking Green – networking enabled, link established
  - Slow Blinking Green – networking disabled
  - Blinking Yellow – Initial power up, diagnostics
  - Blinking Red – networking is enabled, no link detected

MediaLED

- States:
  - Green – removable media (CF/IDE) can safely be removed.
  - Red – removable media is mounted, in write mode, DO NOT remove.

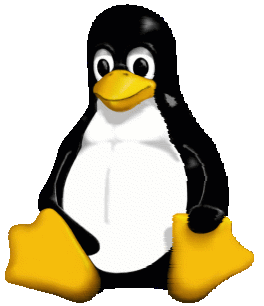
Taurus Software

Software Overview

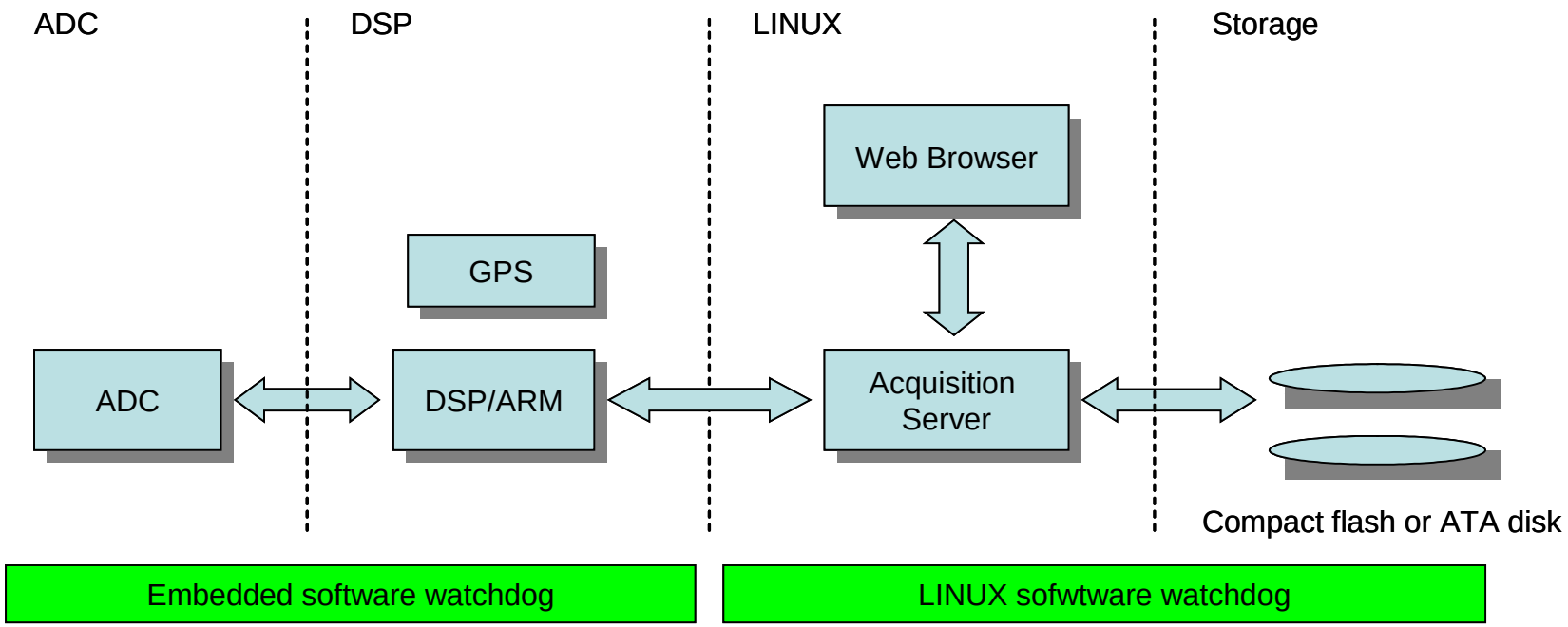
1. Software Introduction
2. Software Modules
3. Data Organization
4. Taurus Configuration
5. Real-time Data Access
6. Data Downloading

Taurus Software Introduction

- First true internet device for the seismic market.
- Web server based data acquisition system, named ***Apollo***
- “Thin client” approach, no special software required to interact with the Taurus.
- A networked Taurus can be accessed from anywhere in the world!
- Linux based operating system.
- User friendly upgrade mechanism



Software Modules



Data Organization

- Data types: waveform (time series), SOH, configuration, etc.
- Format: STORE system.
- STORE object combines waveform, SOH and config data for a given time period – all in a single file.
- Waveform data is stored in 1st difference Steim format.
- SOH & config data are stored in XML/RDF.
- Data is self describing (where, when, whom).

Taurus Configuration

- All data types are recorded by default.
- Minimal configuration required to get data recording started.
- Units can be configured individually.
- Units can have its configuration uploaded as an XML file.
- All configuration changes are logged to the STORE for traceability.

Accessing real-time data

- 2 protocols: UDP/IP or HTTP.
- UDP/IP:
  - Broadcasts data packets to an unicast or multicast IP address.
- HTTP:
  - Uses a TCP/IP socket and HTTP between Taurus and receiving software.
  - HTTP allows POST and GET commands to/from Taurus.
  - HTTP is implemented in all web servers/browsers.

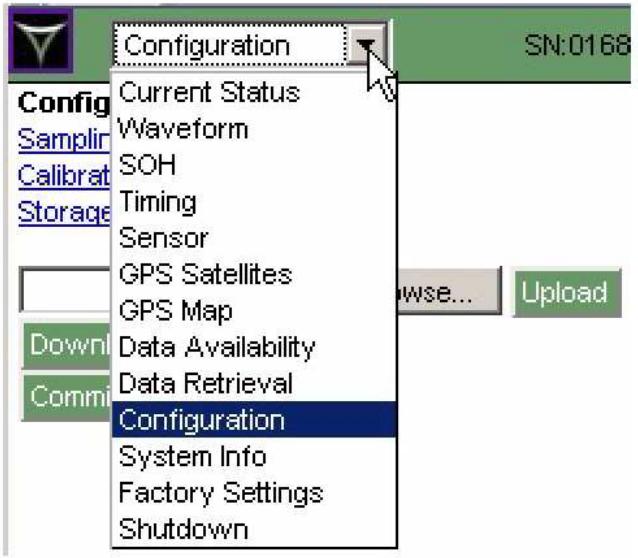
Data Downloading

- Request for specific data segments via web interface or HTTP commands
- Request for: time series data, SOH and config
- Option to directly extract data into MiniSEED, ASCII, SEISAN formats

Using the Taurus

User Interface

- On-board colour LCD.
- 5-button navigation.
- Access to acquisition system via web browser
- Functions
  - Real-time waveform data
  - SOH data
  - Configuration information
  - Calibration commands

