Taurus Seismograph Overview

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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





Taurus in System





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





- 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: $43.07k\Omega$ (low) or > 9M Ω (high)



- Digitizer Performance
 - Dynamic range: > 141 dB
 - Shorted input noise: <1 count RMS (of 24 bits) at 100 sps</p>
 - > 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



- 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



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



- Timing System
 - Internal VCXO clock disciplined to GPS
 - > Timing accuracy $< 100 \ \mu s$
 - ➢ 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)



- 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



- 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



- 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



- 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



• 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



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:

- \bigcirc <u>Off</u> Taurus is powered off.
 - <u>Solid Red</u> Taurus is booting up.

Normal conditions to capture data:

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

Busy condition:

<u>Fast Blinking Yellow</u> - 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:

- \bigcirc <u>Off</u> controller is powered down
- Solid Yellow controller is booting (~8 seconds)
- Fast Blinking Green networking enabled, link established
- Slow Blinking Green networking disabled
 - D <u>Blinking Yellow</u> Initial power up, diagnostics
 - Blinking Red networking is enabled, no link detected





MediaLED

• States:

- <u>Green</u> removable media (CF/IDE)
 can safely be removed.
- <u>Red</u> 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)





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

	🗿 Taurus Digital Seismograp	oh - Status - Micro	soft Internet Explore	er 💶 🗖 🔀
Status Pag	<u>E</u> ile <u>E</u> dit <u>V</u> iew F <u>a</u> vorites <u>T</u>	ools <u>H</u> elp		
	🌀 Back 👻 🕥 – 💌 😰	a 🏠 👌	Google -	*
	http://199.71.138.61/	pages/taurus/status.p	age	💙 🋃 Go
da	Status 💎			SN: 102 📥
de		Mode:	Communications	
1		Store(IDE):	27.3% of 400.00 MB	
annels	\ Menus	Store Time Left:	9.5 d	
	Home	IP:	199.71.138.61	
re	Button	Time:	2006-02-14 19:30:30	
		Temp: 22.8 °C	Power: 2.1 W Packets: 3243	
	Status Dara	GRS Failed Doo	r Closed Recording	
	Status Dars —	Sensor Power P	ovver Ethernet	
าค		and its	20 30	
		9.30 <u>0</u>		Near Real-time
tua	1	9:30	po po po po	Waveform
lus				
C	Ľ	9:301 1.4	F*	
veform				
				2
	🙆 Done			Second Intranet



5-Button Layout and Functions





Taurus Navigation: Menus



5-button pad





Taurus Navigation: Fields/Links





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: <u>http://Taurus.IP.Address</u>.
- 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

\forall	Status 🔀	SI	SN: 957	
Sto Sto	Status Waveform SOH Alerts Data Availability Data Retrieval Timing Sensor Store Tools System Info Log In Shutdown	nunications 100 sps % of 1.57 GB 0.1.15 -04-25 16:46:28 ower: 3.0 W :kets: 7311 Recording Ethernet	V Log In ▼ SN	: 957
163	τ 6 ¹⁰ , β0	40 ,	Userid: central	
163 E	46 <mark>20</mark> β0		Log In Reset	
162	46 ²⁰ β0	<u>4</u> 0 ,		

Menus

- Main menu pages:
 - > Status

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- > Waveform
- > SOH
- > Alerts
- Data Availability
- Data Retrieval
- > Timing
- > Sensor
- Store Tools
- Configuration
- System Info
- Advanced Configuration
- > Upgrade
- Log off
- > Shutdown

Configuration Page

Advanced Configuration Pages

Advanced Configuration: Sensor Details

	Du	all	\forall	Advanced Confi	guration 💎	SN: 957			
			Sensor	r Details					
			Sensor	:	Trillium 40	✓ Add Del			
			Sensor	Name:	Trillium 40				
			SP/LP N	lode:	LP	~			
			XYZ/U	VW Mode:	XYZ	~			
			Calibrat	tion Mode:	VOLTAGE	~			
			Needs	Power:					
			Detect	Sensor Presence:					
			Sensitiv	vity Units:	V/(m/s)	~			
			Sensitiv	vity Value:	1500.000000				
Advanced Configu	ration 🔝		SI Sensor	Control Lines	Mass Auto-Centerin	q			
Sensor Control Lines			Previ	ous	Apply (Commit Reset			
Sensor:	Trillium 40	✓ Add	Del			Y	Advanced Configurat	ion 🔝	SN: 957
Assert (On) Level:	ZERO	~					Sensor:	Trillium 40	Add Del
Deassert (Off) Level:	HIGH_Z	~					001001.		
Positive Voltage Level [V]:	PLUS_5	~					Red Threshold [V]:	2.0	
Pulse Duration [s]:	1	~					Auto-Center on Red:		
Ctrl Line 1 (pin H):	XYZ/UVW On=UV	~					Yellow Threshold [V]:	0.4	
Ctrl Line 2 (pin W):	SP/LP On=SP	~					Auto-Center on Yellow:		
Ctrl Line 3 (pin G):	Unused Deassert	~					Yellow Holdoff Time [h]:	1.000000	
Ctrl Line 4 (pin Z):	Ch 1 Cal Enable	~					Retries per Auto-Center	: 0	
Ctrl Line 5 (pin c):	Ch 2 Cal Enable	~					Retry Interval [min]:	1	
Ctrl Line 6 (pin Y):	Ch 3 Cal Enable	~					Previous	Apply Commit	Reset
Previous	Apply	Commit R	Reset				/ * * 2	Nanon	netrics

