GEOTECH INSTRUMENTS, LLC

SMART-24 SERIES

DATA DIGITIZER MODEL SMART-24D®

DATA RECORDER MODEL SMART-24R®

STRONG MOTION DATA RECORDER MODEL SMART-24A®

BOREHOLE DATA DIGITIZER MODEL SMART-24B

User's Manual

Version 2.9

MANUAL SUBJECT TO CHANGE WITHOUT NOTICE

October, 2011

For information relating to other Geotech Instruments products and manuals, inquires may be addressed to:

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Revision History

Date	ECN	Rev	Initials	Description
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09/14/04		1.2		Updated cable diagrams
10/05/04		1.3		Updated cable diagrams
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12/23/04		2.0	PBA	Major update
11/02/05		2.1	PBA, DM, MR	Firmware and SMART-24A® Updates
12/06/05		2.2	PBA	Fully incorporated latest firmware and SMART-24A® updates
01/09/07		2.3		Updated cable diagrams
05/16/07		2.4		Updated cable diagrams
08/15/08		2.5	WH, MR	SMART-24B Updates
04/20/09		2.6		SMART-24B and SMART-24A® Updates
08/26/10		2.7	MR	Firmware Updates
11/2/10		2.8	MR	Minor Updates
10/28/11		2.9	LO,MR	New ADC versions 05, 06

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CONTENTS

Section 1

1. GENERAL INFORMATION

1.1 PURPOSE OF EQUIPMENT

Geotech Instruments' SMART-24 Series product line encompasses a wide range of data acquisition instrumentation with a common design used for digitizer, portable data recorder and strong motion recorder instruments (the "all-in-one" solution). This manual describes the operation and use of Geotech Instruments' high resolution Data Digitizer Model SMART-24D®, portable Data Recorder Model SMART-24R® and Strong Motion Data Recorder Model SMART-24A® instruments.

Figure 1-1. SMART-24 Series Instrument

The SMART-24D® is a low-power Data Digitizer designed to acquire near real time, high quality data from remote sites and in harsh environments. Acquired data is then transmitted in near real time via TCP/IP over a serial PPP or Ethernet 10/100Base-T link to a central data center.

The SMART-24R® is a low-power Data Recorder designed to acquire and locally store high quality data at remote sites and in harsh environments. This instrument includes all of the capabilities of the SMART-24D® with the added features of recording and storing data files locally on a removable disk drive. Data files can be acquired in triggered,

continuous or windowed recording modes. The SMART-24R® can be configured to record data files and transmit near real time data via TCP/IP simultaneously.

The SMART-24A® is a low-power Strong Motion Data Recorder designed to acquire and locally store high quality strong motion data at remote sites and in harsh environments. This instrument includes all of the capabilities of the SMART-24R® as described in this manual, and is equipped with internal 3-component acceleration sensors and backup battery. The manual will describe the features of the SMART-24D® because they are common to all three models, and will identify what is specific to SMART-24R® or SMART-24A® when necessary. Appendix B provides information on SMART-24A® Installation and Sensor Maintenance.

Based on the SMART-24 Series family of data acquisition cards, these instruments provide high resolution and dynamic range to digitize data from three or six analog inputs. They can be synchronized to a GPS timing reference to provide high accuracy time synchronization and location information. The SMART-24D® and SMART-24R® are ideally suited for seismic monitoring or general-purpose data acquisition at remote locations. In the near real time telemetry mode, the Geotech Instruments' SMART Central Station provides an ideal companion hardware/software solution for a complete easy-to-use 24-bit data acquisition system.

1.2 DESCRIPTION OF EQUIPMENT

The SMART-24D® and SMART-24R® are high resolution 24-bit data acquisition instruments. They are specifically designed for remote field locations where acquired data is either transmitted in near real time, stored locally or both. With the SMART-24R®, mass storage (internal and removable) recording options include up to 40 GB hard disk, PCMCIA ATA hard disk, Compact Flash memory, Hitachi Microdrives, etc. Both instruments are housed in rugged weather tight enclosures suitable for use in harsh environments.

The SMART-24D® and SMART-24R® can provide 3 or 6 analog input channels. Each sensor data channel is digitized using 24-bit ADC technology. Acquired data are time tagged to a high accuracy by synchronizing the internal clock to an external GPS receiver. Data are internally buffered for near real time data telemetry or, in the case of the SMART-24R®, recorded to internal or removable mass storage. The user has several options for interfacing to the instruments for data retrieval and/or system configuration. These include TCP/IP over 10/100Base-T Ethernet or serial PPP. Standard Telnet, FTP and Web access via TCP/IP are provided. A low level ASCII terminal command mode is also available via a serial port or a Telnet connection. All digitizer functions can be accomplished either directly connected locally or remotely over telemetry options that include VSAT, RF, spread spectrum, fiber optics, Ethernet or telephone line (dialup or leased line). The digitizer provides a full and configurable sensor control interface for mass centering, calibration and identification using SMART sensors. An LCD display is provided to give the user operational and status information.

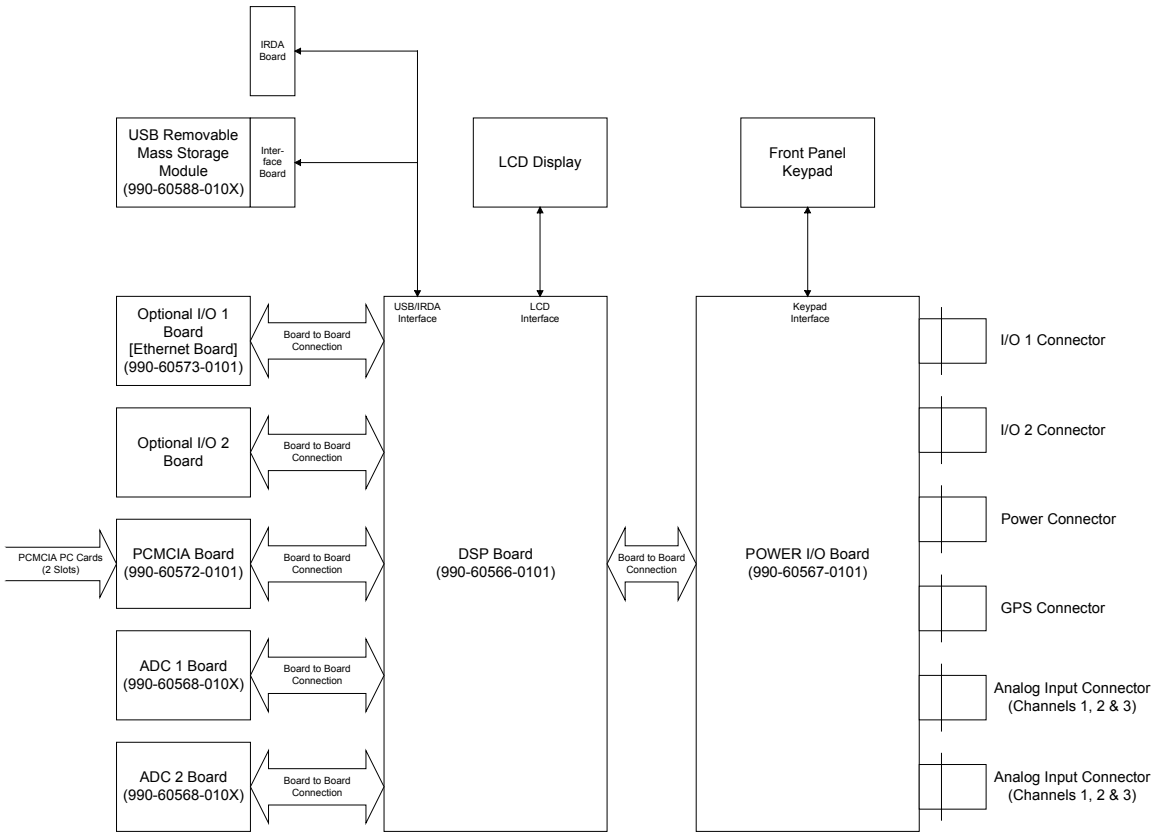


Figure 1-2. SMART-24 Series Block Diagram

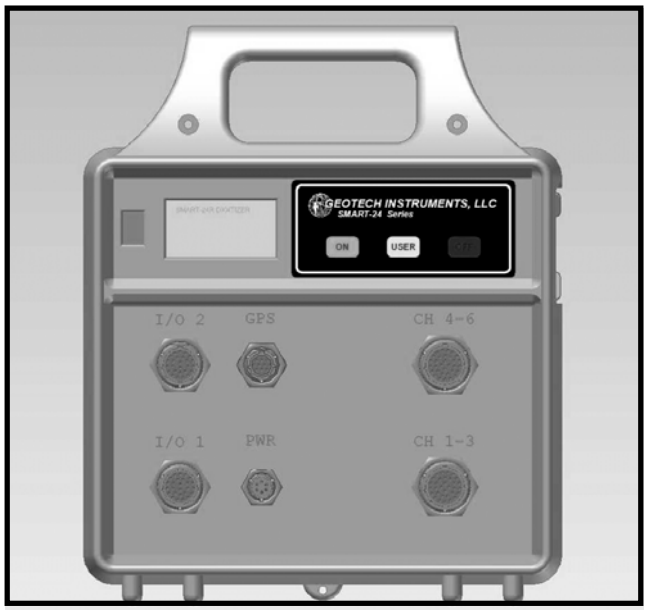


Figure 1-3. SMART-24 Series Front Panel

Figure 1-2 shows a functional block diagram of the SMART-24 Series instruments. Figure 1-3 shows a user control panel view of the SMART-24 Series instruments. Refer to these figures for the following sections.

1.2.1 Packaging

The SMART-24 Series instruments are housed in a portable rugged molded enclosure that provides protection from environmental factors such as wind, rain and dirt. However, it is not intended to provide submersion protection and should not be installed in a location that is susceptible to flooding conditions.

Standard, sealed circular style connectors are provided for external user connection to the unit. These connectors are internally connected directly to the connector and power board thus eliminating expensive wiring harnesses and cabling that could be a source of noise.

Internally, the SMART-24 Series instruments are composed of the following boards:

1. Power I/O Board (P/N 990-60566-0101)

2. DSP Board (P/N 990-60567-0101)

3. Three channel ADC Board (P/N 990-60568-010X, one standard, second board optional)

4. I/O Board (Ethernet P/N 990-60573-0101)

5. I/O Board (second I/O board optional)

6. PCMCIA Interface Board (P/N 990-60572-0101, optional on the SMART-24R® only)

7. Removable USB Mass Storage Module (P/N 990-60640-010X, optional on the SMART-24R® only)

1.2.2 Controls, Indicators and Connectors

All controls, indicators and external connectors are provided on the SMART-24 front panel. These are as follows:

Controls

a) ON - This touch pad button turns power on or, if power is already on, causes the unit to be reset.

b) OFF - This touch pad button turns power off when pressed and held for two seconds or more. An inadvertent momentary press will not cause the unit to

turn off.

c) USER – This touch pad button provides three functions.

- When pressed and held while the ON button is used to turn the unit on, it forces the SMART-24 Series instrument into its Bootloader Mode. This mode allows the user to erase or install firmware and to perform other maintenance operations.
- When pressed and released quickly (less than two seconds) while the instrument is turned on, it controls the display of information on the LCD display.
- When pressed and held (more than two seconds) while the instrument is turned on, it forces any recorded data files to be moved from the internal RAM Drive to an available external disk (SMART-24R® only).

Indicators

A backlit LCD display provides various operational and status information to the user (TCP/IP status, disk drive, status, GPS status, timing status, state of health values, etc.).

Connectors

a) Analog Inputs - Two analog input connectors are provided on the SMART-24 Series instruments, for ADC channels 1-3 and 4-6, respectively.

b) Input/Output (ports 1 and 2) – These two connectors support miscellaneous I/O such as digital I/O, auxiliary analog inputs, serial RS232/RS422 and 10/100Base-T Ethernet.

c) GPS - Provides the connection point for the GPS receiver.

d) Power - Main power and external battery connections.

1.2.3 Setup and Operation

The SMART-24 Series instruments are setup and operated through communications over a TCP/IP connection via one of the serial or Ethernet ports, either locally by a computer directly connected to the unit or remotely over a telemetry link. The Java written utility software, running on the local computer or on the remote host system, is used to easily setup, operate and display data from a SMART-24 Series instrument (see the SMART24Config and SMARTGeoViewer® application documentation). Setup, control and state of health are also available via ASCII commands over serial and Telnet

connections (see the SMART-24 Series Command & Setup Protocol documentation in Appendix C of this manual).

All setup parameters can be individually changed via commands or loaded all at once via a setup parameter file. All configuration parameters are stored in non-volatile memory so that the SMART-24 Series instruments will automatically start up with the saved operating parameters each time they are turned on.

1.2.4 Updates

Application firmware updates are possible via direct or remote connection to the unit over a TCP/IP connection (10/100Base-T or serial PPP).

1.3 SUPPLIED EQUIPMENT

The following items are typically supplied with a SMART-24 Series instrument.

a) SMART-24D®, SMART-24R® or SMART-24A® (configured per customer's specifications, this includes the GPS receiver, additional ADC channels, etc.)
b) SMART-24 Series Mating connector kit
c) SMART-24 Series User's Manual
d) SMART-24 Series Software Disk with utility software and application files

Section 2

2. SPECIFICATIONS

2.1 DATA ACQUISITION

2.1.1 Number of Inputs

3 or 6 channels.

2.1.2 Input Type

Balanced differential with transient protection suitable for active sensors and passive sensors.

2.1.3 Input Impedance

High Impedance: Greater than 1 Megaohms differentially (ADC Ver. 01 & 02).
Low Impedance: Greater than 10 Kilohms differentially (ADC Ver. 03& 04).

2.1.4 Input Range

At gain 1, the following maximum full scales are available when placing the order (all are bipolar differential inputs):

ADC Ver. 01: 40Vpp, 1.7MΩ input impedance, to be replaced by 06 starting with Nov. 2011
ADC Ver. 02: 20Vpp, 2.0MΩ input impedance
ADC Ver. 03: 40Vpp, 17.2KΩ input impedance
ADC Ver. 04: 20Vpp, 20KΩ input impedance
ADC Ver. 05: 5Vpp, 2.6MΩ input impedance
ADC Ver. 06: 40Vpp, 2.0MΩ input impedance, starting with Nov. 2011 (to replace 01)

The user can change these versions by jumper selection on the ADC board (see Geotech Instruments Technical Note No. 1/2008 – ask factory for details):

ADC Ver. 01 can be jumpered to 5Vpp full scale, 214KΩ input impedance.
ADC Ver. 02 can be jumpered to 5Vpp full scale, 500KΩ input impedance.
ADC Ver. 06 can be jumpered to 5Vpp full scale, 250KΩ input impedance.

2.1.5 Common Mode Rejection

Greater than 80 dB.

2.1.6 Input Gain

Software selectable gains of 1, 2, 4, 8, 16, 32 and 64.

2.1.7 SMART-24A® Internal Sensors

Type:	Force Balance Accelerometers (Geotech PA-23)
Response:	DC to 100 Hz
Full Scale:	±4g (optional ±2g, ±1g)
Dynamic Range:	142 dB (145 dB between 0.1 - 5 Hz)

2.1.8 Digitizer

Over sampled Delta Sigma 24-bit resolution ADC with digital signal processing.