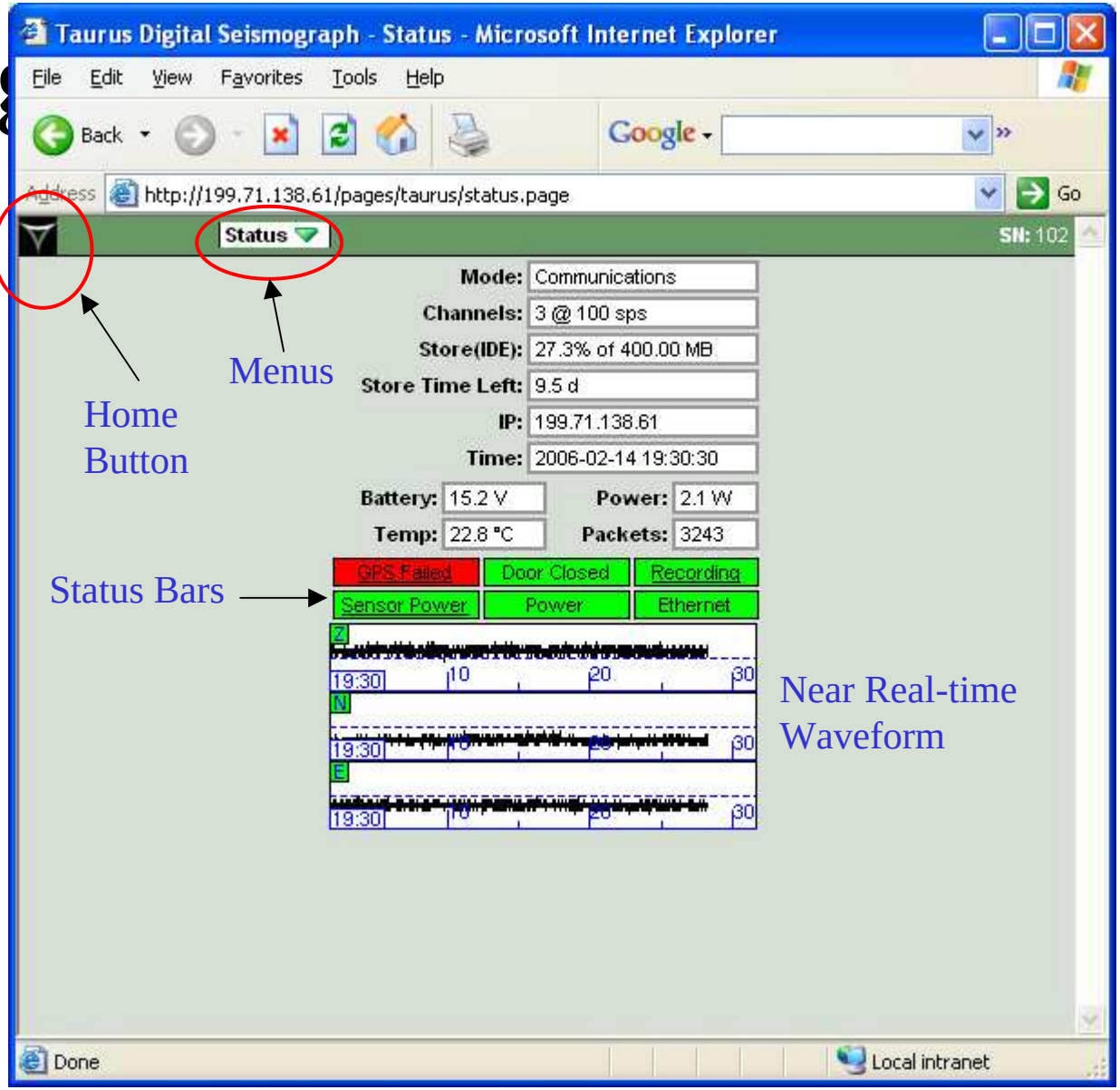


Powering Up

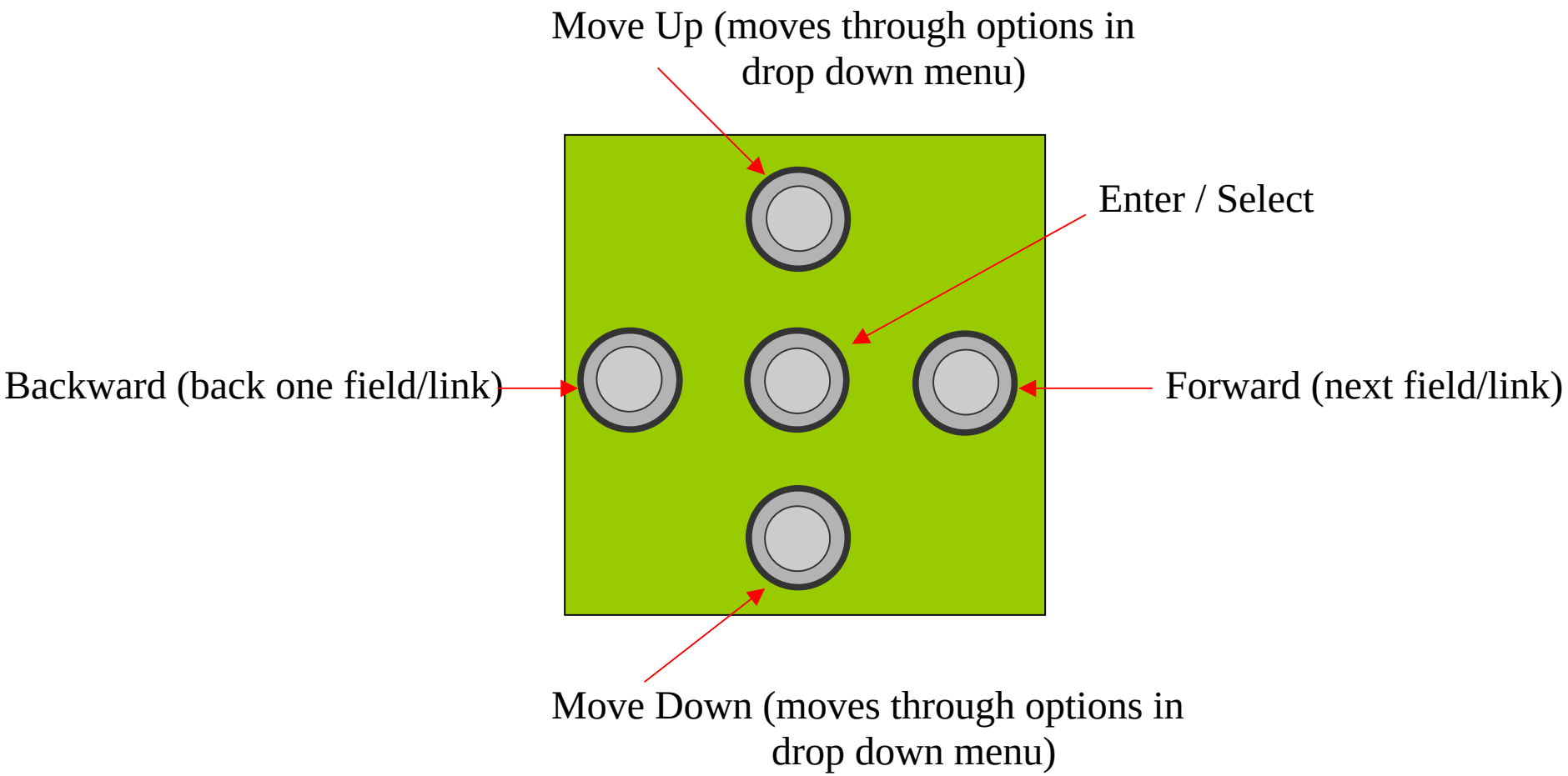
- Basic Steps:
  1. Connect the GPS, sensor and ethernet cables (if applicable).
  2. Connect the power cable (9-36 V DC).
  3. The SuperLED will transition from solid red to blinking yellow to blinking red or green.
     - The Digitizer, Controller and Timing subsystems are started when power is connected to the Taurus
     - Typically about 3 minutes
  4. After 2 minutes, press and hold the center button for 1 second to activate the display (10 to 15 seconds)

Status Pag

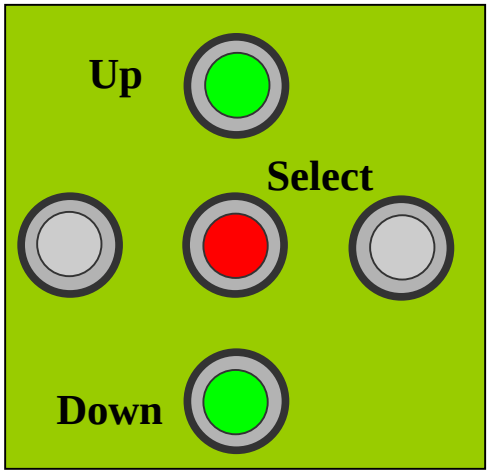
- Mode
- Channels
- Store
- IP
- Time
- Status
- Waveform