Advanced Configuration: Communications

\forall	Advanced Configura	ation マ		S	N: 957	
	Communications					
	Default Interface:	Ethernet		~		
	Ethernet [ata Strea	ming			
	Serial Port 1 5	Serial Port	2			
	Discovery					
	Previous App	ly Com	nmit R	eset		
	Advanced C	onfigura	ation マ		SN: 9	57
	Ethernet					
	Mode:		Static IP)	~	
	Static IP Addres	SS:	10.10.1.	15		
	Static Subnet N	lask:	255.255	.0.0		
	Static Default G	ateway:	10.10.0.	1		
	Previous	Арр	ly Cor	mmit R	eset	
	Advar	nced Co	nfigurati	ion マ 🛛		SN: 9
	Data	Streamii	ng "			
	Strea	m NP Pac	kets:			
	IP Ad	dress:	2	224.5.9.35	;	
	Port #	ŧ	3	32004		
	Pre	vious	Apply	Commit	Rese	t

Sensor Page

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

Data Availability

$\overline{\gamma}$	SN: 95								
Month Week Day Text									
🔇 Mar-Apr 2007 📎									
		s	м	т	w	т	F	s	
	>	18	19	<u>20</u>	<u>21</u>	22	23	24	
	\gg	25	<u>26</u>	27	28	29	30	31	
	8	1	2	3	4	5	6	7	
	\gg	8	9	10	11	12	13	14	
	>	15	16	<u>17</u>	18	<u>19</u>	<u>20</u>	21	
	>	22	23	24	<u>25</u>	26	27	28	
	_	Pe	rcer	nt Da	ita A	vail	able	9	_
)	<50	<95	<99	<mark>9</mark> <1	00	100	
	Re	fres	<u>h</u>						

Time Series Data Retrieval

• Select data type Time Series

• Select channels

\forall	Data Retrieval 🔝		SN: 957
Channel	Selection		
Select	Channel	Overall 1	lime Range
	taurus_0957/band/timeSeries1/	2007-03-	20 21:49:44.480 - 2007-04-25 19:28:44.550
	taurus_0957/band/timeSeries2/	2007-03-	20 21:49:44.480 - 2007-04-25 19:28:44.550
	taurus_0957/band/timeSeries3/	2007-03-	20 21:49:40.360 - 2007-04-25 19:28:44.550
Next			
	Cu	rrent Cho	ices
	Data Type: Time	Series	Change Data Type
	Channels: none	e	Change Channel
	Start Time: none End Time: none	e e	Change Time
	Data Format: none	e	Change Format
	Station Info: Net	work: NE ion: STN01	Change Station Info
	Clear All Choices		

Time Series Data Retrieval

Select start time and duration • Select format \bullet

\forall	Data Retrie	val マ			SN: 957					
Choose	the time to	downloa	d:							
Year	Month	Day		Time						
2007	April 💌	20 💌	0	:0	:0					
Duration Show Av	: 1 ailable Times	Hours	•	•						
Next	Next									
		Curre	ent Cho	ices						
Data T	ype: TimeSer	ries			Change Data Type					
Chanr	taurus_ taurus taurus	0957/ban 0957/ban 0957/ban	d/timeSei d/timeSei d/timeSei	ries1/ ries3/ ries2/	Change Channel					
Start T	ime: none				Change Time					
End T	ime: none				onunge nine					
Data For	mat: none				Change Format					
Station	Networi Station: Info:taurus_ taurus_ taurus_	k: NE STN01 0957/band 0957/band 0957/band	d/timeSer d/timeSer d/timeSer	ries1/: BH ries3/: BH ries2/: BH	Z <u>Change Station Info</u> E N					
Clear All	Choices									

Time Series Data Retrieval

- Confirm choices and click download
- Confirm choices and click Indicate filename and destination

Data Retrieval 💎	SN: 957	Save As						? 🔀
Confirm your choices below are correct: The current version cannot download more than 488 Mi MiniSEED format.	Bofdata in	Save in:	🛅 testdownloa	ads	~	G 🔊 🛙	••	
This will use network.station.channel names and will loo NE.STN01.BHN	ok similar to:	My Recent Documents	STN01_tauru	ıs_0957_20070425_000000.sı	eed			
Current Choices		Desktop						
Data Type: TimeSeries CI taurus_0957/band/timeSeries1/	hange Data Type							
Channels: taurus_0957/band/timeSeries3/ taurus_0957/band/timeSeries2/	hange Channel	My Documents						
Start Time: 2007-04-20 00:00:00 End Time: 2007-04-20 01:00:00	hange Time	-						
Data Format: MiniSEED CI	hange Format							
Station: STN01		My Computer						
taurus_0957/band/timeSeries1/; BHZ CI taurus_0957/band/timeSeries3/; BHE	hange Station Info		File name:	STN01_taurus_0957_200	/0420_00	0000 seed	~	Save
taurus_0957/band/timeSeries2/: BHN Clear All Choices		My Network	Save as type:	.seed Document		1	~	Cancel

Powering Down

• **<u>Do not</u>** 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)

 \wedge

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

 \wedge

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