2.1.9 Anti-alias Filter

Brickwall digital FIR filter, cutoff at 80% of output Nyquist frequency and 140 dB down at the output Nyquist frequency.

2.1.10 Intermodulation Distortion

Less than -110 dB.

2.1.11 Total Harmonic Distortion

Less than -110 dB.

2.1.12 Output Sample Rates

Data channels can be sampled at either primary or secondary sample rates, or both. Primary sample rate values are 2000, 1000, 500, 250, 200, 125, 100, 50, 40, 25, 20, 10, 5 and 1 samples per second, software selectable. Secondary sample rates are dependant on the primary sample rate selected.

Table 2-1. Primary and Secondary Sample Rates

Primary Sample Rate	**Allowed Secondary Sample Rates**					
2000	1000	500	400	250	200	100
1000	500	250	200	125	100	50
500	250	125	100	50	25	-
250	125	50	25	-	-	-
200	100	50	40	25	20	10
125	25	-	-	-	-	-

100	50	25	20	10	5	-
50	25	10	5	-	-	-
40	20	10	8	5	4	2
25	5	-	-	-	-	-
20	10	5	4	2	1	-
10	5	2	1	-	-	-
5	1	-	-	-	-	-
1	-	-	-	-	-	-

2.1.13 Noise

Typical noise performance at 100 sps and a gain of 1 is 0.8 counts RMS.

2.1.14 Dynamic Range

Typical dynamic range performance at 100 sps and a gain of 1 is greater than 132 dB.

2.1.15 Channel Sampling Skew

All channels sampled simultaneously ±50 ns, sample clock phase locked to internal or external time reference

2.1.16 Calibration

For each channel, calibration signals can be produced as sine wave, step, pulse and pseudo random binary pulse signals, 0.5 mVpp to 5 Vpp @ 50 mA. The frequency range is from 0.001 to 100 Hz.

2.2 TIMING

2.2.1 Type

Voltage controlled TCXO phase locked to GPS receiver when available.

2.2.2 Stability

±0.5 ppm over the operating temperature range (when not locked to GPS receiver).

2.2.3 Data Sample Time Tag Accuracy

Better than ±10 microseconds of UTC when phase locked to GPS receiver.

2.2.4 GPS Duty Cycle

Programmable power on duty cycle for the GPS to conserve power.

2.3 ACQUISITION MODES

2.3.1 Continuous Recording

User selected start time, record until data storage full, or ring buffer (overwrite oldest data) modes.

2.3.3 Event Triggered Recording

Threshold, STA/LTA (updating or non-updating), and external digital input trigger. User programmable pre-event length and post-event length.

2.3.2 Timed Window Recording

Four user programmable recording windows (continuous or event recording within a timed window).

2.4 DATA STORAGE

2.4.1 Type

Internal or removable, hard disk (up to 240GB), PCMCIA ATA hard disk, Compact Flash memory (up tp 64GB), Hitachi Microdrives. Removable mass storage uses a USB 2.0 interface. Most media can be formatted with two partitions.

2.4.2 Recording Format

Standard FAT file system, drives readable directly on a PC. Format converters available for 32-bit SUDS, SAC, SEG-Y, SEISAN, MiniSEED, SEED, Matlab and ASCII formats. For other formats, contact factory for information.

2.5 INTERFACES

2.5.1 Communications

Two User I/O ports for setup and data telemetry over VSAT, RF, spread spectrum, Ethernet or telephone line (dialup or leased line) infrastructures. The

configurable user I/O interfaces support Serial (RS232 or RS422/485) (PPP) and 10/100Base-T Ethernet (TCP/IP).

Telemetry uses CD1.1 or Earthworm output protocol for sending in real time continuous data, and/or event triggered data.

2.5.2 GPS

Dedicated port used as the interface to the GPS receiver. It supports serial RS422/485 I/O and 1PPS connection plus switched power to the external GPS receiver. Cables up to 500m long can be used.

2.5.3 Analog Input

Two analog input connectors with three sensor channels on each.

2.5.4 Power

One connector that supports the input of main power as well as a connection for an external battery.

2.5.5 LCD Display

Backlit LCD display that provides various operational and status information to the user.

2.5.6 PCMCIA

Internal PCMCIA interface for ATA compatible devices, including Compact Flash memory and Fortezza authentication cryptocard.

2.5.7 Other I/O

Analog inputs, external trigger input/output, 1PPS input/output.

2.6 GENERAL

2.6.1 Firmware

Firmware utilizes a multi-tasking real time operating system.

2.6.2 Field Upgrades

Application firmware is programmed into FLASH ROM that can be updated via direct or remote connection to the unit over a TCP/IP connection (10/100Base-T or serial PPP) as required.

2.6.3 Setup and Operation

The user can setup, operate and collect data from the unit via local (direct connect) or remote TCP/IP connection (10/100Base-T or serial PPP).

2.6.4 Utility Software

Java written setup, control, data collection and real-time display utility software provided.

2.6.5 State of Health

Hardware diagnostics and state of health information provided. Monitored state of health include the following:

1) Temperature
2) Input Voltage
3) Internal supply voltages
+5V, +3.3V, +1.8V, +/-Analog supplies
4) Timing & GPS Status
5) Sensor Mass Position
6) 2 auxiliary analog inputs
7) 6 general purpose digital inputs

2.7 POWER

2.7.1 Input

+10 to +16 Vdc. 12 Vdc nominal.

2.7.2 Power Consumption

SMART-24D® & SMART-24R® typical power consumption at 100 sps, GPS & disk drive power cycling:

< 1.2 W average typical (3 channels)
< 1.9 W average typical (3 channels plus Ethernet)
< 1.6 W average typical (6 channels)
< 2.3 W average typical (6 channels plus Ethernet)

SMART-24A® typical power consumption at 200 sps, internal sensors, GPS & disk drive power cycling:

< 2.5 W average typical (3 channels plus Ethernet)

2.7.3 SMART-24A® Internal Battery

12V sealed battery for 36-hour continuous operation after main power failure.

2.8 PHYSICAL

2.8.1 Construction

Portable rugged molded case.

2.8.2 Size

4.1 in (105 mm) wide x 10.35 in (263 mm) long x 13.65 in (347 mm) high.

2.8.3 Weight

8.5 lbs (3.9 kg)

2.8.4 Operating Temperature

-20°C to +65°C; PCMCIA PC Card and hard disk options may limit this range.

2.8.5 Humidity

0 to 100%

2.9 OPTIONS

2.9.1 Non-removable Data Storage

An additional PCMCIA board can provide support for an internal (non-removable) PCMCIA ATA type storage device for local data recording or Fortezza authentication cryptocard.

2.9.2 ADC Board

An additional ADC board can provide the extension from 3 to 6 channels.

2.9.3 Communications

Various options are available for data telemetry: VSAT, RF, spread spectrum, Ethernet or telephone line (dialup or leased line).

Section 3

3. INSTALLATION

3.1 GENERAL

The SMART-24 Series instruments are rugged, self-contained remote data acquisition systems designed for maximum reliability and simplicity of operation. These instruments are also very versatile. Installation can range from a simple three channel stand alone recording system connected to a 12V power supply and sensor to a complex remote array requiring many different power, telemetry and physical site considerations.

NOTE

The SMART-24 Series instruments are designed to operate over a wide range of temperature and humidity conditions. However, for best results a SMART-24 Series instrument should be installed in a vault, shelter or covered with a box that will protect it from direct exposure to rain, hail, sleet, wind and rapid temperature changes.

3.2 UNPACKING AND INSPECTION

When the SMART-24 Series instrument is removed from its shipping carton, the unit should be thoroughly inspected for shipping damage. Verify that there is no damage to the enclosure, with particular attention to the connectors, LCD display and push buttons. Generally inspect the visible portions of the instrument for evidence of damage. Verify that all items on the packing list are included in the shipment. Report any damage or discrepancies to Geotech Instruments. Make notes of any damage during shipment for use in preparing any claims against the carrier.

3.3 FUNCTIONAL CHECKOUT

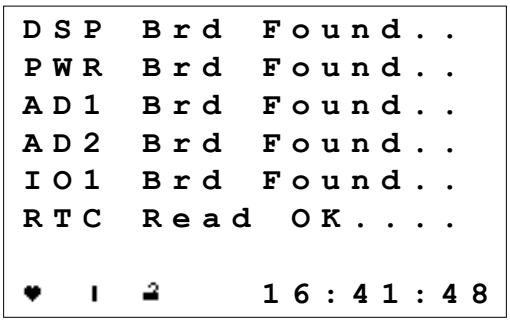
A quick functionality check may be performed on the SMART-24 Series instrument to determine if it is operational using the following procedure:

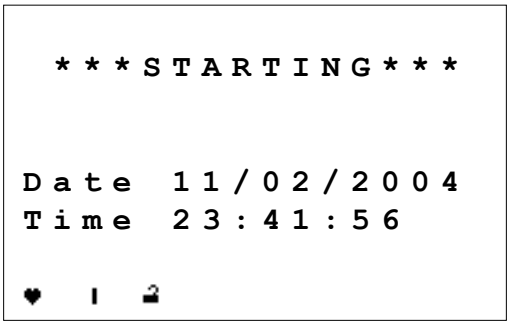
1. Connect the SMART-24 Series instrument to a +12V dc power supply (with the supply turned off) at the connector labeled POWER. A connecting cable

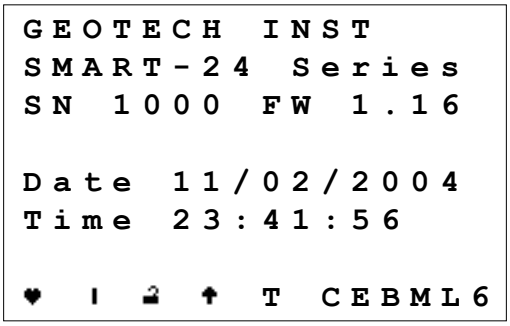
may have to be made from the supplied connector kit (see connector pinouts in section 3.5.6).

2. Switch the power supply on. The LCD display on the status/control panel should become active and provide status information. If the LCD does not become active, press the ON touch pad button on the status/control panel to switch the SMART-24 Series instrument on.

3. The user should see a series of screens on the LCD display similar to the following showing that the unit is functioning properly. Some variation may be noted due to differences in hardware and software configuration.







4. Press and hold the OFF touch pad button on the status/control panel to switch the SMART-24 off. Disconnect the power supply cable from the SMART-24 power input connector.

3.4 MOUNTING A SMART-24 SERIES INSTRUMENT

3.4.1 Location

3.4.1.1 SMART-24D® & SMART-24R® Instrument Location

The SMART-24D® and SMART-24R® instruments are designed to be temporarily or permanently located on any convenient surface. They may be placed in any convenient position and orientation that provides easy access to the external connectors and removable drive bay.

Three mounting points are provided if the unit is to be attached to a wall, sub panel, etc. There are two mounting point located in the unit's handle area and one at the bottom of the unit. See section 3.4.2.1 for mounting details.

3.4.1.2 SMART-24A® Instrument Location

The SMART-24A® instrument is designed to be permanently mounted to a rigid structural member or seismic pier. The mounting surface should be smooth and level. When locating a space for the unit, care should be given to allow enough clearance so that the top cover can be removed for maintenance, cable connection can be made and the removable drive bay can be accessed.

The base plate of the SMART-24A® provides mounting points as well as leveling and orientation aids. See section 3.4.2.2 for mounting details.

3.4.1.3 GPS Receiver Location

If the optional GPS receiver is to be installed with a SMART-24 Series instrument, its location is very important. The GPS receiver must be installed in an outdoors area with as close to an unobstructed 180° view of the sky as possible (horizon to horizon). Any obstructions (buildings, trees, etc.) will reduce the probability of finding enough GPS satellites to obtain a lock. This will cause the GPS receiver to remain powered up longer without locking thus increasing average power consumption and time synchronization drift. The GPS receiver is supplied with a standard 50-foot length of cable. The SMART-24 therefore must be located close enough to a suitable GPS location for the connecting cable to reach. The GPS cable can be extended to 1000 feet if necessary. Lengths longer than 1000 feet are not recommended. The GPS receiver has a female 3/4 inch 14 NPT spigot on its bottom surface for mounting.

3.4.2 Mounting

3.4.2.1 SMART-24D® & SMART-24R® Instrument Mounting

The SMART-24D® and SMART-24R® instruments provide three mounting points if the unit is to be attached to a wall, sub panel, etc. There are two mounting point located in

the unit's handle area (top) and one at the bottom of the unit. Number 8 size screws can be used (3" long in the two handle mounting points and ¾" long in the bottom mounting point) two secure the unit. Figure 3-1 shows the hole pattern for the mounting points.

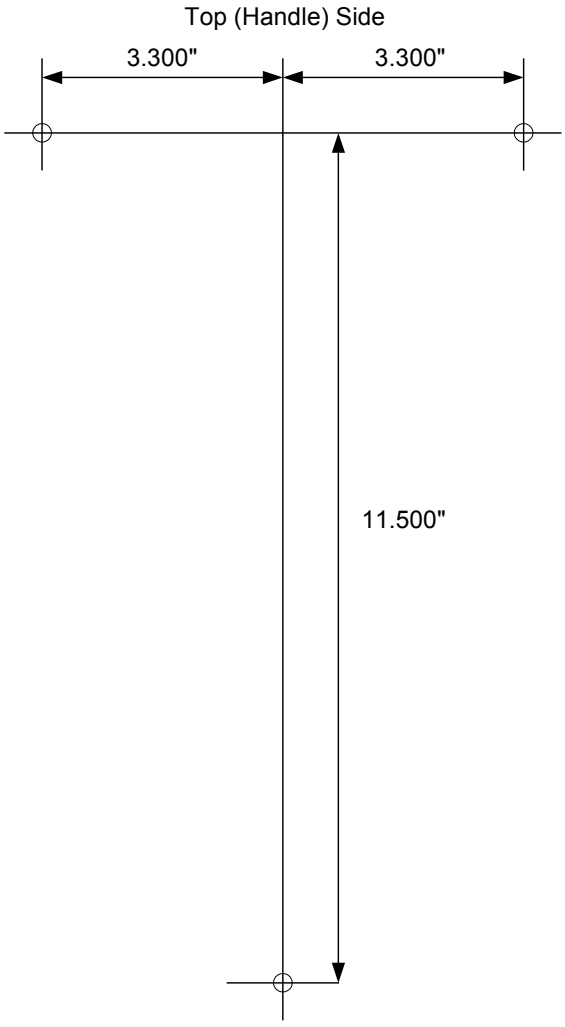


Figure 3-1. SMART-24D® & SMART-24R® Instrument Mounting Points

3.4.2.2 SMART-24A® Instrument Mounting

The base plate of the SMART-24A® provides mounting points as well as leveling and orientation aids. Figure 3-2 shows mounting hole locations and dimensions for this unit. It also shows the recommended clearance area around the unit for case removal and removable drive access during field maintenance. The mounting surface should be smooth and level.