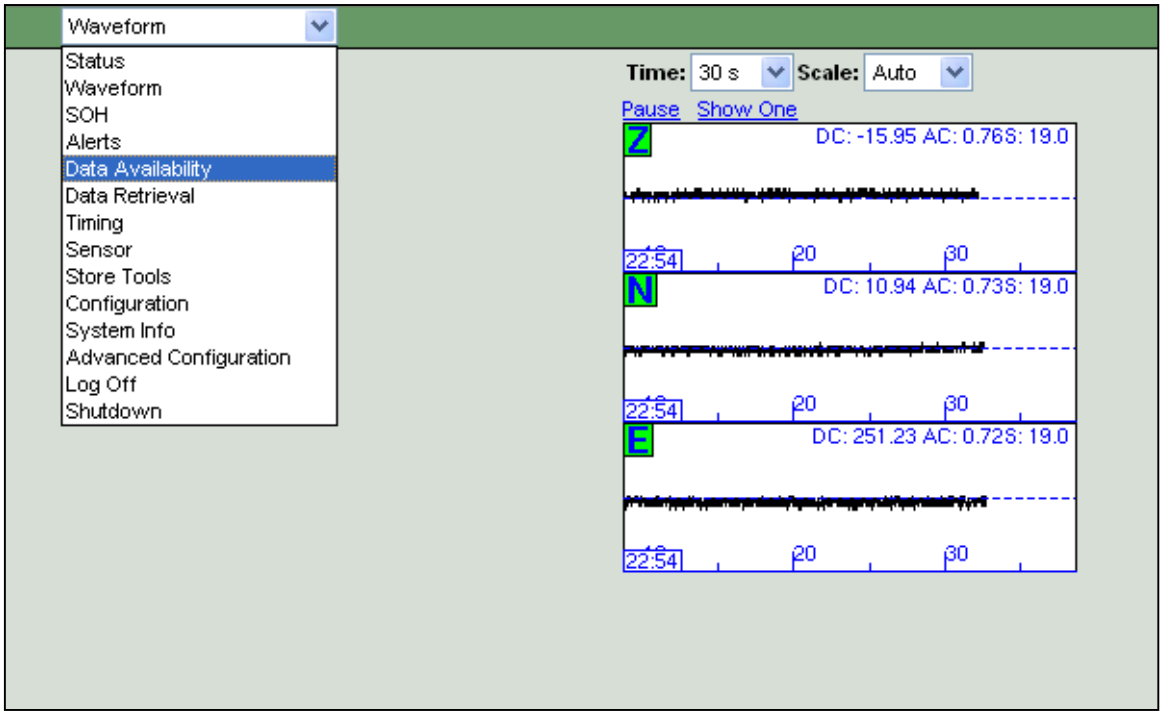
5-Button Layout and Functions



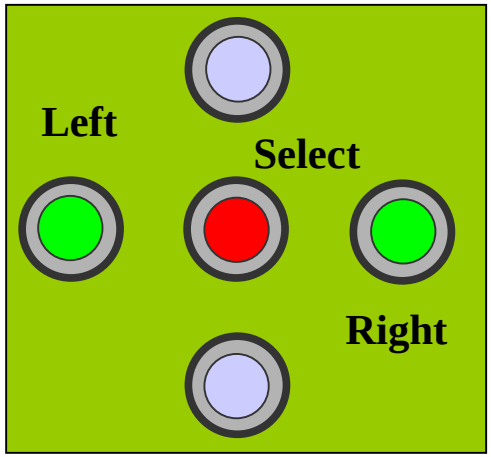
Taurus Navigation: Menus



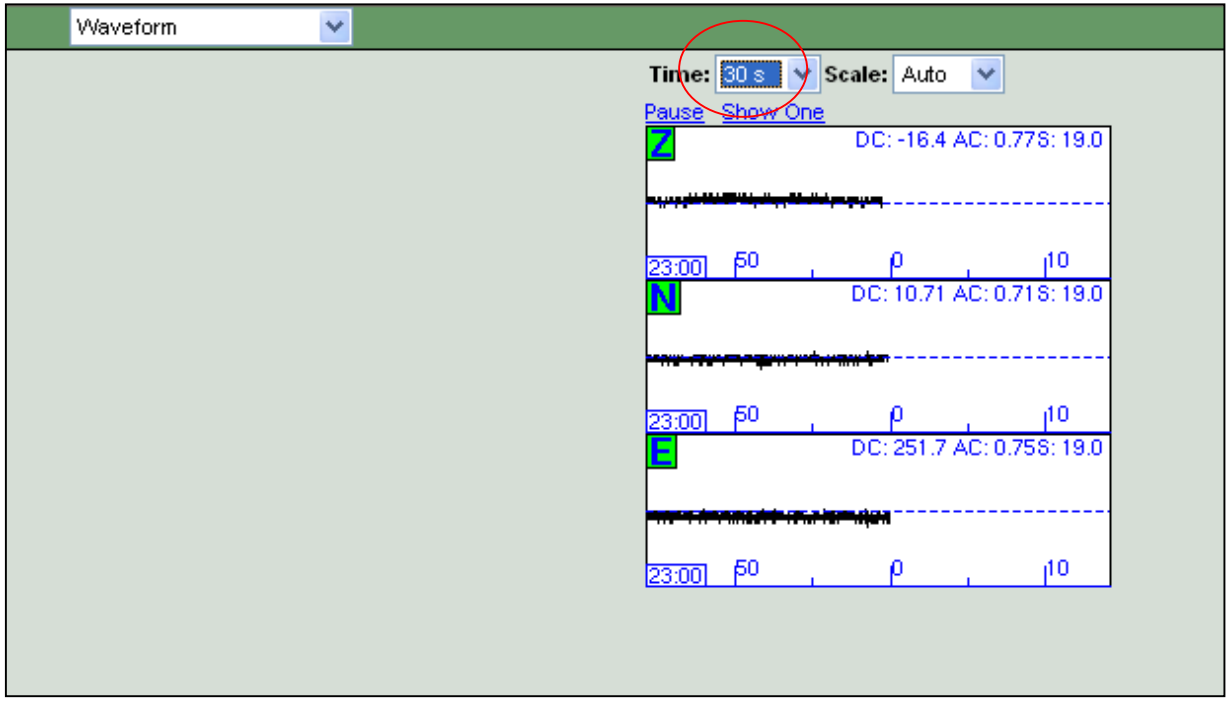
5-button pad



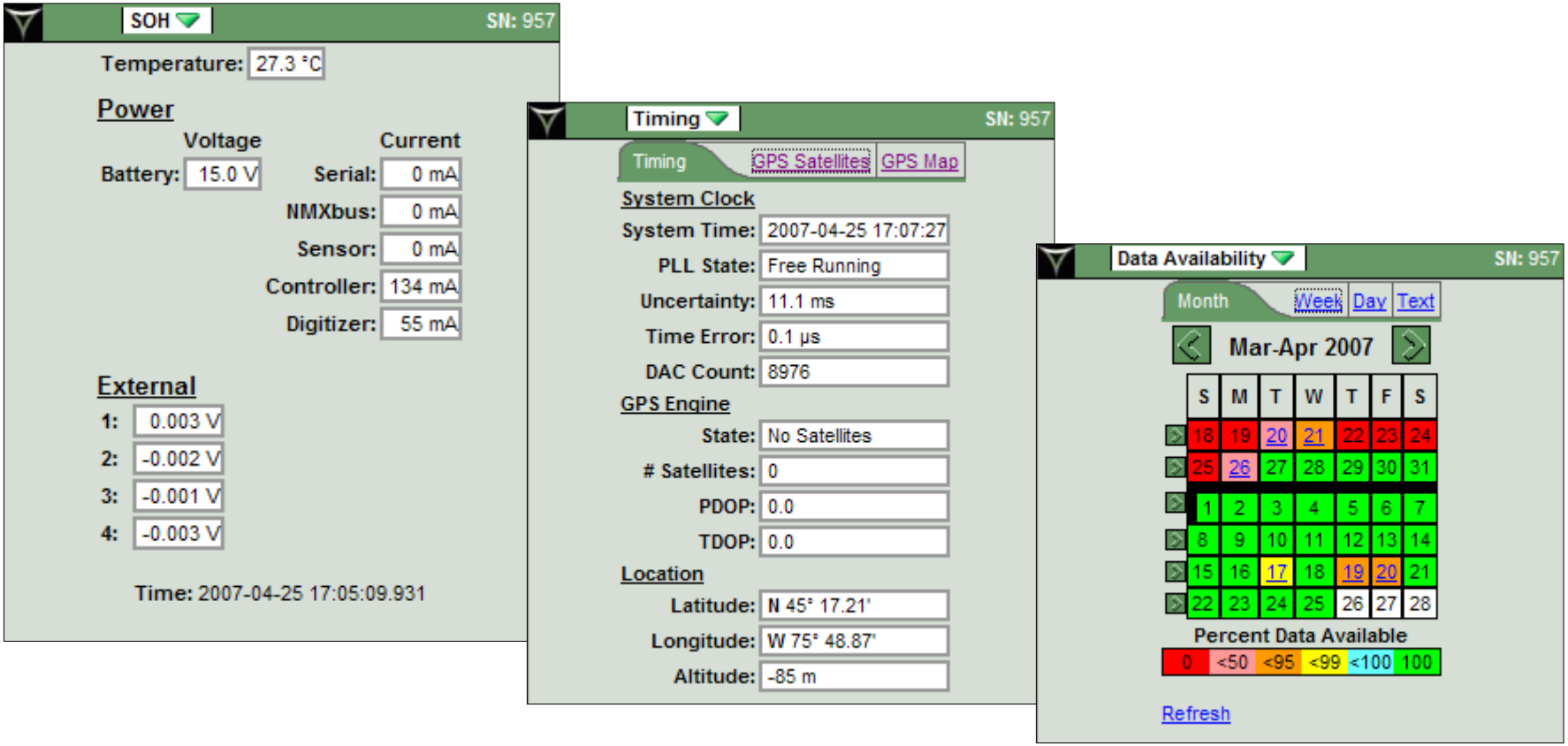
Taurus Navigation: Fields/Links



5-button pad



Navigate Taurus Pages

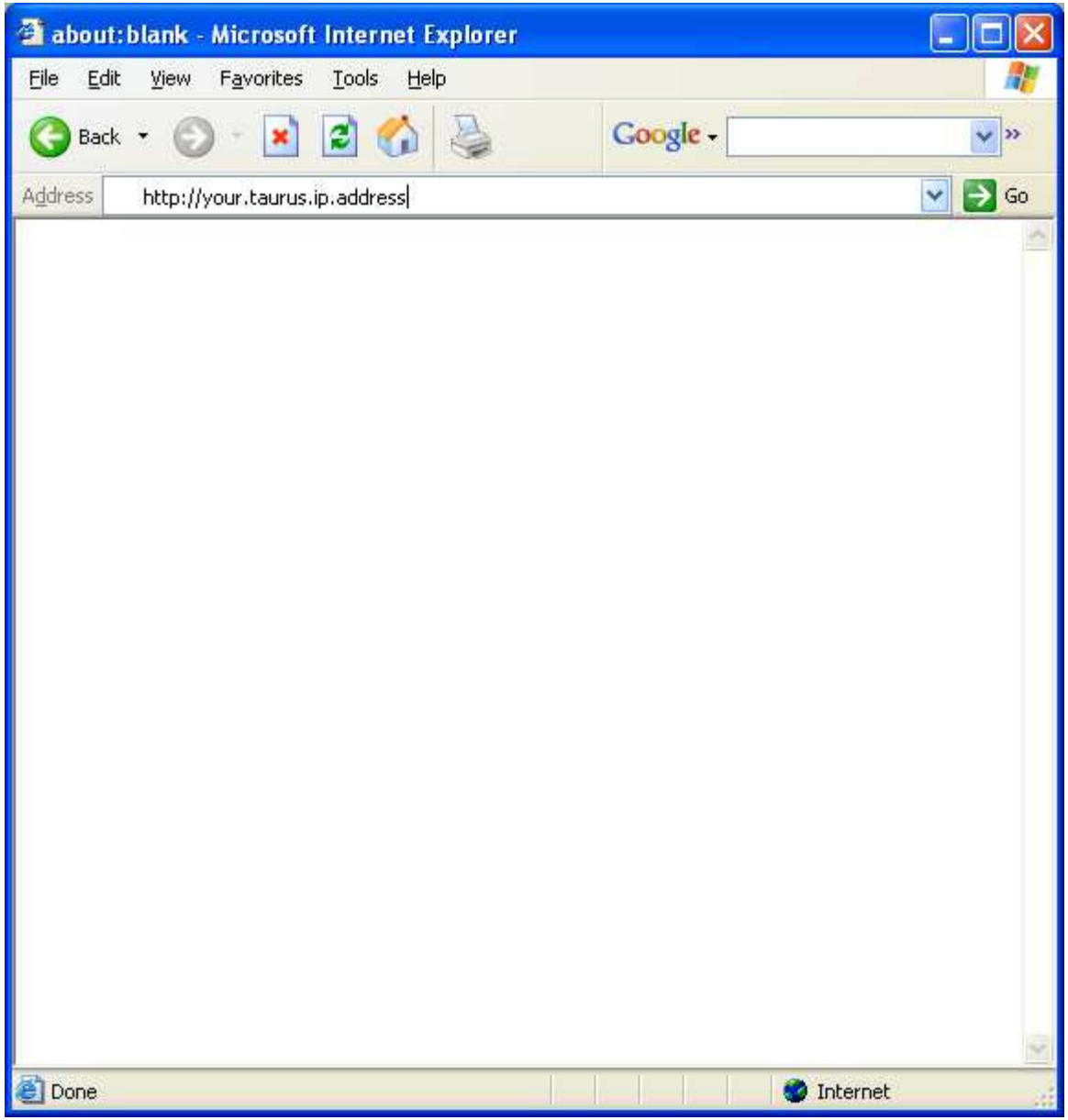


Accessing the Taurus

- From external web browser:
  1. Connect the Taurus using the ethernet cable (15228) to your LAN or computer directly.
  2. Open your browser and go to the Taurus URL: http://Taurus.IP.Address.
- The IP address of the Taurus is shown on the Current Status Page of the internal browser.

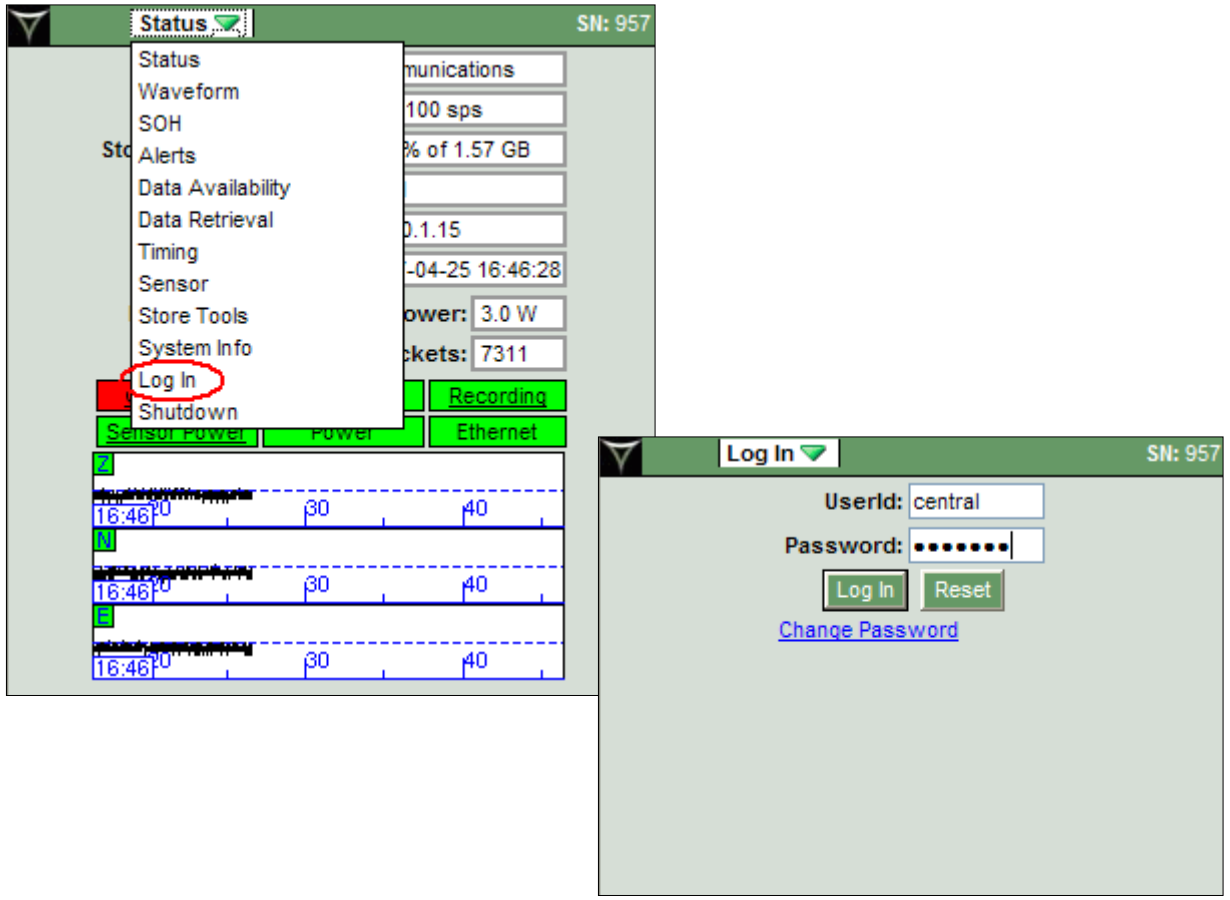
Ext. Browse

- IE/Netscape/Firefox
- Enter Taurus IP



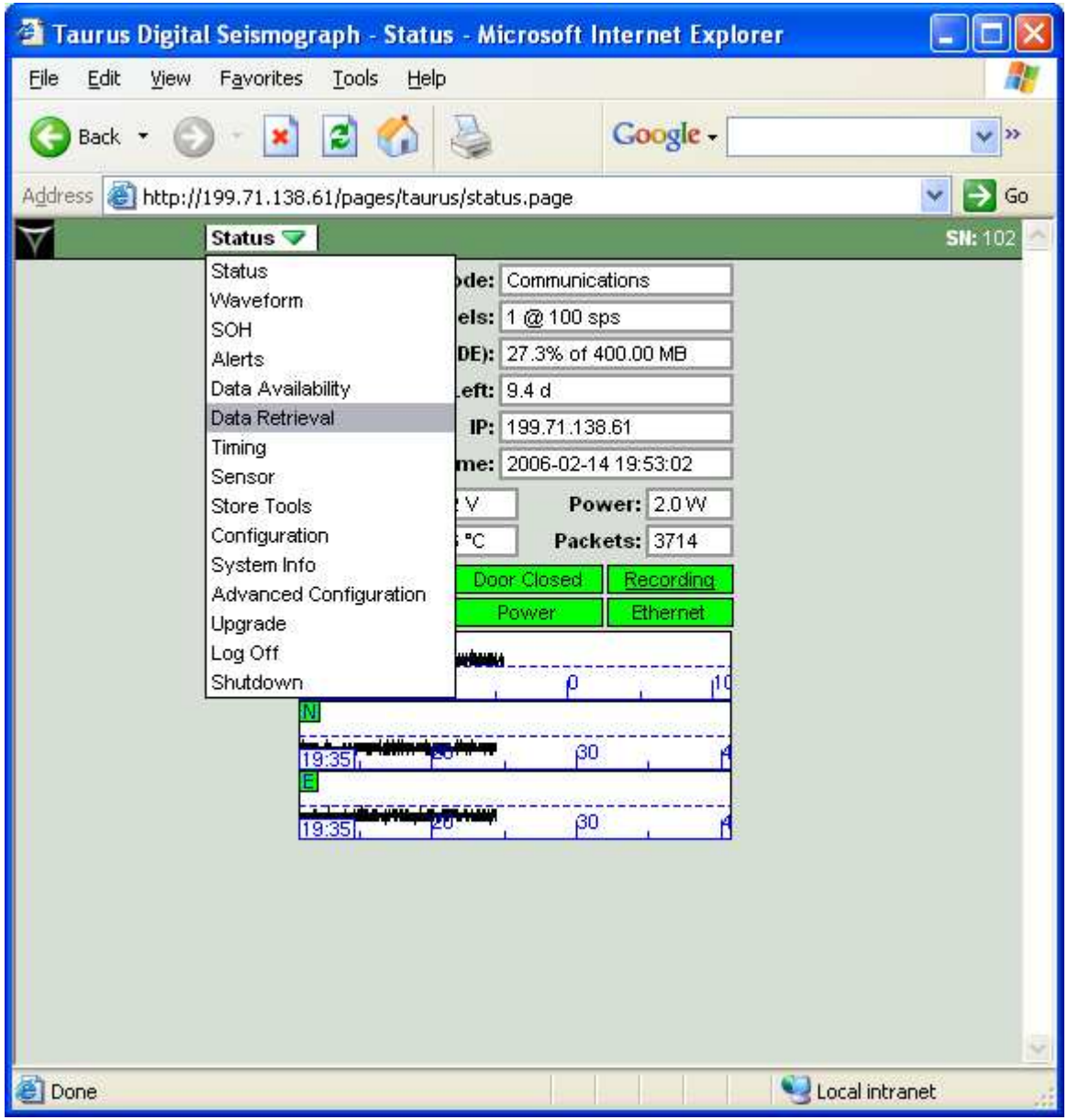
Login

- User:
  - central
- Password:
  - central

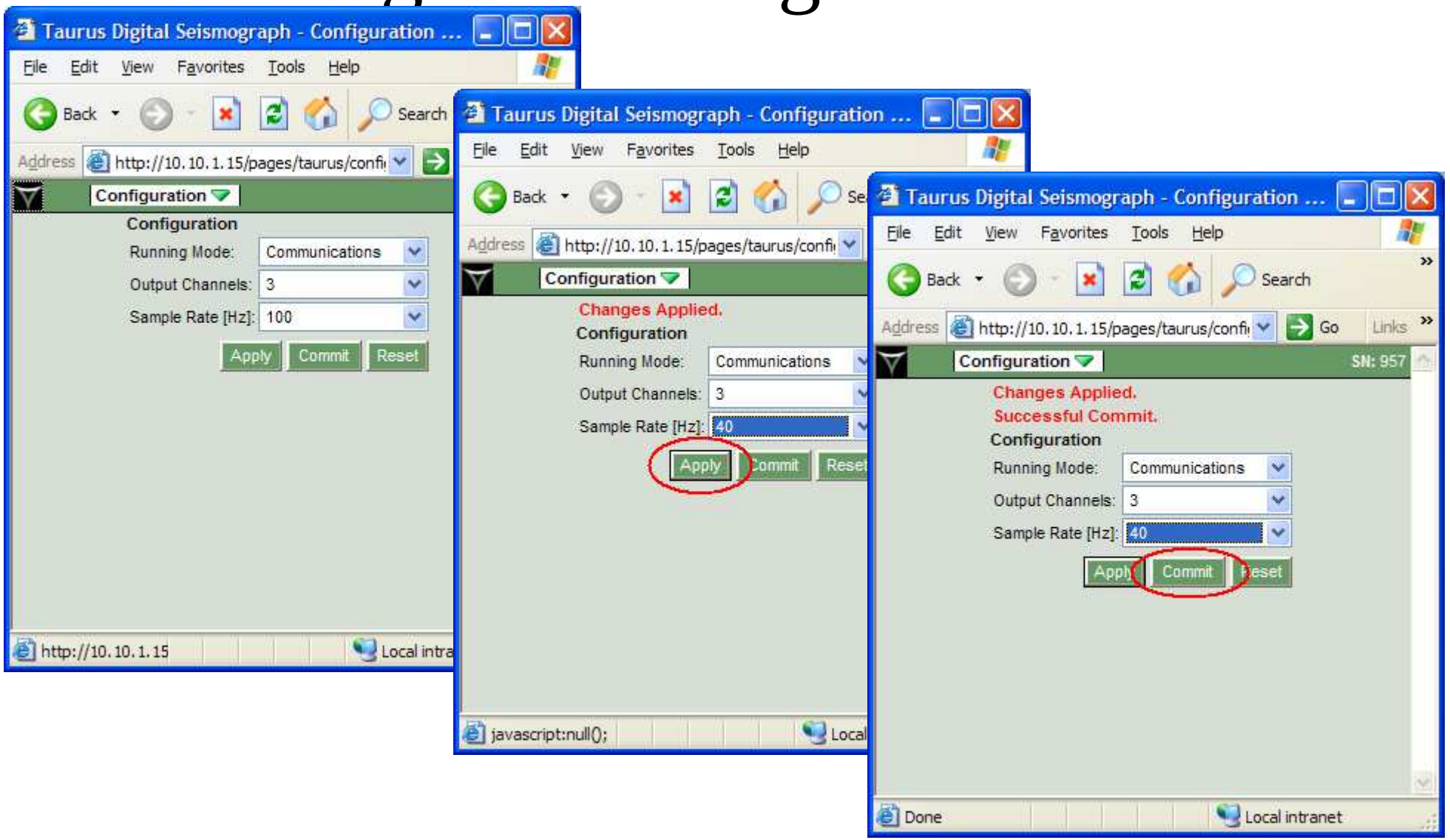


Menus

- Main menu pages:
  - Status
  - Waveform
  - SOH
  - Alerts
  - Data Availability
  - Data Retrieval
  - Timing
  - Sensor
  - Store Tools
  - Configuration
  - System Info
  - Advanced Configuration
  - Upgrade
  - Log off
  - Shutdown



Configuration Page



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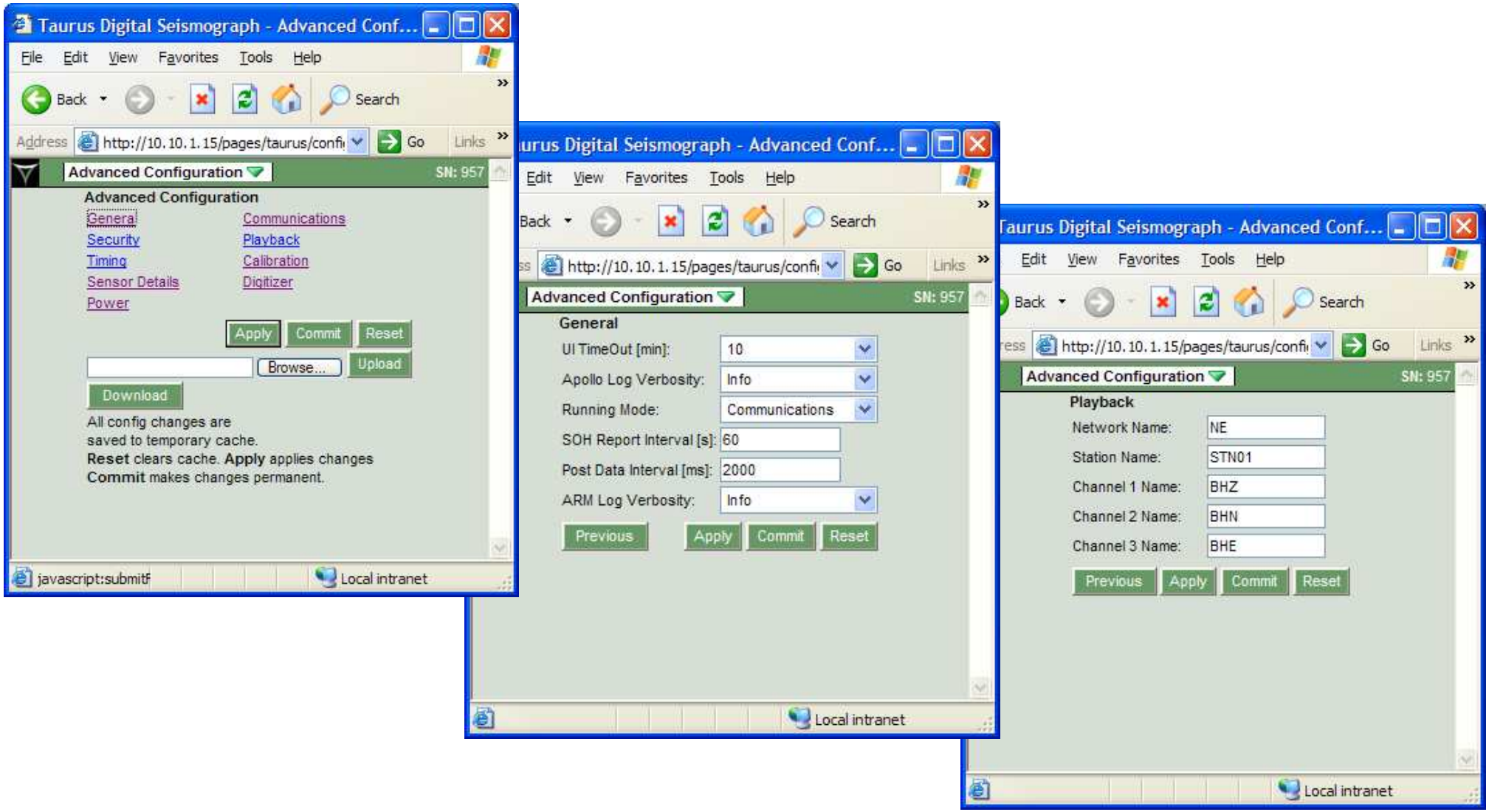
Advanced Configuration Pages