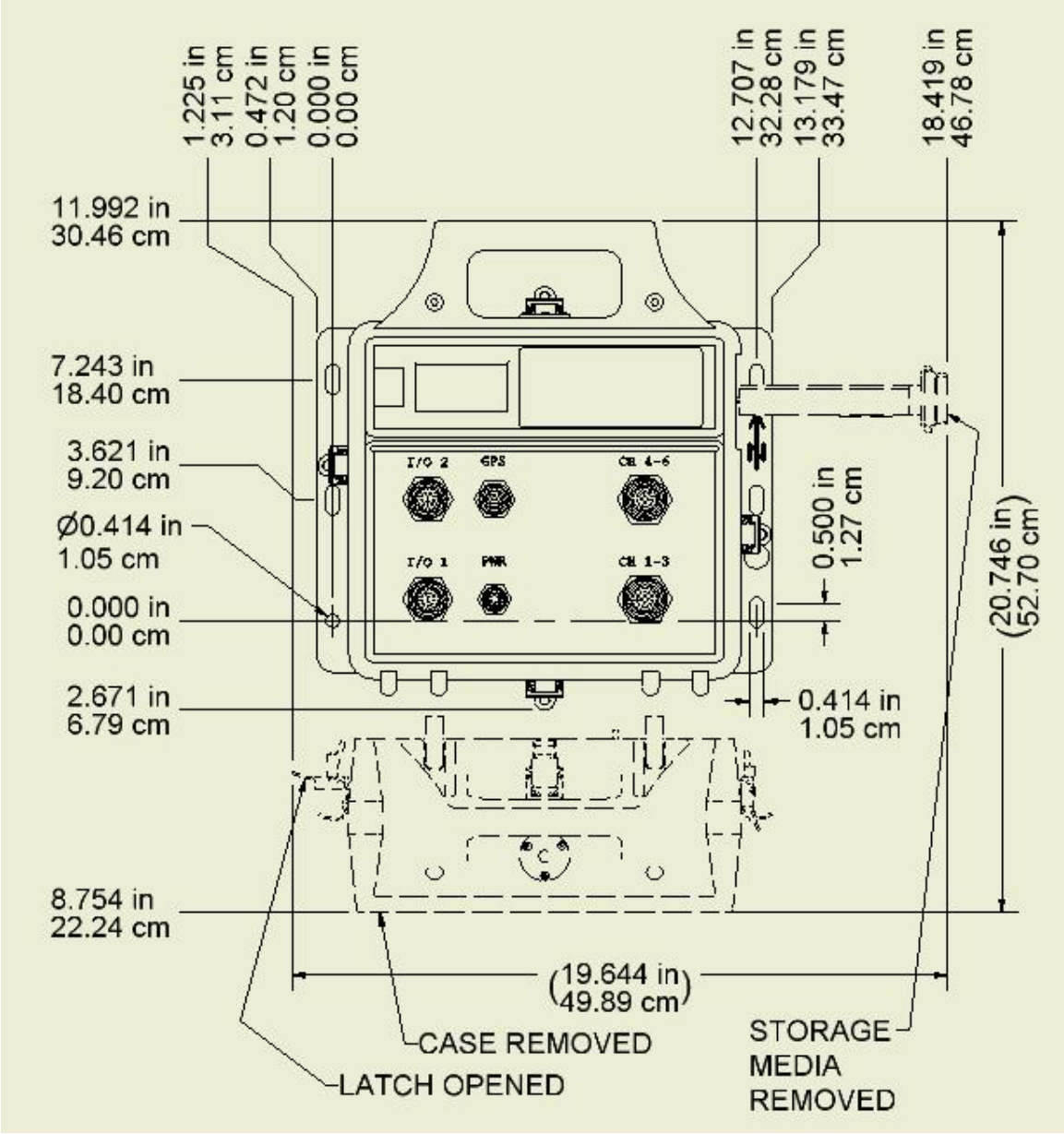


Figure 3-2. SMART-24A® Instrument Mounting Points (Top View)

Using the dimensions shown in Figure 3-2 or using the Smart-24A® base as a template; (1) align the instrument in the North direction (refer to Figure 3-3) and (2) locate three holes in a triangular pattern for concrete anchor installation (Figure 3-4).

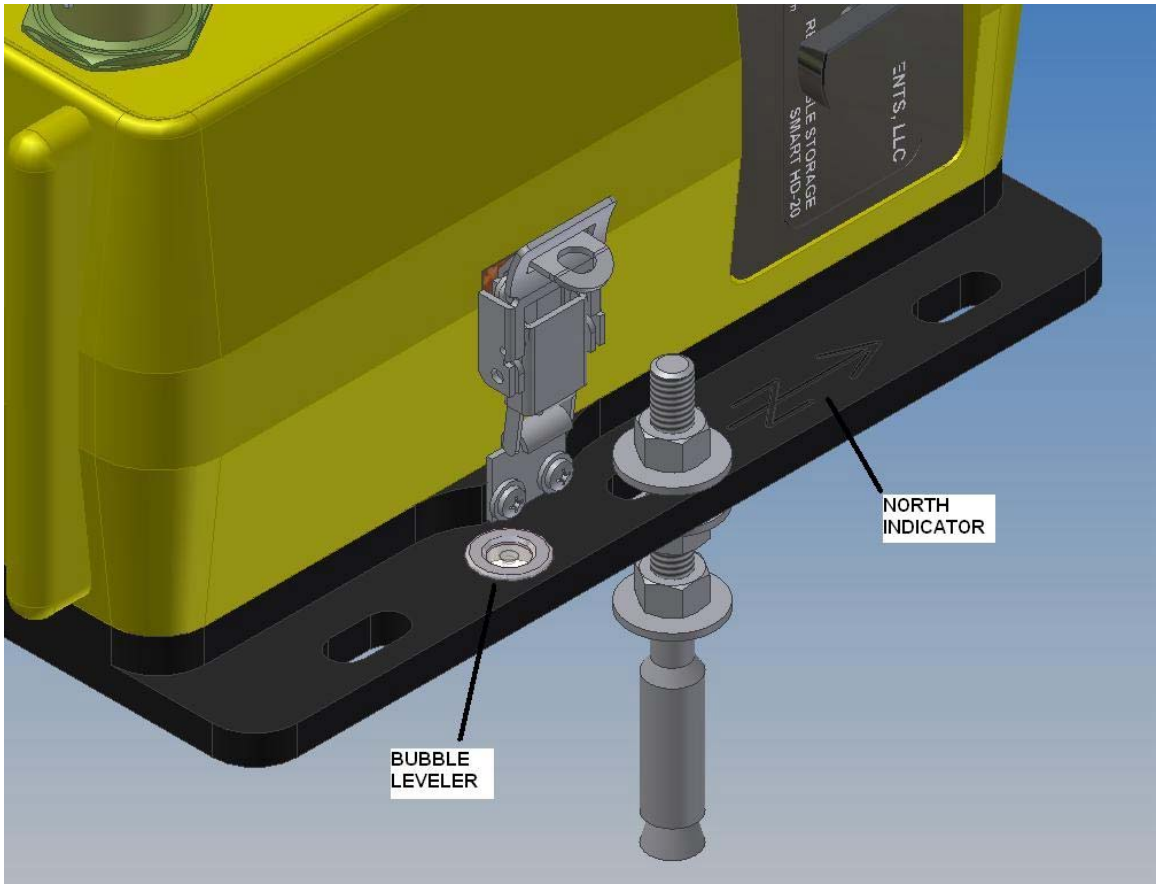


Figure 3-3. SMART-24A® North Direction and Bubble Level Indicators

Drill three 3/8-inch diameter holes to a minimum of 1 ¾ inch depth for anchor installation. Secure each anchor with one washer, and one nut. Tighten the nut sufficiently to engage the anchor against the concrete. Install another nut, then washer on each of the three anchors. Place the Smart-24A® flush to the 3 washers on each anchor. Raise or lower each corner of the Smart-24A® with the nuts just beneath the base plate to level the unit, using the bubble level (Figure 3-3) as a guide. Secure the Smart-24A® at each anchor with a washer and nut on the top side of the base plate as shown Figures 3-3 and 3-4.

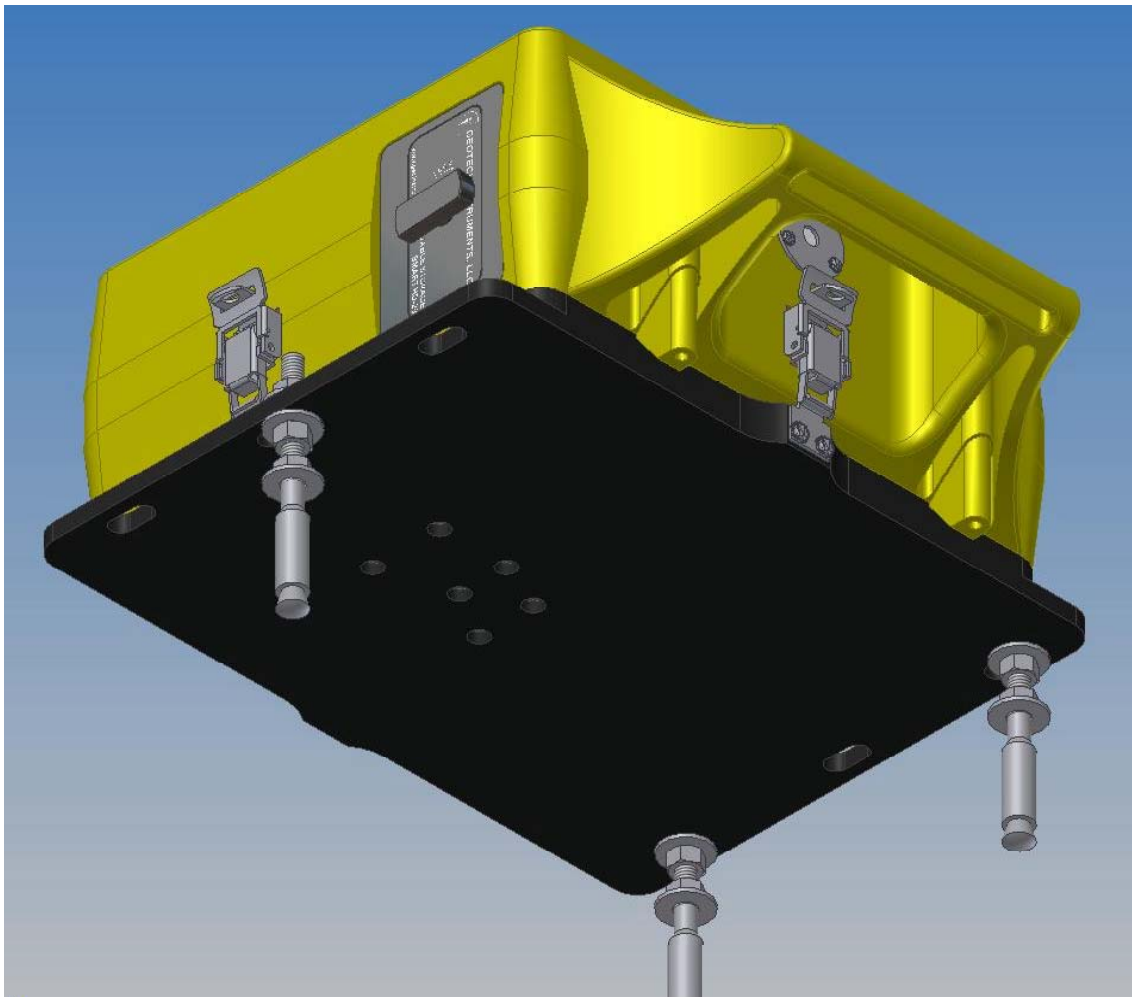


Figure 3-4. SMART-24A® Triangular Mounting Point Pattern with Concrete Anchors

3.4.2.3 SMART-24A® Sensor Offset Adjust

Once mounted, the sensors in the SMART-24A® may need to be mechanically adjusted to null any output offset. Access to the internal sensors is accomplished by unlatching the case on four sides and by carefully removing the case, lifting the handle end and rotating the case back (Figure 3-5). The case assembly will still be connected to the base assembly through the battery wiring and a ribbon cable (these connections are not shown in Figure 3-5). Keep these connections in place.

To zero the sensors, a small flat bladed screwdriver can be carefully inserted through the three holes in the shield (Figure 3-5) to adjust the sensor zero position up or down by turning the brass set screw. The groove for the screwdriver is 0.020 inch wide. For easier

access, it is also possible to remove the metal shield surrounding the sensors and directly access the sensors (Figure 3-6). Clockwise rotation will adjust the offset in the negative direction, while counter clockwise rotation will adjust the offset in the positive direction. Turn the adjustment set screw in the appropriate direction to zero each sensor. Be sure to turn the brass mechanical set screw; do not touch the potentiometer (not shown) on the printed circuit board!

The technician can monitor the adjustment via the LCD screen (select the Data Channel Statistics screen for channels 1, 2 and 3 as shown in section 4.2.2 and Figure 4-10). The Telnet command 'level' can also be used to monitor the adjustment (see section 4.5.5.1 for details). Note that the LCD screen displays data averaged over 5 seconds, so it may take 10 seconds or more for the display value to settle between adjustments. Also note that the adjustment is very sensitive. While the absolute maximum allowable value is ±12500 counts or ±0.005 V, the technician should try to adjust the offset value to less than ±2500 counts or ±0.001 V if possible. Any value less than ±2500 counts or ±0.001 V should be left alone.

When complete, reattach the metal sensor shield (if needed) and latch the case back into place on four sides.