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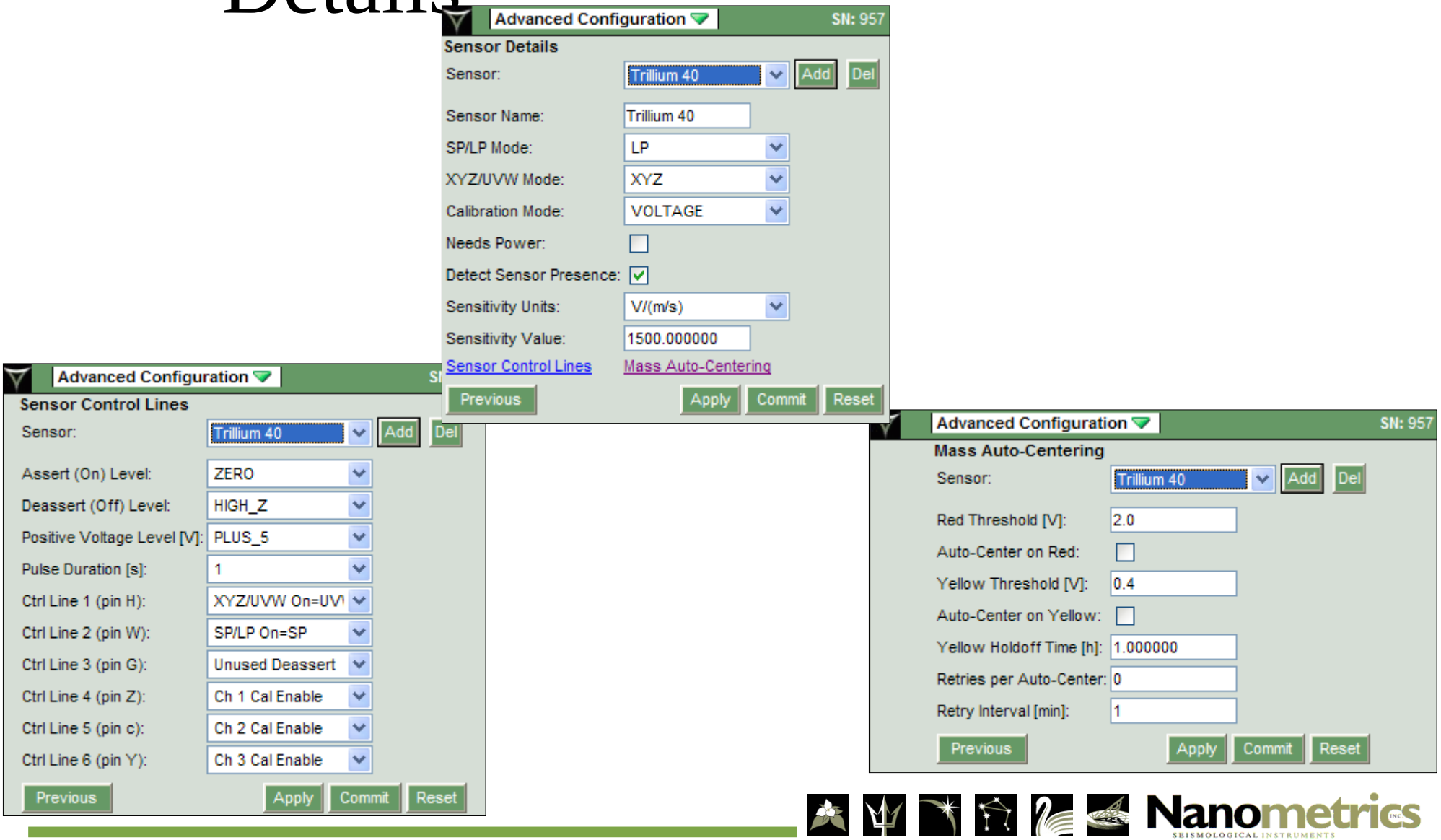
Advanced Configuration: Sensor Details



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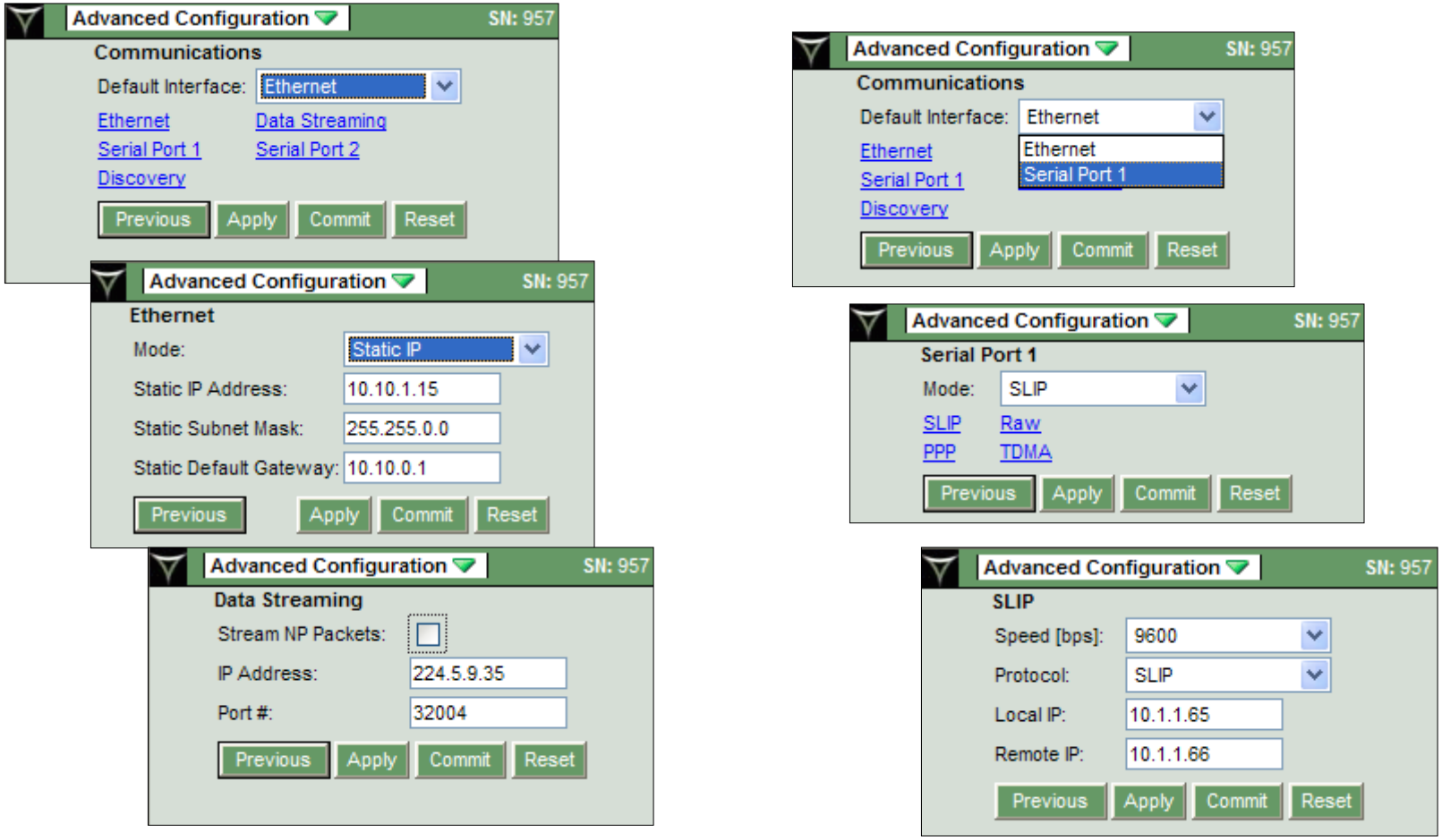
Advanced Configuration: Communications



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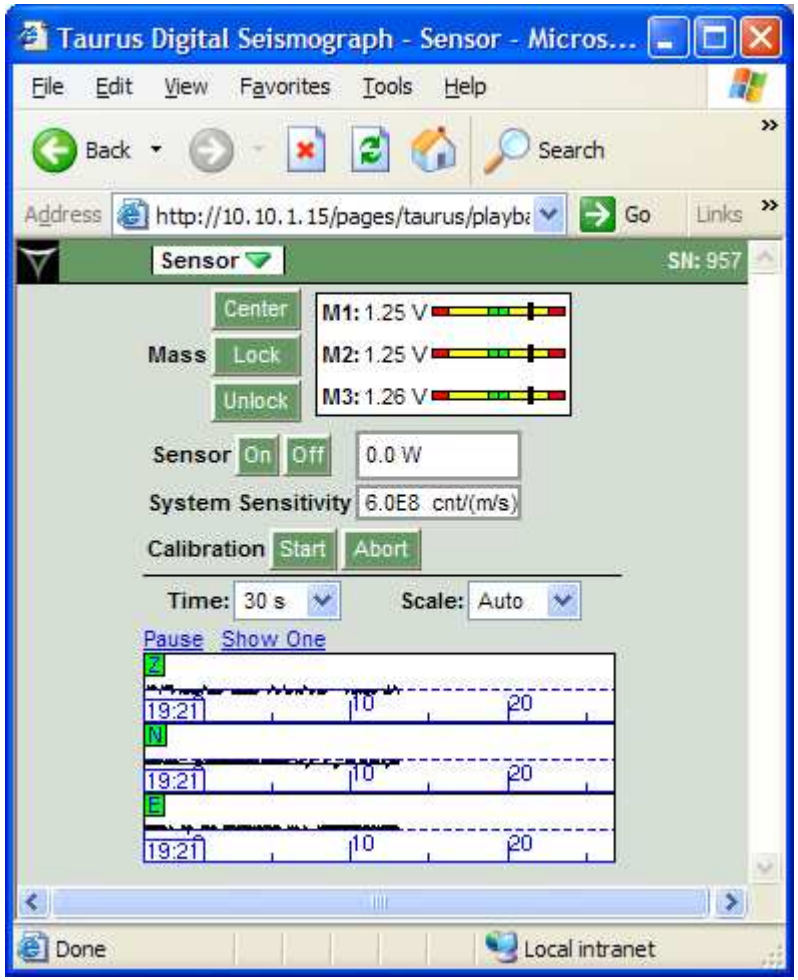
Sensor Page

- Mass positions
- Sensor Consumption
- View waveform
- One touch functions:
  - Calibration
  - Mass center
  - Mass lock / unlock
  - Power on /off



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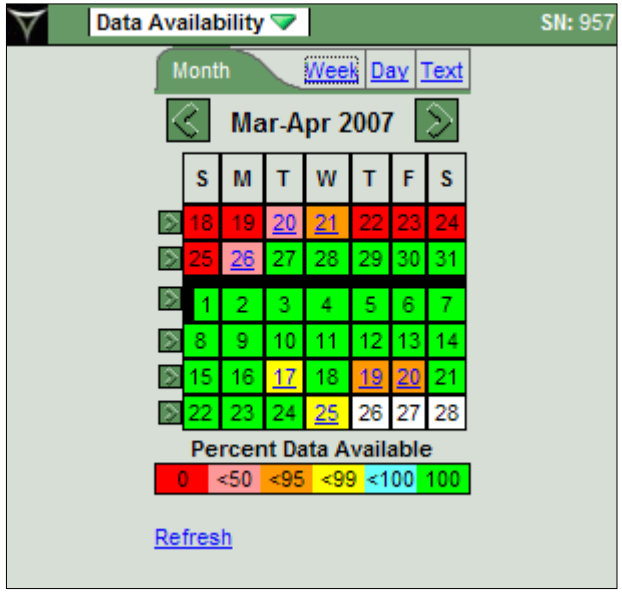
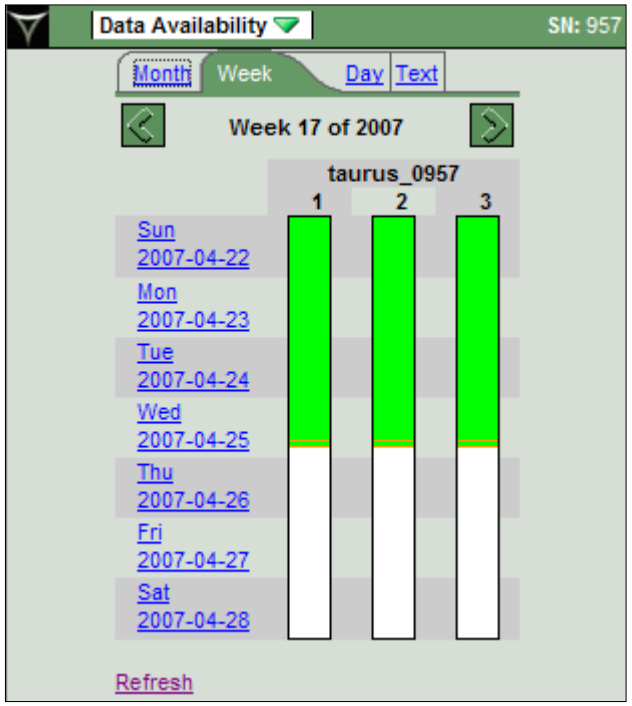
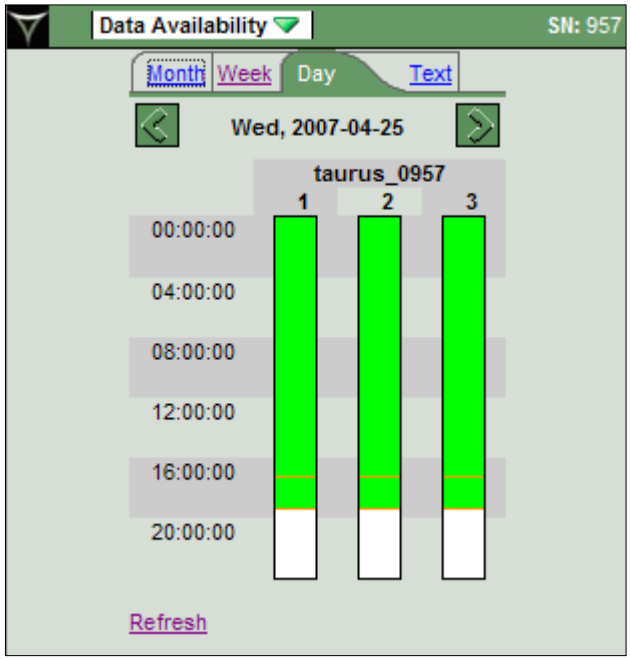
Data Availability