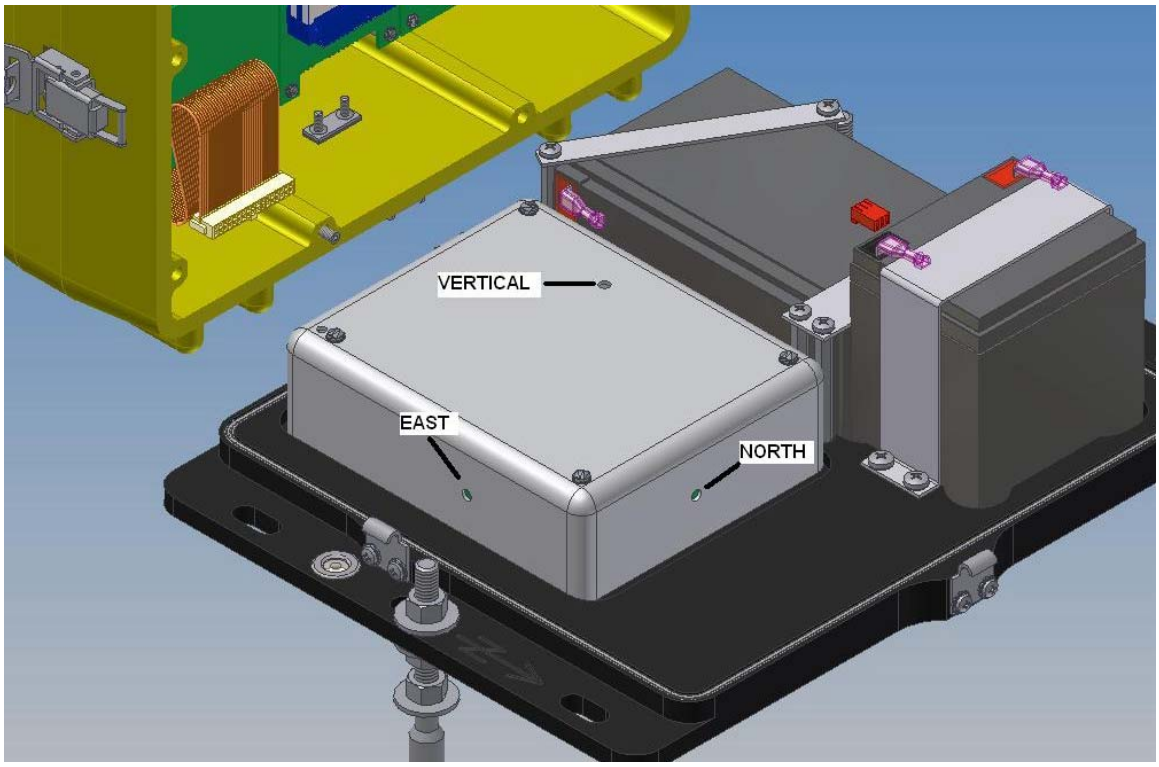


Figure 3-5. SMART-24A® Case Unlatched and Opened

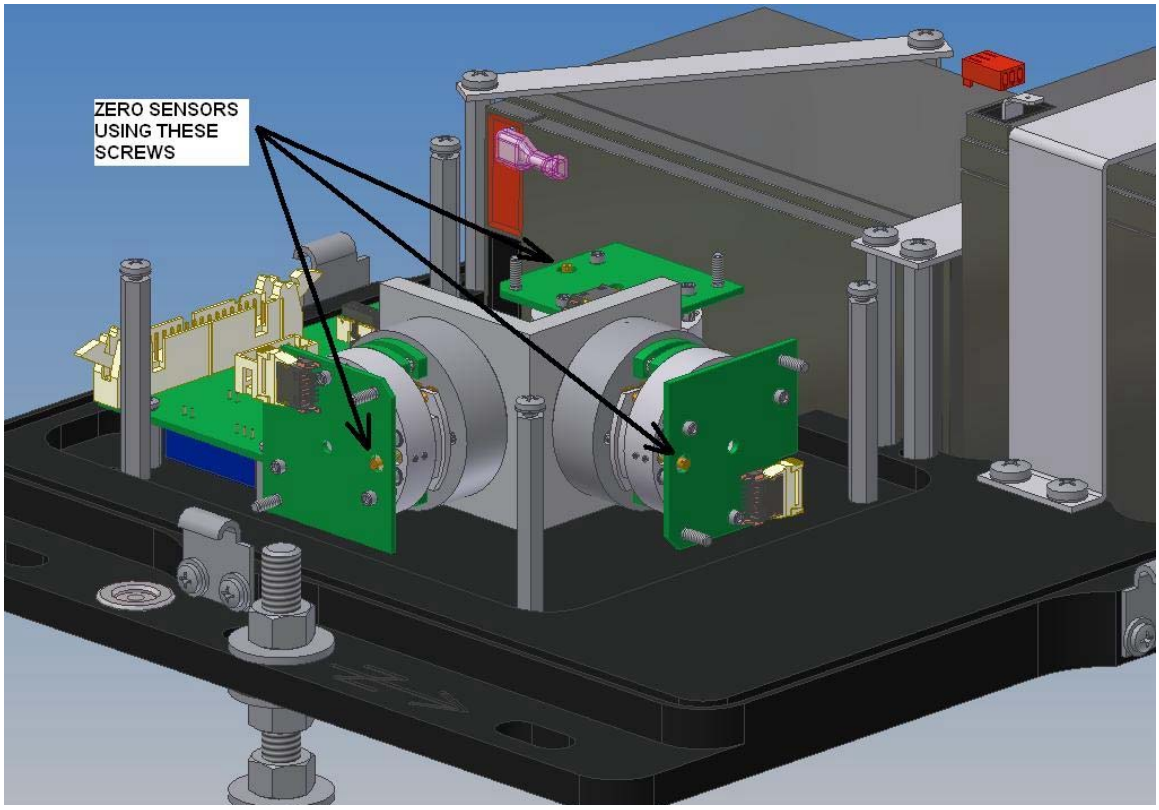


Figure 3-6. SMART-24A® Sensor Offset Zeroing Set Screws

3.4.2.4 SMART-24A® Sensor Replacement

Refer to Figure 3-6 for sensor replacement. The vertical sensor is replaced by removing three sealed screws located on the bottom side of the base plate. The horizontal sensors are replaced by first releasing the L bracket from the base plate by removing three sealed screws located on the bottom side of the base plate. A horizontal sensor can then be removed from the L bracket as needed. When replacing a sensor, ensure that a sensor labeled as horizontal is replaced with a new sensor that is also labeled as a horizontal sensor. Similarly, ensure that a sensor labeled as vertical is replaced with a new sensor that is also labeled as a vertical sensor. Also note very carefully the sensor orientation as shown in Figure 3-6. Replace the sensors in the correct orientation and with their ribbon cables correctly connected to the sensor interface board.

3.4.2.5 SMART-24A® Battery Replacement

Because the batteries lose their capacity over time, they should be replaced periodically.

ATTENTION! The battery manufacturer recommends replacing batteries **every three years**, or even **every two years when operated in hotter climates**.

Battery Specifications

We strongly recommend that you purchase batteries from Geotech Instruments. Should they be procured by the user, Geotech Instruments recommends:

- Power Sonic Model PSH-1280F2, 12V 8.5Ah, 36W/cell
- Power Sonic Model PSH-1255F2, 12V 6.0Ah, 24W/cell (both for units equipped with two internal batteries)

These batteries have a pressure release valve for the hydrogen build-up during charging cycles. In float charging mode, the hydrogen release is minimal and SMART-24A® comes with its own vent (under the handle) to release this hydrogen.

***WARNING!* Fire, burn or explosion hazard**. Do not install a non-rechargeable battery in SMART-24A®. Only install a sealed lead acid battery with the specifications above (or strictly equivalent). Before installing the new battery make sure it is fully charged. Charging the battery inside SMART-24A® releases hydrogen which becomes explosive above certain concentrations. Handle batteries with care, and do not drop them or attempt to take them apart. Recycle used batteries or dispose them in accordance with local regulations. Do not throw used batteries onto a fire.

3.5 CONTROLS, INDICATORS AND CONNECTORS

Figure 3-7 shows the SMART-24 Series instrument controls, indicators and connectors described in the following sections.

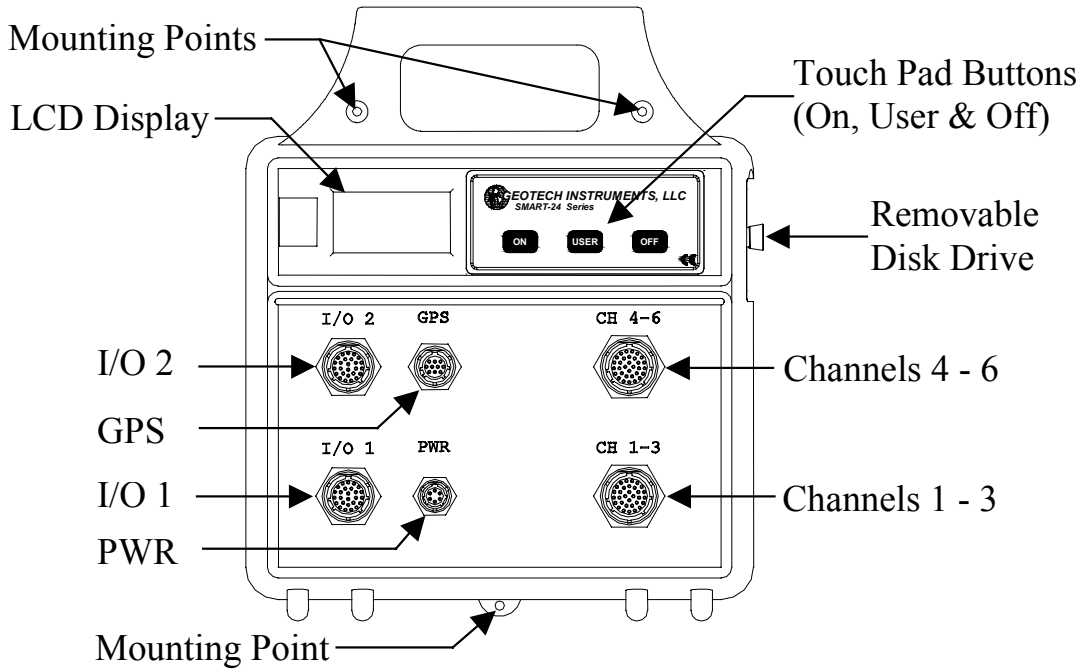


Figure 3-7. SMART-24 Series Control, Indicator and Connector Locations

3.5.1 ON Touch Pad Button

Purpose:

Located on the front panel, pressing this button switches power on to a SMART-24 Series instrument. If power is already on, it causes the unit to be reset. Note that a SMART-24 Series instrument will automatically turn itself on if external power has been removed and then re-applied.

3.5.2 OFF Touch Pad Button

Purpose:

Located on the front panel, pressing and holding this touch pad button for more than two seconds powers a SMART-24 Series instrument off. Note that a SMART-24 Series instrument will automatically power itself on if external power is removed and then re-applied.

3.5.3 USER Touch Pad Button

Purpose:

Located on the front panel, quickly pressing and releasing (< 2 seconds) this touch pad button allows the user to view various operational and status information on the LCD display. The first press will activate the LCD backlight for easy viewing. Subsequent presses will cause the unit to step through different operational and state of health data displays. After 10 seconds of inactivity, the LCD backlight will turn off. After 4 minutes of inactivity, the LCD display will return to the main home screen.

Pressing and holding this button, for longer than 2 seconds, will cause the unit to flush any buffered data files to the external hard disk.

Pressing and holding this button while power is applied to the unit forces it into the Bootloader mode. This mode allows the user to erase or install firmware and to perform other maintenance operations.

3.5.4 LCD Display

Purpose:

This is a backlit LCD display that provides various operational and status information to the user (TCP/IP status, disk drive, status, GPS status, timing status, state of health values, etc.).

3.5.5 CH 1-3 & CH 4-6 Connectors

Purpose:

These connectors (CH 1-3 and CH 4-6) are used to supply the analog sensor input voltage to the digitizers. They also provide the calibration output signals. Unregulated 12V dc switched power output is also provided to the user on this connector.

Connection:

18-32S circular connector type.

Signals:

Table 3-1 gives the analog connector pin assignments and descriptions.

Table 3-1. CH 1-3 & CH 4-6 Connector Pins

PIN	NAME	FUNCTION
G	CH1_SIG_POS	Channel 1 (Z) positive differential input (±10V)
H	CH1_SIG_NEG	Channel 1 (Z) negative differential input (±10V)
Z	CH1_SIG_SHLD	Channel 1 (Z) shield (AGND)
J	CH1_CAL_POS	Channel 1 (Z) positive differential calibration output
K	CH1_CAL_NEG	Channel 1 (Z) negative differential calibration output
a	CH1_CAL_SHLD	Channel 1 (Z) shield (AGND)
L	CH1_MASSP	Channel 1 (Z) single ended mass position input (±10V) referenced to power ground
b	CH1_AUTOZ/	Channel 1 (Z) auto zero digital control output (open collector) referenced to power ground
M	CH2_SIG_POS	Channel 2 (N) positive differential input (±10V)
N	CH2_SIG_NEG	Channel 2 (N) negative differential input (±10V)
c	CH2_SIG_SHLD	Channel 2 (N) shield (AGND)
P	CH2_CAL_POS Or CAL_CTRL_USER/	Channel 2 (N) positive differential calibration output Or Calibration digital control output (user defined, open collector)
R	CH2_CAL_NEG Or CAL_CTRL_1/	Channel 2 (N) negative differential calibration output Or Calibration digital control output 1 (Z) (open collector)
d	CH2_CAL_SHLD Or CAL_CTRL_GND	Channel 2 (N) shield (AGND) Or Calibration digital control ground return
S	CH2_MASSP	Channel 2 (N) single ended mass position input (±10V) referenced to power ground
e	CH2_AUTOZ/	Channel 2 (N) auto zero digital control output (open collector) referenced to power ground
A	CH3_SIG_POS	Channel 3 (E) positive differential input (±10V)
B	CH3_SIG_NEG	Channel 3 (E) negative differential input (±10V)
V	CH3_SIG_SHLD	Channel 3 (E) shield (AGND)
C	CH3_CAL_POS	Channel 3 (E) positive differential calibration output

	Or CAL_CTRL_2/	Or Calibration digital control output 2 (N) (open collector)
D	CH3_CAL_NEG Or CAL_CTRL_3/	Channel 3 (E) negative differential calibration output Or Calibration digital control output 3 (E) (open collector)
W	CH3_CAL_SHLD Or CAL_CTRL_GND	Channel 3 (E) shield (AGND) Or Calibration digital control ground return
E	CH3_MASSP	Channel 3 (E) single ended mass position input (±10V) referenced to power ground
X	CH3_AUTOZ/	Channel 3 (E) auto zero digital control output (open collector) referenced to power ground
g	PWR	Power output (+12Vdc nominal, fused protected at 0.5 amps)
h	PWR_GND	Power ground return
F	SER_1_POS	SMART seismometer serial 1 communications positive differential signal (function TBD)
Y	SER_1_NEG	SMART seismometer serial 1 communications negative differential signal (function TBD)
f	SER_2_POS	SMART seismometer serial 2 communications positive differential signal (function TBD)
j	SER_2_NEG	SMART seismometer serial 2 communications negative differential signal (function TBD)
T	SER_3_POS	SMART seismometer serial 3 communications positive differential signal (function TBD)
U	SER_3_NEG	SMART seismometer serial 3 communications negative differential signal (function TBD)

3.5.6 Power Connector

Purpose:

The POWER connector supports the input of external DC power as well as a connection for an external battery.

Connection:

10-6P circular type (10 shell, 6 pins)

Signals:

Table 3-2 gives the POWER connector pin assignments and descriptions.

Table 3-2. POWER Connector Pins

PIN	NAME	FUNCTION
F	PWR	External power input, +10Vdc to +15Vdc, fused
E	PWR_GND	Power and chassis ground.
B	BAT_1	External 12Vdc battery connection, fused
A	BAT_1_GND	Power and chassis ground.
C	BAT_2	External 12Vdc battery connection, fused
D	BAT_2_GND	Power and chassis ground.

3.5.7 Input/Output Connectors

Purpose:

The INPUT/OUTPUT connectors provide various I/O connections such as for Serial RS232/RS422 and 10/100Base-T Ethernet as well as future optional connections, whose use is determined by the internal setup of the unit by jumpers.

The I/O2 connector provides an Event Trigger Digital Output which is active during SMART-24 event recording, and also an External Trigger Digital Input that can be used to for external event triggering.

Two external digital inputs referenced in Table 3-3b are used to denote two bits for vault door open and equipment housing open of the channel security byte contained in the channel status field of the CD1.1 Data Format Frame. This field is described in section 4.7.7. Also, an internal switch is used to indicate the authentication seal broken and the digitizing equipment open bits of the channel security byte.

Connection:

16-26S circular type (16 shell, 26 pins).

Signals:

Table 3-3 (a, b) gives the INPUT/OUTPUT connector pin assignments and descriptions for I/O1 and I/O2.