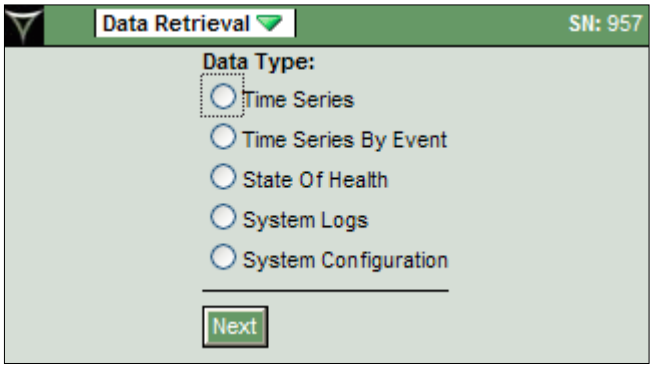




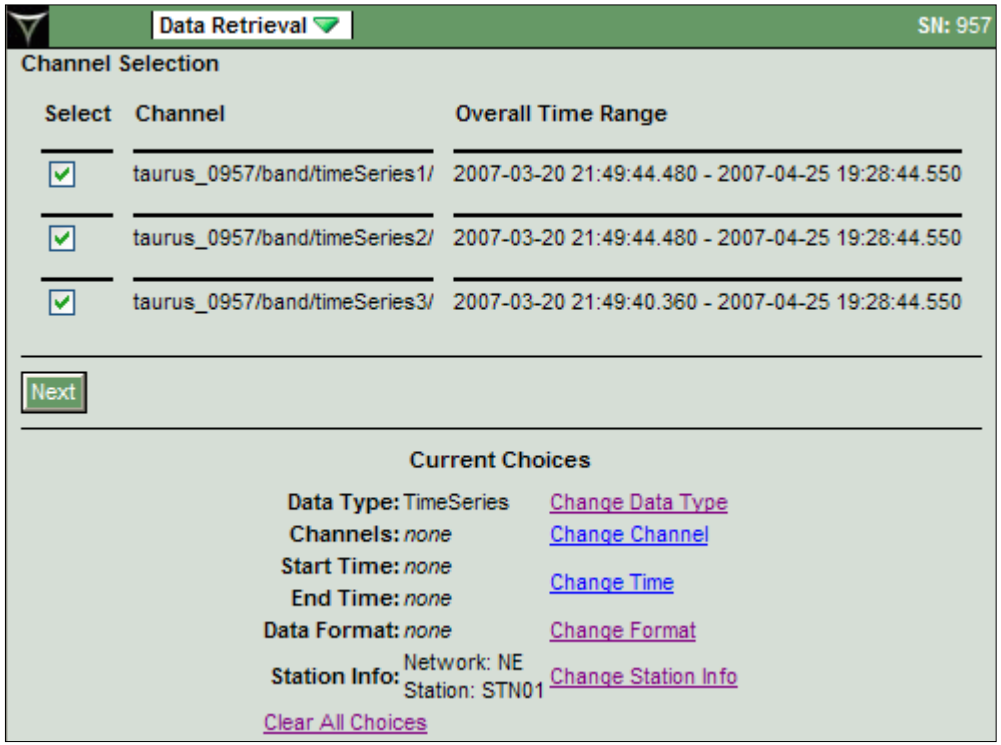


Time Series Data Retrieval

- Select data type Time Series

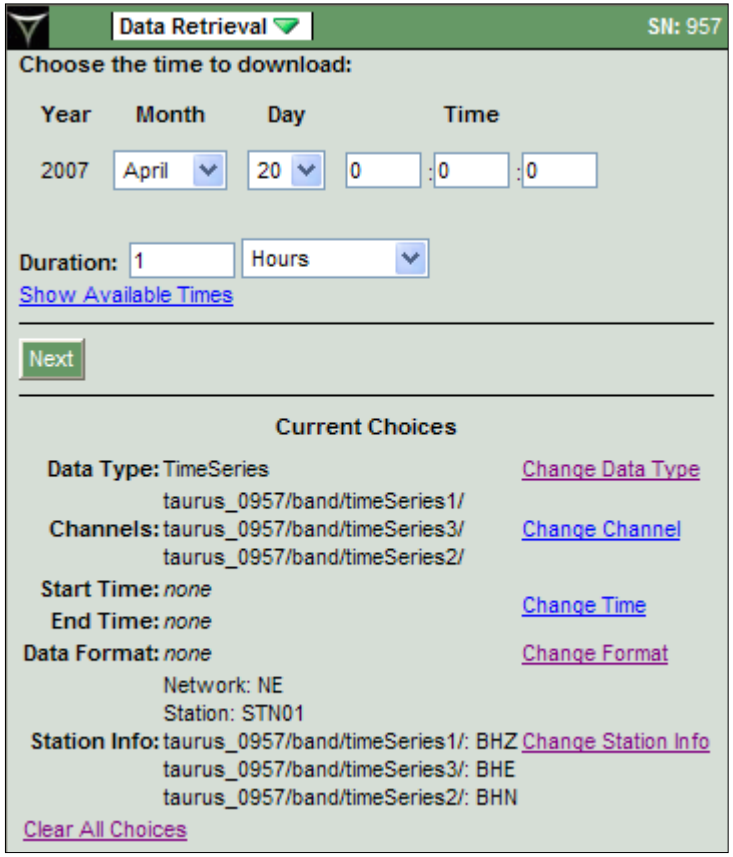


- Select channels

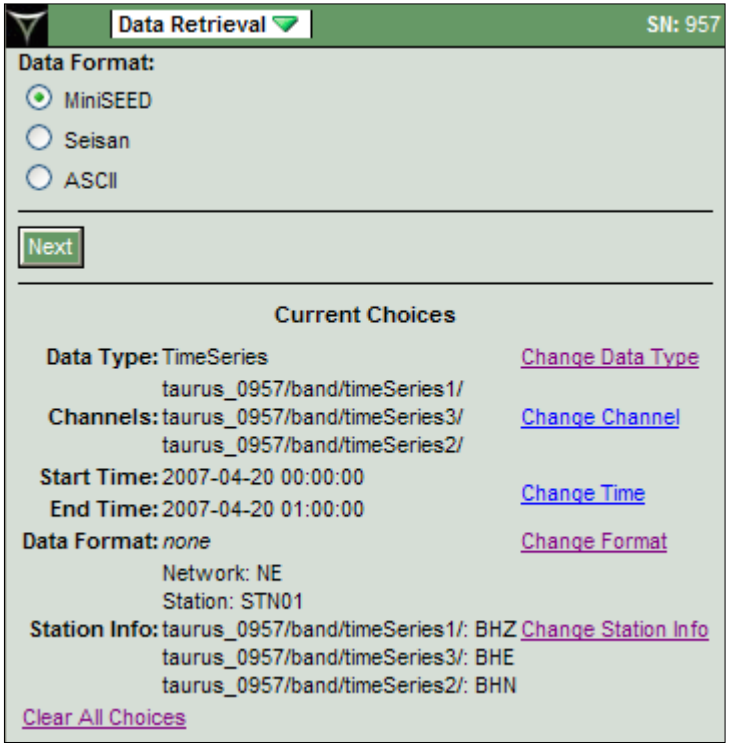


Time Series Data Retrieval

- Select start time and duration



- Select format



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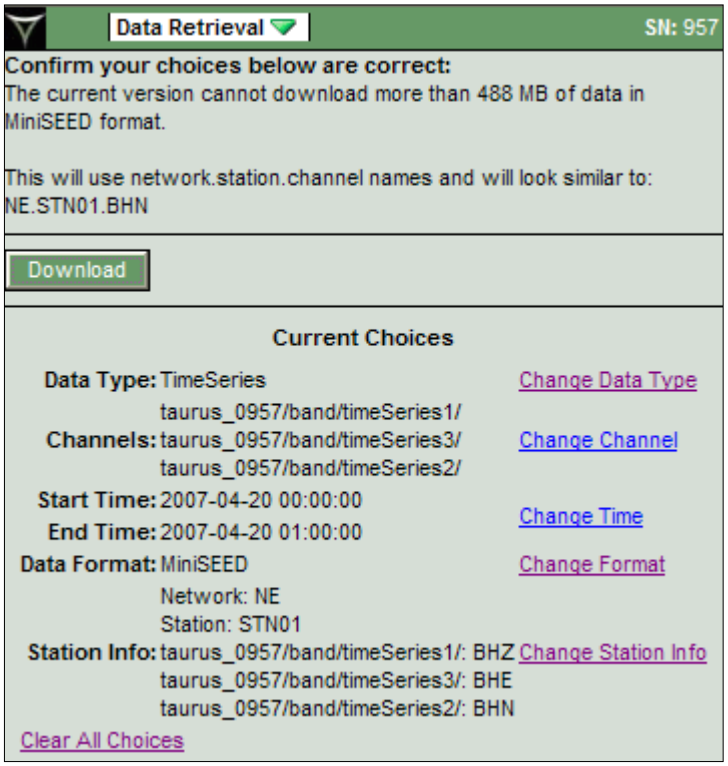
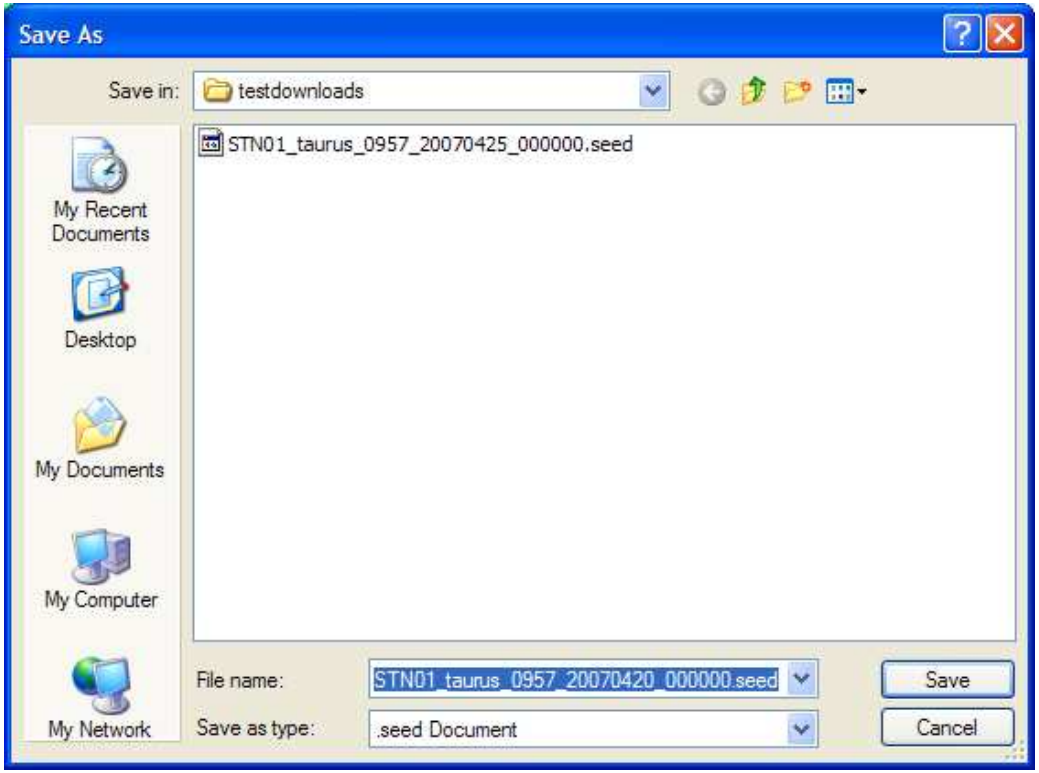
Time Series Data Retrieval

- Confirm choices and click download



- Indicate filename and destination



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Powering Down

- ***Do not*** just disconnect the power cable! 
- Basic Steps:
  1. If in **Buffered mode** first wake up the Controller and display by pressing and holding center button for 1 second (takes ~1.5 minutes).
  2. Go to Shutdown page from the web browser's drop down menu.
  3. Select the Shutdown option.
  4. Wait for status LEDs to be blinking ***slowly*** to indicate the Controller has been shut down.
  5. Disconnect the Taurus power cable.

Installing Removable Media

- Always properly power down the Taurus Controller before removing or inserting media (CF/IDE)

You may lose data if the media is removed while the Taurus Controller is running.

You may lose data if the media is not inserted before the buffer fills-up.

Installing Removable Media…

1. Lift the plastic lever on the media door.
2. Twist the door knob counter clockwise to the unlocked position (lever is vertical).
3. Flip the lever flat against the door, allowing the handle to push against the chassis and causing the door to pop free/open.