Table 3-3a. I/O1 INPUT/OUTPUT Connector Pins

PIN	NAME	FUNCTION
A	RX (RX+)	RS232 RX
T	TX (RX-)	RS232 TX
B	RTS (TX+)	RS232 RTS
C	CTS (TX-)	RS232 CTS
U	DTR	RS232 DTR
b	DSR	RS232 DSR
D	CD	RS232 CD
V	RI	RS232 RI
E	GND	RS232 Signal Ground
S	TBD	Future
R	TBD	Future
P	TBD	Future
a	TBD	Future
F	TD+	Ethernet 10/100Base-T TX Data +
W	TD-	Ethernet 10/100Base-T TX Data -
G	RD+	Ethernet 10/100Base-T RX Data +
H	RD-	Ethernet 10/100Base-T RX Data -
X	TBD	Future
Y	TBD	Future
J	TBD	Future
K	TBD	Future
Z	TBD	Future
L	TBD	Future
c	TBD	Future
M	Spare_ana_in+	Spare Analog Input (+/-10V)
N	Spare_ana_ret	Spare Analog Input Return (GND)

Table 3-3b. I/O2 INPUT/OUTPUT Connector Pins

PIN	NAME	FUNCTION
A	RX (RX+)	RS232 RX
T	TX (RX-)	RS232 TX
B	RTS (TX+)	RS232 RTS
C	CTS (TX-)	RS232 CTS
U	DTR	DIGITAL O.C. OUT1 (TRIGGER OUT)
b	DSR	DIGITAL IN4/ (EXTERNAL TRIGGER IN)
D	CD	DIGITAL IN5/ (EQUIPMENT HOUSING OPEN)
V	RI	DIGITAL IN6/ (VAULT DOOR OPEN)
E	GND	RS232 Signal Ground
S	TBD	Future
R	TBD	Future
P	TBD	Future
a	TBD	Future
F	TBD	Future
W	TBD	Future
G	TBD	Future
H	TBD	Future
X	TBD	Future
Y	TBD	Future
J	TBD	Future
K	TBD	Future
Z	TBD	Future
L	TBD	Future
c	TBD	Future
M	Spare_ana_in+	Spare Analog Input (+/-10V)
N	Spare_ana_ret	Spare Analog Input Return (GND)

3.5.8 GPS Connector

Purpose:

The GPS connector supports serial I/O and 1PPS connection to an external GPS receiver.

Connection:

12-10S circular type (12 shell, 10 pins).

Signals:

Table 3-4 gives the GPS connector pin assignments and descriptions.

Table 3-4. GPS Connector Pins

PIN	NAME	FUNCTION
A	TX+	GPS RS422 TX Data +
B	TX-	GPS RS422 TX Data -
G	RX+	GPS RS422 RX Data +
H	RX-	GPS RS422 RX Data -
C	1PPS+	GPS RS422 1PPS +
D	1PPS-	GPS RS422 1PPS -
F	GPSPWR	GPS Power
E	GPSGND	GPS Ground
J	GPSGND	GPS Ground
K	GPSGND	GPS Ground

3.6 GENERAL INSTALLATION

This section covers general installation and connection topics.

3.6.1 Power Connections

Power connections to a SMART-24 Series instrument are made via the external POWER connection at either the external battery or external input pins, or both as described in the following sections.

3.6.1.1 External Power Input

Main power is delivered to the SMART-24 Series instrument via the external power input pins of the POWER connector. This input is nominally +12 Vdc with respect to ground. In addition or alternately, an external battery supply may be connected at pins B & C of the POWER connector. Pins A, D & E of the power input connector serve as the negative input or power return for either input. The unit will operate normally with input voltages from +10 dc to +16 Vdc and will automatically turn off when the input voltage falls below +10 Vdc. The unit will restart when the external power input returns to a value greater than +11.3 Vdc.

The LCD display indicates the status of the external power input.

3.6.1.2 External Battery

NOTE

Only +12 Vdc rechargeable lead acid or lead acid gel cell batteries should be used with a SMART-24 Series instrument.

External back up batteries can be connected to a SMART-24 Series instrument via pins B & C of the POWER connector, again using pins A & D for the power return. These pins are transient protected and fused. When the main external power input is above approximately +12.750 Vdc, any connected batteries will receive a trickle charge from the unit to maintain at full capacity. Should the main external power input go away, current will be drawn from the batteries to power the unit until the battery voltage drops to +10.000 Vdc, at which time it will turn itself off.

3.6.2 Analog Input Connections

Sensor inputs to a SMART-24 Series instrument are made via the channel input connectors (CH 1-3 and CH 4-6).

3.6.3 GPS Connections

The GPS connector provides the interface to the GPS receiver. It is connector and pin compatible with, and should only be used with a Geotech Instruments GPS receiver and supplied cable. Cable length to the GPS must be limited to 400 feet or less.

3.6.4 Input/Output Connections

The I/O (I/O1 & I/O2) connectors provide various interfaces to the setup, configuration and data transfer functions over Serial RS232/RS422, Ethernet, USB and/or FireWire 1394 connections.

3.7 SITE SPECIFIC INSTALLATION

For system purchases from Geotech Instruments system drawings, site installation wiring diagrams and instructions are provided in the system level documentation for that job.

For other installations, contact Geotech Instruments for site-specific installation advice.

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Section 4

4. OPERATION

4.1 CONNECTION AND POWER UP

4.1.1 Power Connection

Power is supplied to the SMART-24 Series instrument via the PWR connector. A nominal +12 Vdc (+10 to +16 Vdc) should be supplied to pins F (+) and E (-) of this connector. Normally the supplied power cable (P/N 990-60626-010) should be used when no external batteries will be used with the unit. This cable provides stripped and tinned wire terminations (white is positive, black is negative) suitable for connection to a power supply. While the SMART-24 Series instruments are low power, the power supply must have enough reserve capacity to supply the inrush startup current of the unit plus any connected devices such as the GPS and sensors. Typically a 2 to 3 Amp power supply will work.

If other power system configurations are to be used such as external batteries, solar panels, etc., custom wiring will have to be designed. Please consult the factory for possible power system configurations.

4.1.2 GPS Connection

If a GPS-3 receiver is to be used with the SMART-24 Series instrument, it is connected to the unit at the GPS connector with the supplied GPS cable and receiver (P/N 990-60000-0101).

4.1.3 Sensor Connection

Sensors are connected to the SMART-24 Series instruments at the CH 1-3 and CH 4-5 connectors. Please refer to the sensor user manual and section 3.5.5 of this manual for specific connection information. Cables to standard Geotech sensors are available and shown in Appendix A.

4.1.4 Communications Connection

The I/O1 and I/O2 connectors of the SMART-24 Series instruments are used to make the communication connections to external computers, either locally or remotely. As configured from the factory, a SMART-24 Series instrument provides the following three connection options:

1. 10/100Base-T Ethernet TCP/IP connection on the I/O1 Connector (if the Ethernet board is installed in the unit). This connection can be used to connect to a network or directly to a PC. The I/O Serial and Ethernet cable (P/N 990-

60649-0101) provides a standard RJ45 plug that is wired in a crossover configuration that can be connected directly to a PC RJ45 network receptacle. It can also be connected to a network hub or switch provided that they have auto MDI/MDIX crossover detection. The factory TCP/IP defaults for this connection are:

IP Address:	192.168.0.1
Subnet Mask:	255.255.255.0
Default Gateway:	192.168.0.255

If a connected PC's network settings are setup to be compatible with these factory defaults, the user will have full access to the SMART-24 Series instrument as described in the following sections.

2. Serial PPP server TCP/IP connection on the I/O1 connector. This connection can be used to connect directly to a PC's serial port or to a modem or other serial telemetry option. The I/O Serial and Ethernet cable (P/N 990-60649-0101) provides a standard 9-pin D type female connector that can be connected directly to a PC's serial port. Alternatively the I/O Serial Modem cables (P/N 990-6XXXX-0101 for 25-pin D type or P/N 990-6XXXX-0101 for 9-pin D type) can be used to connect to an external AT command compatible modem. A connected modem will automatically be setup in auto answer mode.

   The serial PPP server built into the SMART-24 Series instruments provides a TCP/IP connection similar to that of a dialup Internet Service Provider (ISP) connection. When directly connected to a PC (no modem), the PC can be configured to provide a direct cable dialup connection to the unit. Please refer to your operating system documentation for details. The factory TCP/IP defaults for this connection are:

PPP Server IP Address:	192.168.0.30
PPP Server Subnet Mask:	255.255.255.0
IP Address served to connecting PC:	192.168.0.31

   Serial Port Defaults:

Baud Rate:	115200
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

   A user must logon to the PPP server using the unit's system user name and password. The factory defaults for these are:

User Name:	smart24	(lower case)
Password:	changeme	(lower case)

3. Serial ASCII character command terminal on the I/O2 connector. This connection can be used to connect directly to a PC's serial port or to a modem or other serial telemetry option. The I/O Serial and Ethernet cable (P/N 990-60649-0101) provides a standard 9-pin D type female connector that can be connected directly to a PC's serial port. Alternatively the I/O Serial Modem cables (P/N 990-6XXXX-0101 for 25-pin D type or P/N 990-6XXXX-0101 for 9-pin D type) can be used to connect to an external AT command compatible modem. A connected modem will automatically be setup in auto answer mode.

   This connection provides a simple low-level ASCII command mode (described in section 4.3.1) using only a simple terminal program such as HyperTerminal. It allows the user to setup the unit and to view status information from it. Note that one cannot view or upload data via this connection. The factory serial port defaults are:

Baud Rate:	115200
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

   A user must logon to the ASCII command mode using the unit's system user name and password. The factory defaults for these are:

User Name:	smart24	(lower case)
Password:	changeme	(lower case)

Each of these three connection options is described in more detail in following sections of this manual.

4.1.5 Power Up

Pressing and releasing the ON touch pad button on the front panel will power the unit up. The LCD display on the front panel should become active and provide status information

4.1.6 Power Down

The unit can be turned off either through software command or by pressing and holding the OFF touch pad button on the front panel for longer than two seconds. While there is no special sequence of events in turning a SMART-24 Series instrument off, power should not be abruptly removed while the unit is moving data to the removable hard disk

drive (the 'M' symbol will be displayed on the LCD home screen while data is being moved to the disk drives).

4.1.7 General Operation

Setup, control and data collection is performed via one of the I/O ports as described above. Utility software as described in following sections of this manual can be used with a directly connected computer on the local port to setup the unit and view data. As part of a larger system, the SMART-24 Series instruments can be accessed remotely via VSAT, Ethernet, radio or modem links.

If the SMART-24 Series instrument was supplied with a larger system that includes a SMART Central Station, please refer also to the SMART Central Station documentation for details of connecting and operating the SMART-24 Series instrument with the SMART Central Station based system

4.2 LCD DISPLAY OPERATION

The SMART-24 Series instruments provide a backlit LCD display to provide various operational and status information to the user (TCP/IP status, disk drive, status, GPS status, timing status, state of health values, etc.). Once the unit is booted and running, the user can control the display using the USER touch pad button as described in section 3.5.3. The following sections show and describe the LCD display screens currently available.

4.2.1 Bootup Screens

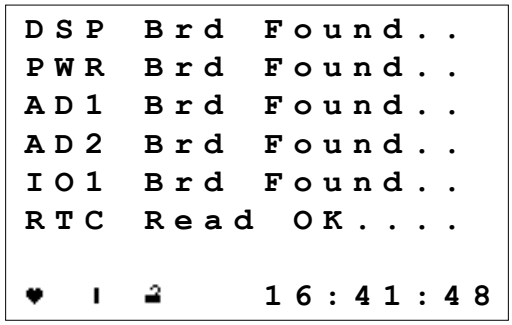


Figure 4-1. SMART-24 Series LCD Startup Screen

The Startup screen (Figure 4-1) shows the initial boot sequence of the unit. The internal PC boards are identified and the real time clock (RTC) is read.

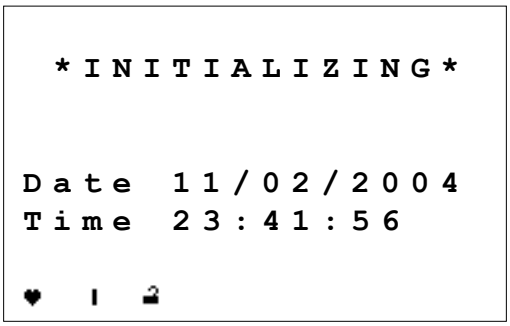


Figure 4-2. SMART-24 Series LCD Initializing Screen

After the Startup screen, the unit may display the Initializing screen (Figure 4-2). During this time, the unit is initializing its hardware and reading the saved configuration. Depending on the unit's configuration, this screen may pass so quickly the user may not see it all the time. If the unit 'hangs' at this screen for more than a few minutes, the boot process has failed for some reason and the user should restart the unit.

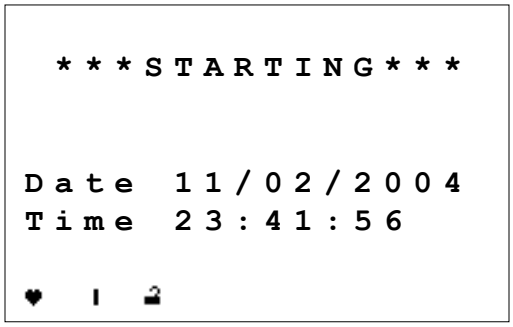


Figure 4-3. SMART-24 Series LCD Starting Screen

The Starting screen (Figure 4-3) appears after the unit has completed initialization and checked the stored application firmware and saved configuration. The unit has now started loading the main application firmware. Depending on the unit's configuration it may take up to 30 seconds to pass this screen.

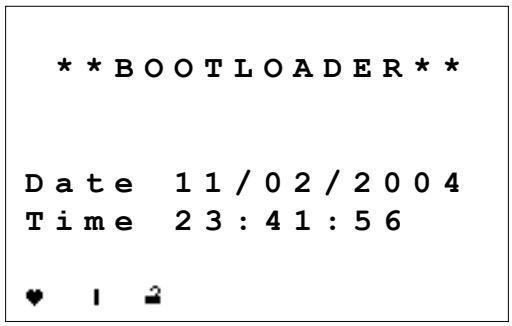


Figure 4-4. SMART-24 Series LCD Bootloader Screen

If the user commands the unit to enter the Bootloader mode by using the USER touch pad button during startup or by software command, the unit will display the Bootloader screen (Figure 4-4) as long as the unit is in the Bootloader mode. The user can still step through some of the state of health screens while in the Bootloader mode.

4.2.2 Operational Screens

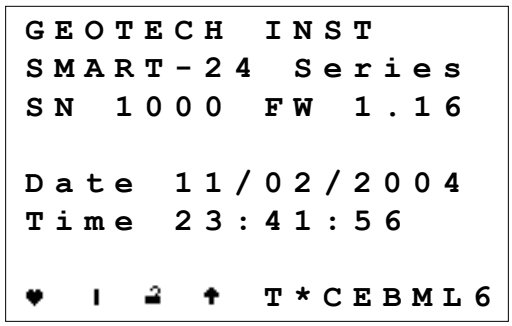


Figure 4-5. SMART-24 Series LCD Home Screen

Once the SMART-24 Series instrument has loaded the application firmware and started, the unit will display the Home screen (Figure 4-5). This screen shows the unit's serial number and the version number of the currently running application firmware. It also shows the current date and time. Note that the date and time is UTC time if a GPS is connected to the unit.

The user can turn on the LCD backlight and step through the other display screens using the USER touch pad button as described in section 3.5.3. After 10 seconds of inactivity the backlight will turn off and after 4 minutes of inactivity the display will return to the Home screen.

The bottom line of the display is reserved for the special operational icons. The four icons on the left of the display are always displayed no matter which screen is currently being displayed. The letter icons on the right are only displayed when at the Home screen. The following gives the meaning of each of the special operational icons.

ICON	PURPOSE
♥	System heart beat flashing once per second. Basic system functions are running.
I	When rotating the ADCs are running and sending data to the main CPU.
🔓	Timing Unlocked. Internal timing is not locked to an external reference such as the GPS.
🔒	Timing Locked. Internal timing is locked to an external reference such as the GPS.
✚	When displayed the power is turned on to the GPS receiver. When not displayed the GPS power is off.
T	When displayed, a CD data connection has been made to a server and real time data is being transmitted.
*	When flashing, indicates that an external drive is not available or an error has occurred that has caused the unit to stop recording new data.
C	When displayed, continuous data files are being recorded.
E	When displayed, event data files are being recorded.
B	When displayed, calibration data files are being recorded**.**
M	When displayed, recorded files are being moved from drive A to either drive B, C or D. The external drive should NOT be removed or power turned off while the M icon is displayed or disk corruption could result.
L	Will flash when the available external disk free space falls below 25% of the total available external disk space. Will also flash if no external drives are found.
3/6	Displays the number analog input channels available in the unit.

The unit will step through the following screens when the USER touch pad button is used.

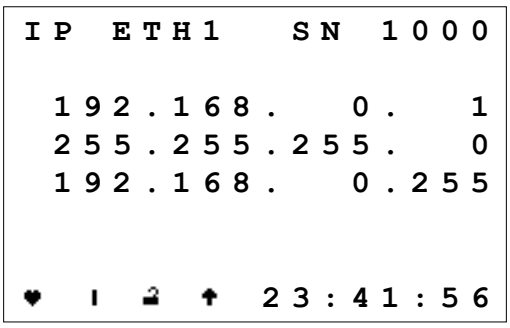


Figure 4-6. SMART-24 Series LCD IP Address Screen

If there are active TCP/IP connections, the unit will display an IP Address screen (Figure 4-6) for each connection found. The label following the 'IP' identifies the connection. In this case it is the Ethernet port on I/O1. Other possible labels are 'ETH2' (Ethernet port on I/O2), 'SP1' (serial PPP on I/O1) and 'SP2' (serial PPP on I/O2). This screen also shows the unit's serial number. Then it gives the connection's IP address, subnet mask and default gateway values. The time is also displayed in the lower right of the screen, replacing some of the special operational icons.

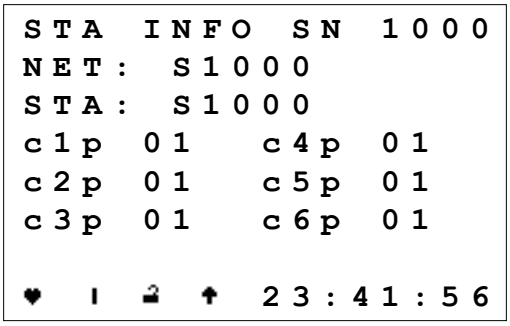


Figure 4-7. SMART-24 Series LCD Station Information Screen

The Station Information screen (Figure 4-7) shows the configuration of the main real time CD data transmission connection (CD Profile 1). This screen shows the following information:

- Unit Serial Number
- Network Name Label
- Station Name Label
- Channel names and location codes for the six primary data channels (displayed only if the corresponding ADC board is actually installed in the unit)

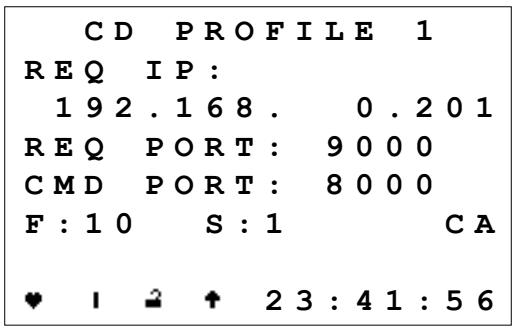


Figure 4-8. SMART-24 Series LCD CD Profile Information Screen

The CD Profile Information is displayed in a set of screens (Figure 4-8). There is one screen for each enabled CD data transmission connection (CD Profile). These screens show the configuration of the enabled CD Profiles and give the following information:

- CD Data Connection Request IP Address (of the destination computer).
- CD Data Connection Request Port (of the destination computer).
- CD Command Connection Port (on this unit).
- Data Frame Size (F:10) in seconds.
- SOH Send Rate (S:1) in seconds.
- Compression Enabled/Disabled ('C' will be displayed if enabled).
- Authentication Enabled/Disabled ('A' will be displayed if enabled).

The real time CD data transmission operation will be discussed in detail in section 4.7.5.

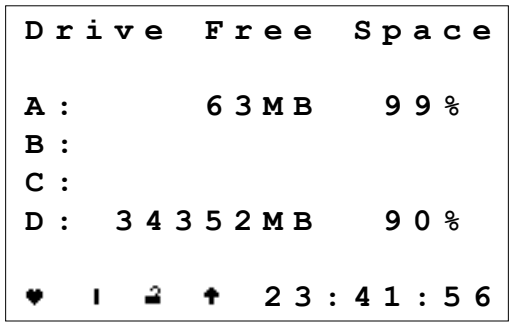


Figure 4-9. SMART-24 Series LCD Drive Status Screen

The Drive Status screen (Figure 4-9) shows the current free space remaining on any connected disk drives in the system. The free space is given in megabytes remaining and in a percentage of the total drive size. If the free space for a drive is not displayed, that drive is not currently installed in the system or not recognized. Drive A is the internal RAMDISK of the unit. Drives B and C are assigned to the internal PCMCIA slots (if installed) and drive D is the removable USB drive module. Note that since the removable drive D is normally powered down when not in use, if the drive is removed or replaced

the change will not be recognized until the next time the unit needs to turn the drive on to move files to it. Section 4.7.10 gives more details on the operation on the disk drive system.

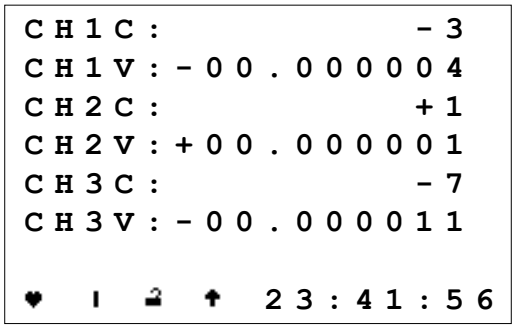


Figure 4-10. SMART-24 Series LCD Data Channel Statistics Screen

The Data Channel Statistics screens (Figure 4-10) (one for channels 1, 2 & 3 and one for channels 4, 5 & 6 if installed) show the average or mean offset for each channel in counts (CHXC) and volts (CHXV). The volt display depends on the full-scale front-end gain and the channel gain settings being programmed correctly (using Smart24Config or the low level ASCII commands SFG and SCG described in Appendix C). These values are calculated over a 5 second window. These screens can be disabled by using the DDC command (see Appendix C).

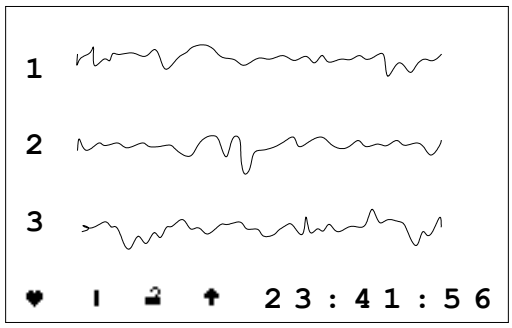


Figure 4-11. SMART-24 Series LCD Data Display Screen

The Data Display screens (Figure 4-11) (one for channels 1, 2 & 3 and one for channels 4, 5 & 6 if installed) show the data waveforms for each channel. The waveforms are displayed in a 10 second window, updated every ten seconds (they do not scroll). They also auto scale to the max/min values for each ten-second window. The waveforms can be displayed in a dot point mode (hard to see sometimes) or a fill mode (easier to see but makes the waveform look a little odd sometimes). The DDC command (see Appendix C) can be used to enable/disable these screens and control the display mode. These displays are only intended to be used as a quick check of the signal in the field, not for a detailed signal viewer.

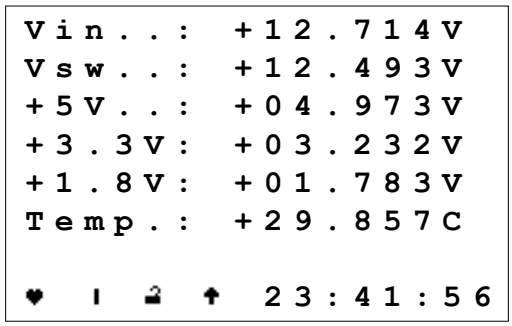


Figure 4-12. SMART-24 Series LCD State of Health Screen

The State of Health screen (Figure 4-12) shows some of the unit's current state of health values. These values are:

- Vin – The main +12 Vdc input voltage from the PWR connector. This voltage includes a voltage drop of approximately 0.4 volts from the true input voltage due to a protection diode.
- Vsw – The main internal +12 Vdc voltage distributed to the unit after all fusing, protection circuits and power relay.
- +5V – The main regulated system +5 Vdc power supply.
- +3.3V - The main regulated system +3.3 Vdc power supply.
- +1.8V - The main regulated system +1.8 Vdc power supply.
- Temp – The internal DSP board temperature in degrees Celsius.

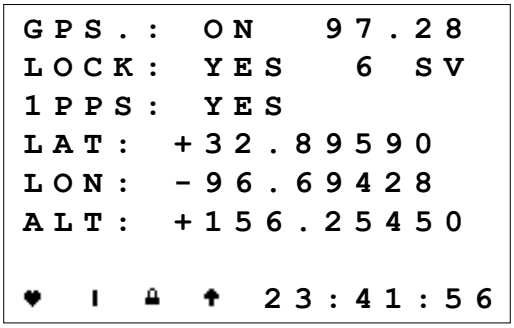


Figure 4-13. SMART-24 Series LCD GPS Status Screen

The GPS Status screen (Figure 4-13) shows some of the unit's current GPS status values. These values are:

- GPS – GPS power ON or OFF. A GPS signal quality measure follows in the upper right-hand corner of the screen. This value ranges from 0 to 100%. Generally a signal quality of greater than 86.00% is required for a GPS lock to the satellites.

- LOCK – GPS is locked (YES) or not locked (NO) to the GPS satellites. The number to the right of this value shows the current number of GPS satellites the receiver is tracking.
- 1PPS – The GPS receiver is generating is 1PPS output (YES) or not (NO).
- LAT – Current GPS latitude (+ for north, - for south).
- LON – Current GPS longitude (+ for east, - for west).
- ATL – Current GPS altitude in meters.

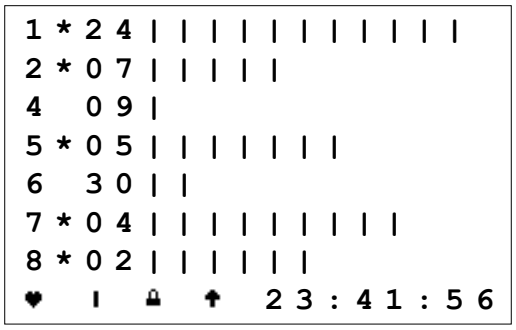


Figure 4-14. SMART-24 Series LCD GPS Satellite Signal Level Screen

The GPS Satellite Signal Level screen (Figure 4-14) shows the signal level from each GPS satellite being tracked by the GPS receiver. The first number is the GPS channel number. The GPS has eight tracking channels, but not all channels will always be tracking a satellite at any given time. Only channels tracking a satellite are displayed. Note that if all channels are tracking a satellite, only seven can be displayed on the LCD screen at a time. The second column with the '*' character indicates that that channel's satellite is locked and is being used to calculate a position and time solution. Generally three satellites with the '*' indication are required for a GPS lock. The second number is the GPS satellite identification number. Each bar on the graph represents 2dB of signal level and the graph displays 0 to 20dB of signal level. Generally a minimum signal level of 4dB (2 bars) is required to lock to that satellite. Once that satellite has reached that level, it can take a minute or two for the locked '*' symbol to appear.

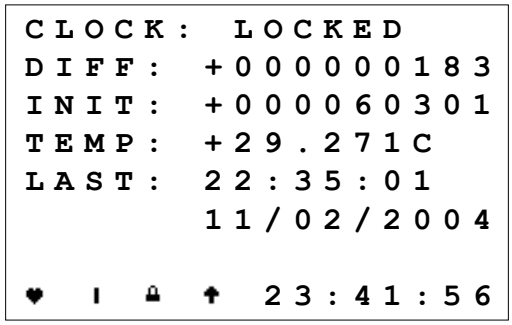


Figure 4-15. SMART-24 Series LCD Clock Status Screen

The Clock Status screen (Figure 4-15) shows some of the unit's current internal clock synchronization status values. These values are:

- CLOCK – Internal clock is locked (YES) or not locked (NO) to the GPS 1PPS signal.
- DIFF – Shows the current time difference between the internal clock and the GPS 1PPS signal. This value is displayed in nanoseconds (10^{-9}). If the GPS if powered off or not locked, this value will not be updated. Generally, this value will be less than +/-1000 nanoseconds when the unit is locked to the GPS reference.
- INIT - Shows the initial time difference between the internal clock and the GPS 1PPS signal when the current or last synchronization cycle was started. This value is displayed in nanoseconds (10^{-9}).
- TEMP – Shows internal oscillator temperature in degrees Celsius.
- LAST – Gives the time and date of the last lock of the internal clock.

4.3 SERIAL PORT OPERATION

The SMART-24 Series instruments provide two external serial ports, one on the I/O1 connector and one on the I/O2 connector. The serial ports can be used to connect directly to the serial port of a PC. They can also be connected to telemetry devices such as radios, modems, etc. If connected to a Hayes AT command compatible dialup modem, the modem will automatically be detected and configured for auto answer mode. Typically these ports are setup with the following factory defaults:

Interface:	RS232
Baud Rate:	115200
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

The serial ports can be configured for RS422 operation. Please consult the factory if RS422 operation is required.