Installing Removable Media…

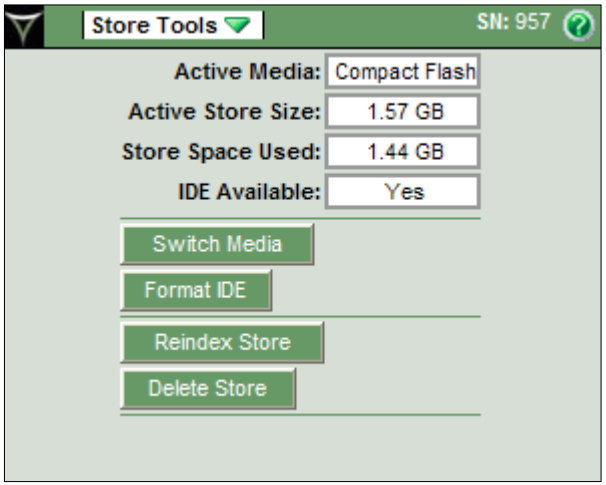
- Make sure Media Access LED is green OR the power is off.
- Gently pull on the end of the CF/IDE to remove it.
- Gently insert the replacement CF/IDE.

Inserting Removable Media…

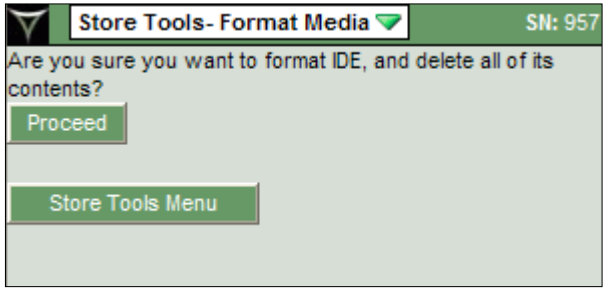
- Place and push the media door in place.
- Twist the knob clockwise to the locked position (horizontal).
- Flip the black plastic lever down as to lie flat against the door as shown.

Formatting Removable Media

1. Login
2. Go to Store Tools Page
3. Select ‘Format *media*’
4. Click Proceed to continue



- Format unformatted media
- Reformat inactive media
- Cannot reformat active media



Removable Media Content

- Directory Structure
  - /logs
    - ApolloError.log
    - Apollo_2007xxyy.log
    - TaurusServer_2007xxyy.log
    - System log, etc.
  - /lost+found
  - /store
    - Taurus_SNxxyy_00n.store
    - Taurus_SNxxyy_00n+1.store

Apollo Support Utilities

Apollo Light

- Used to extract data from Store files on a PC
- Same data availability / retrieval options as Taurus
- Running on local user computer or server
- Self contained Java web server
- Interactive web browser GUI, similar to Taurus
- Requires Java JRE 1.4.2
- Execute batch file: apollo *options*
- Options: port=8080, default 80
- Start web browser: http://localhost [:port]

Apollo Toolkit

- Command-line utilities and scripts
- Download and manage waveform data recorded in a Store
- Store archive management (merge, copy, trim, reindex)
- Data conversion
  - MiniSEED
  - SEED
  - SEG-Y
  - Seisan