Each serial port can be setup to operate in one of four protocols:

1. Serial ASCII Character Command Operation
2. Serial PPP Server Operation
3. Serial PPP Client Operation
4. USGS Real Time Data (RTD) Operation

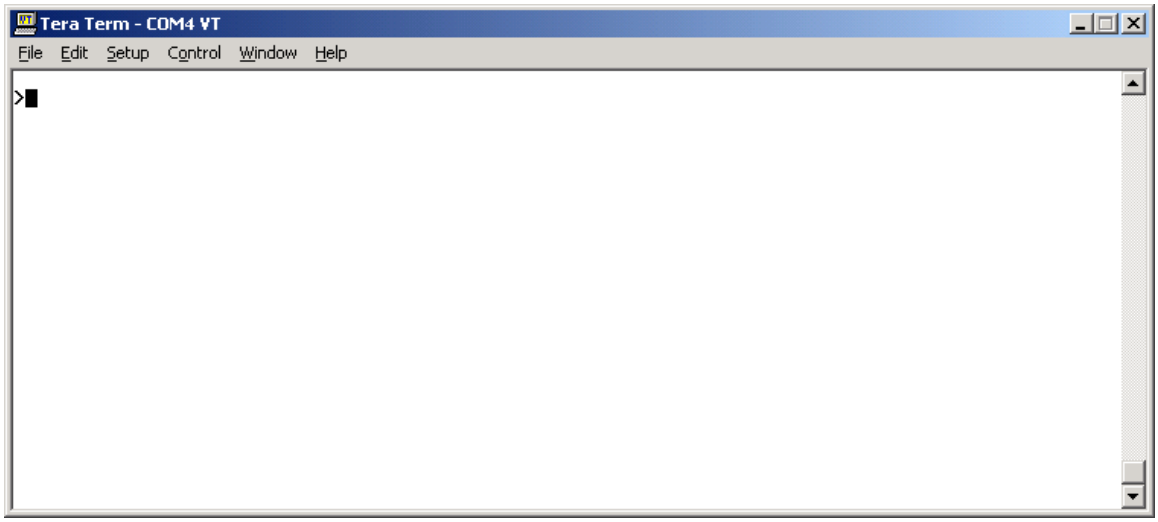
Each of these will be discussed in detail in the following sections. The factory default settings are:

- I/O1 Serial Port - Serial PPP Server Operation
- I/O2 Serial Port - Serial ASCII Character Command Operation (except for a SMART-24A® where the default is the USGS Real Time Data (RTD) Operation.

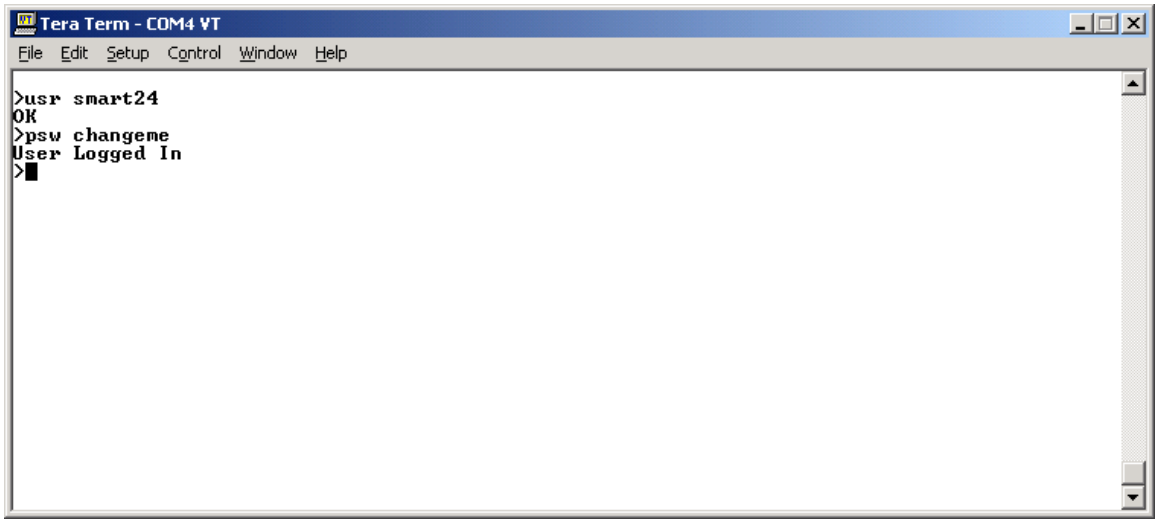
4.3.1 Serial ASCII Character Command Operation

This protocol provides two modes of operation; a simple ASCII character command interface and a log message output interface. The user can setup the unit to default to either the command mode or the log mode on power up, but can easily switch between the two modes while the unit is operating.

In the character command mode, the unit will accept commands from the user using any simple serial port terminal program. The '>' prompt will appear when the unit is waiting for user input. Appendix C contains the SMART-24 Series Command & Setup Protocol Interface Control Document. This document defines all commands the user can use to control and setup the unit at the low level. Status information can also be viewed using this interface. Data, however, cannot be viewed or uploaded via this interface protocol.

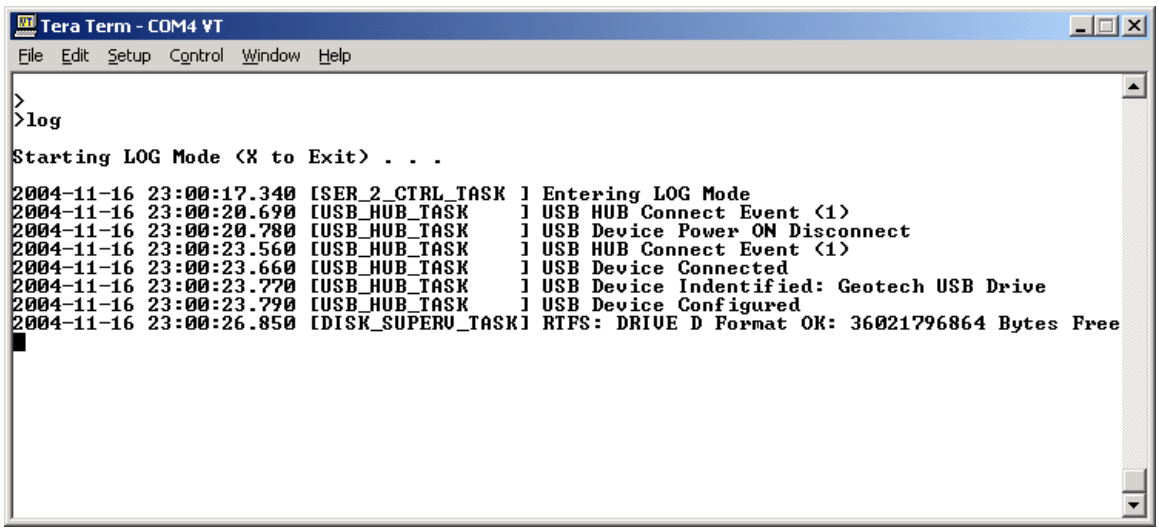


If a system user name and password are set, the user must enter them before issuing commands to the unit. The 'USR' and 'PSW" commands are used to enter them. The factory default user name is 'smart24' (lower case) and the factory default password is 'changeme' (lower case). The command mode will automatically log the user out after an inactivity timeout of 10 minutes.

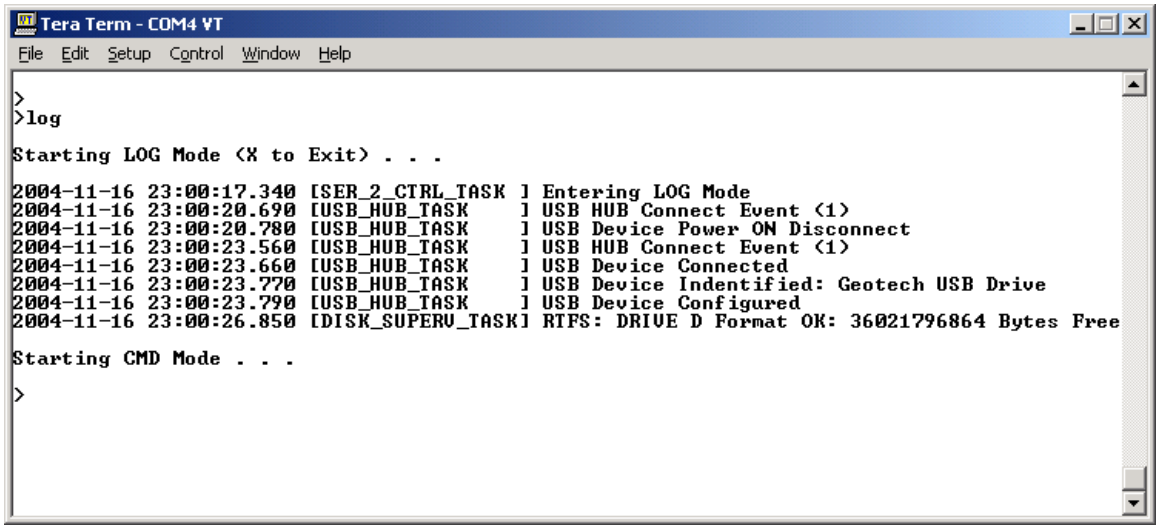


Please refer to Appendix C for a description of all commands that can be entered by the user.

In the log mode, the unit will dump status log messages to the serial port in real time. Any simple serial port terminal program can be used to display these log messages. These are the same messages that are recorded to the log files on the disk drives. This allows the user to monitor the operation of the unit in real time if required. The user can switch to the log mode by simply typing the command 'LOG' at the command prompt. This can be accomplished either logged in or not.



To exit the log mode, the user simply types the letter 'x' to exit this mode and return to the character command mode.



4.3.2 Serial PPP Server Operation

The serial PPP server built into the SMART-24 Series instruments provides a TCP/IP connection similar to that of a dialup Internet Service Provider (ISP) where the unit acts as the server that the user calls into and connects to. In this mode the unit (server) is waiting for a user to connect to it. The user can use standard PPP protocols (LCP, IPCP, PAP, CHAP & IP) to connect to the unit to establish a TCP/IP connection in this mode. If a modem is connected to the serial port configured for this mode, it will auto answer and start the connection negotiation process. When connected directly to a PC (no modem), the PC can be configured to provide a direct cable dialup connection to the unit. Please refer to your specific operating system documentation for details (an example for Windows XP is shown later in this section). The factory TCP/IP defaults for this connection are:

PPP Server IP Address:	192.168.0.30
PPP Server Subnet Mask:	255.255.255.0
IP Address served to connecting PC:	192.168.0.31

Baud Rate:	115200
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

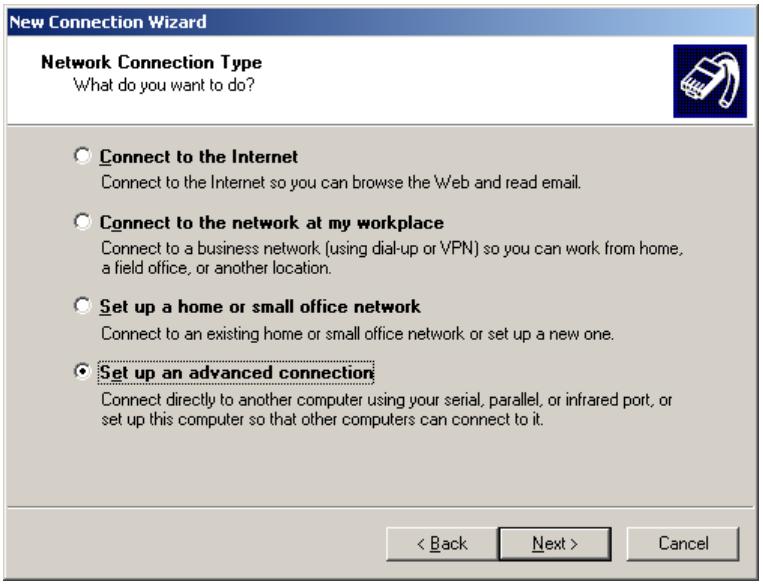
A user must logon to the server, which uses the unit's system user name and password for this. The factory defaults are:

User Name:	smart24	(lower case)
Password:	changeme	(lower case)

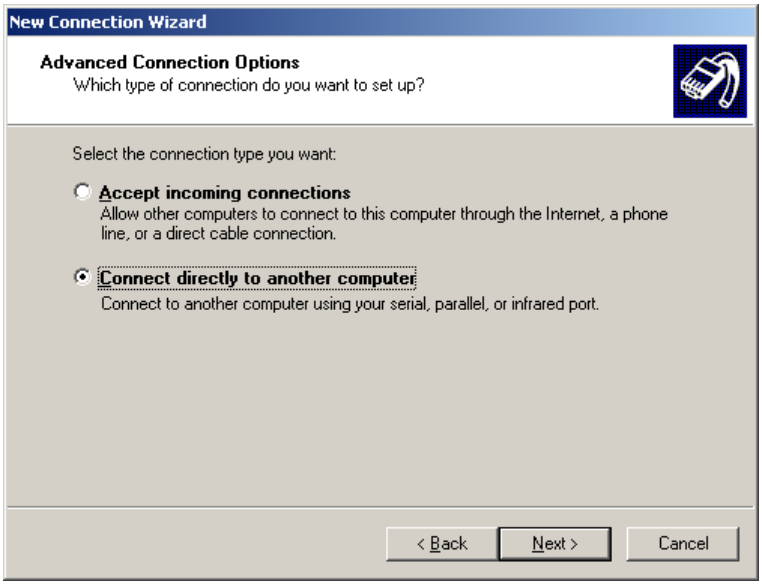
Once connected, the user can perform any of the TCP/IP based operations available in the unit such as; Telnet, FTP, HTTP and the CD-1.1 real-time data and command connections.

The following is an example of setting up Windows XP for a direct serial port cable networking connection to a SMART-24 Series instrument.

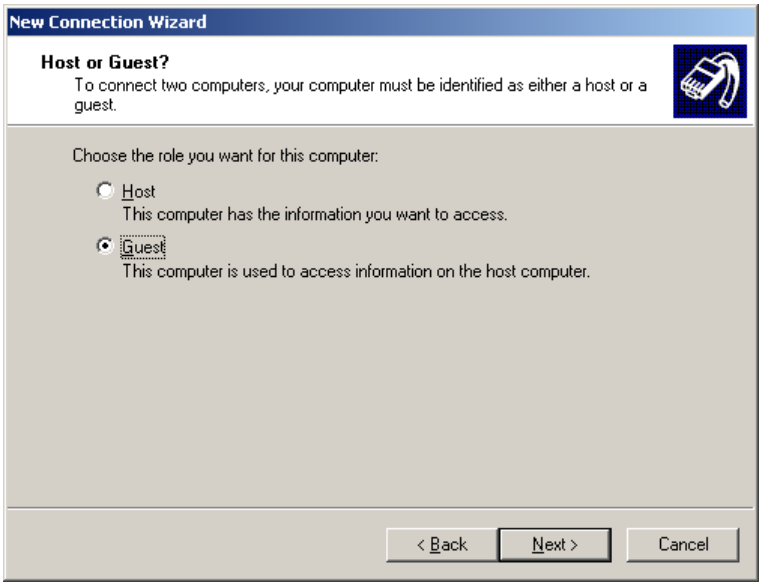
From the Network and Dial-up Connections selection in the control panel, start the New Connection Wizard and click 'Next'.



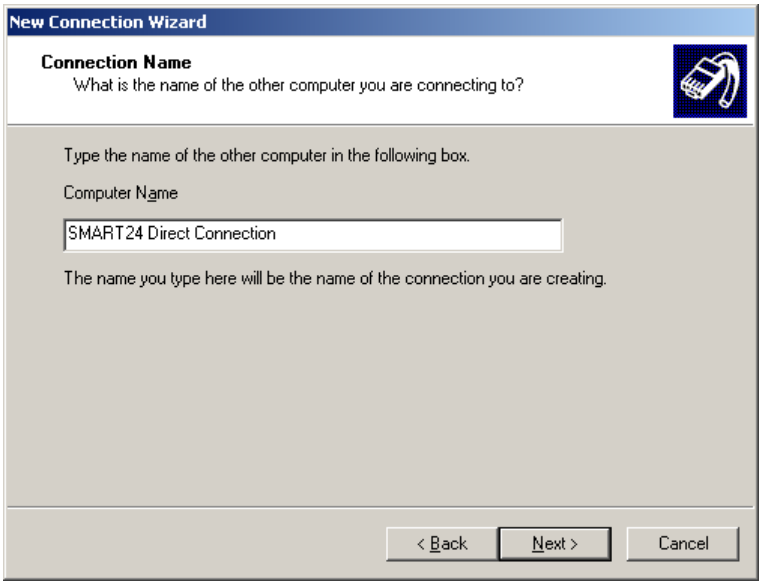
Select the 'Set up an advanced connection' option, then click 'Next'.



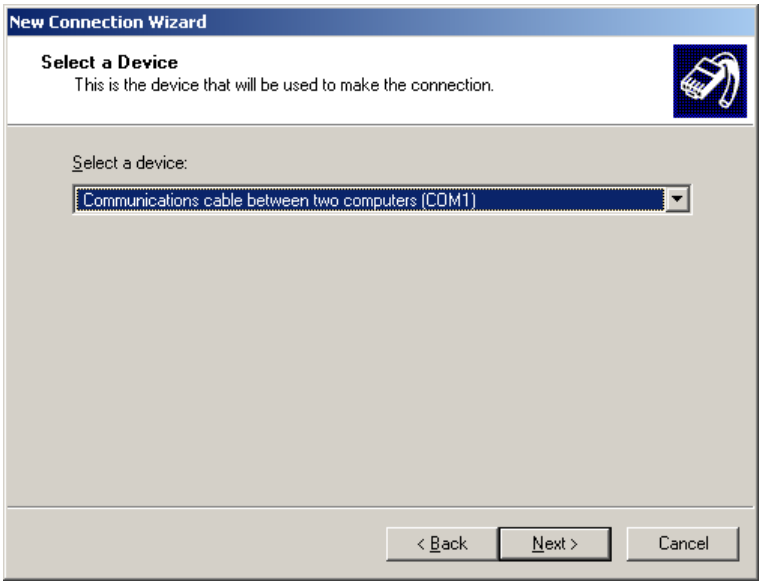
Select the 'Connect directly to another computer' option, then click 'Next'.



Select the 'Guest' option, then click 'Next'.

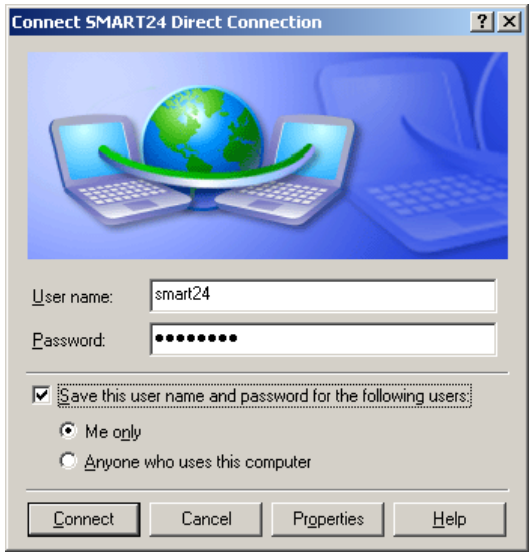


Now type in a connection name, then click 'Next'. It does not really matter what name is used here, it just identifies the connection in the network connection list. There is no need to setup individual connections for each unit the user may have. This on connection can be used for all units (one at a time).

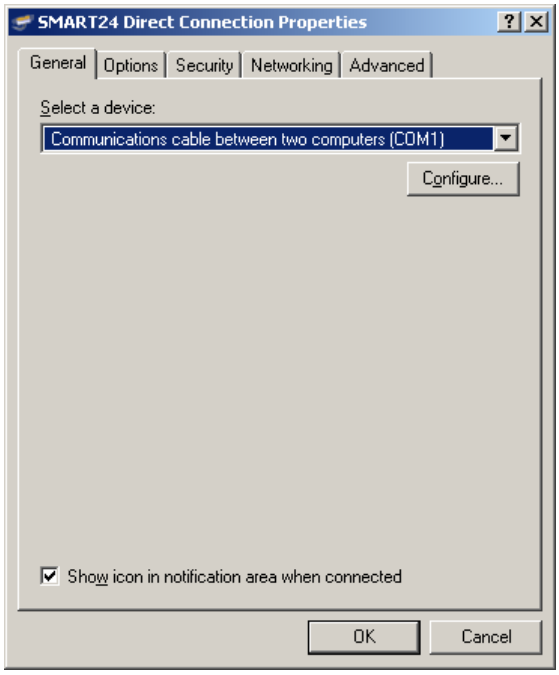


Select the 'Communications cable between two computers (COMX)' option, then click 'Next'. Select X for an available serial port on the PC to connect with. If this option is not displayed, there may not be an available serial port on the PC to use.

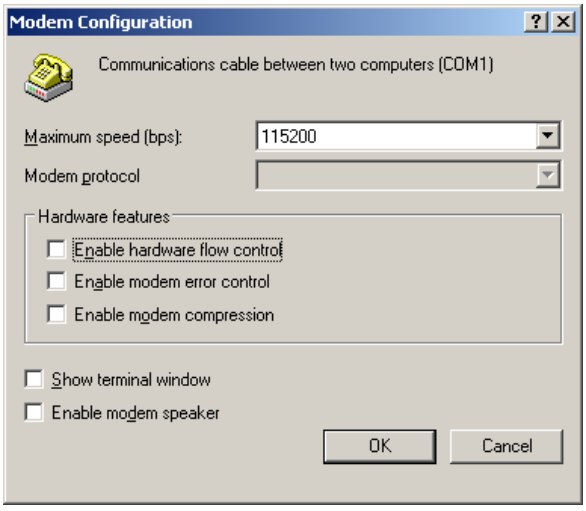
Now click 'Finish'. Windows XP will then try to start the connection by displaying the following dialog box:



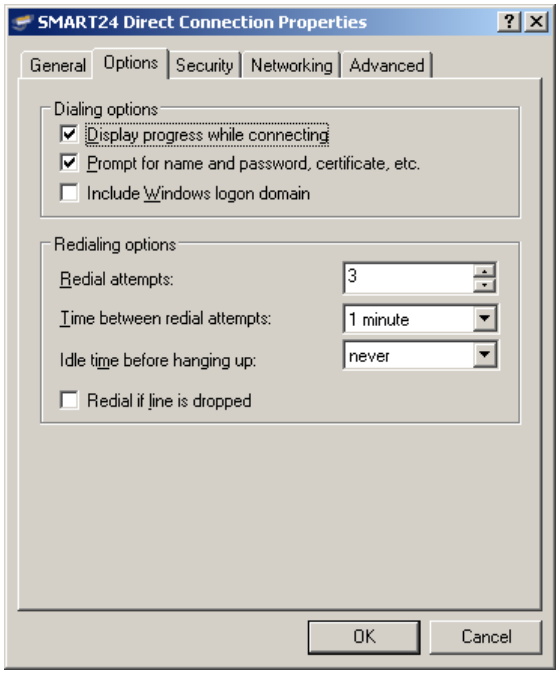
If the user has not changed the default user name and password, type in 'smart24' for the User Name and 'changeme' for the Password. Otherwise enter the current user name and password. Select whether the save the user name and password or not. Then click 'Properties'.



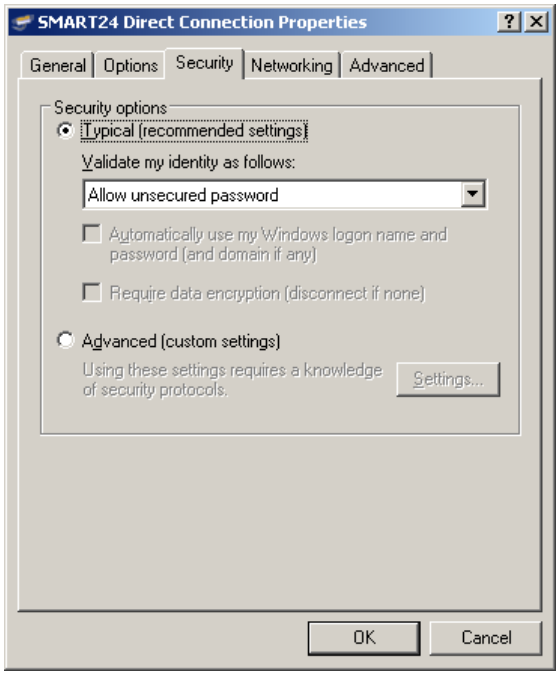
On the ‘General’ tab, click ‘Configure...’.



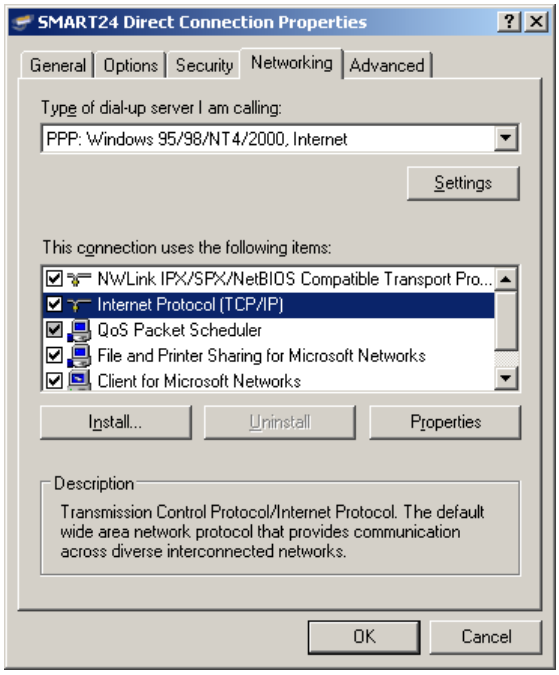
On the Modem Configuration box select the serial port baud rate (usually 115200) and uncheck all check boxes as shown above. Then click ‘OK’.



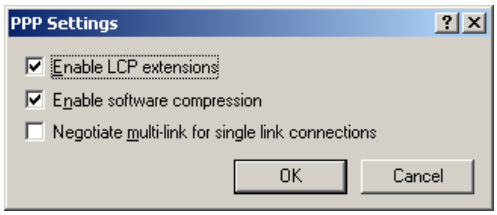
No changes are usually needed on the 'Options' tab, but it should match the above screen shot.



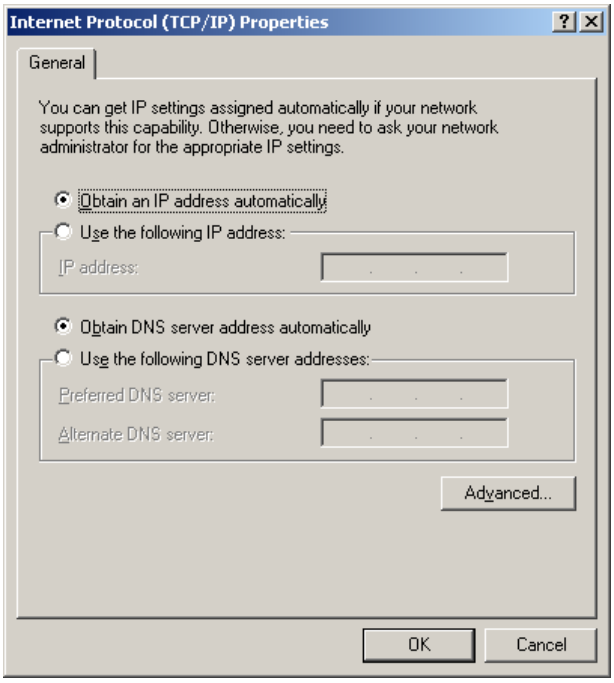
On the 'Security' tab, select the 'Typical (recommended settings)' option and select 'Allow unsecured password'.

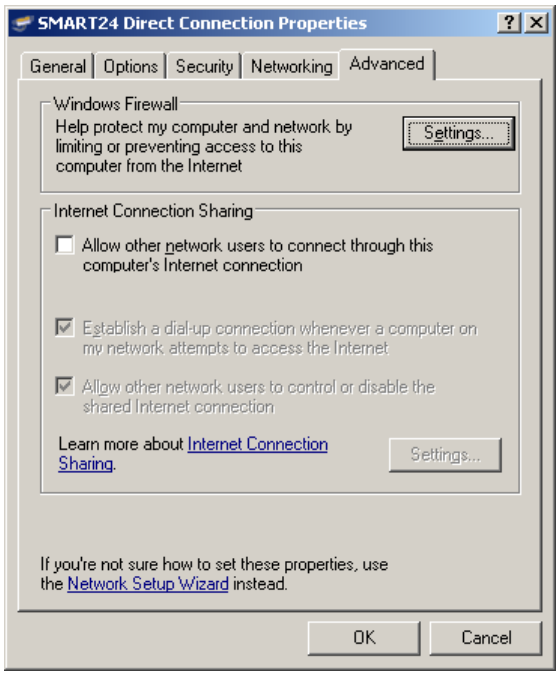


On the 'Networking' tab, no changes are necessary. Note that the list of protocols may be different depending on the PC's configuration. Click on 'Settings' and the PPP Settings box should look like the following and then click 'OK'.

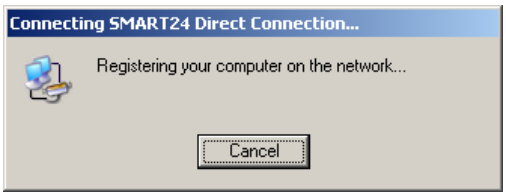


Select the 'Internet Protocol' then click 'Properties'. The Internet Protocol (TCP/IP) Properties should be setup like the following and then click 'OK'.

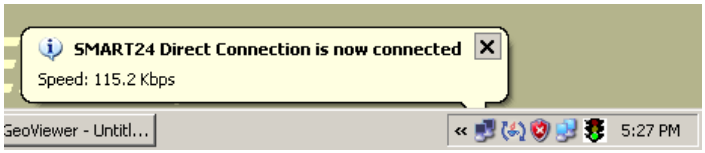




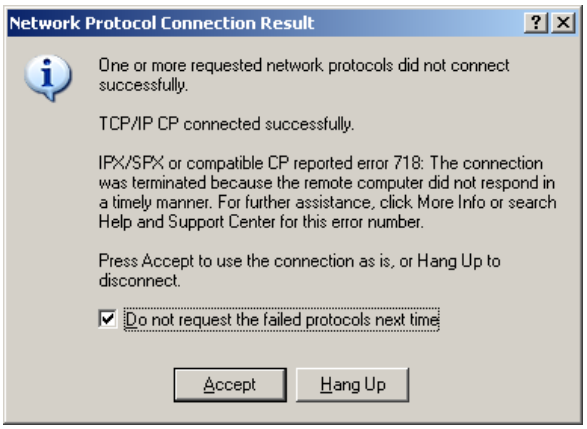
Back on the Connection Properties box, the 'Advanced' tab should look like the above. Now click 'OK' to close the Connection Properties box to return to the Connect box. Click 'Connect' to start the connection process. If a unit is connected to the serial port, the user should see the following dialog boxes.



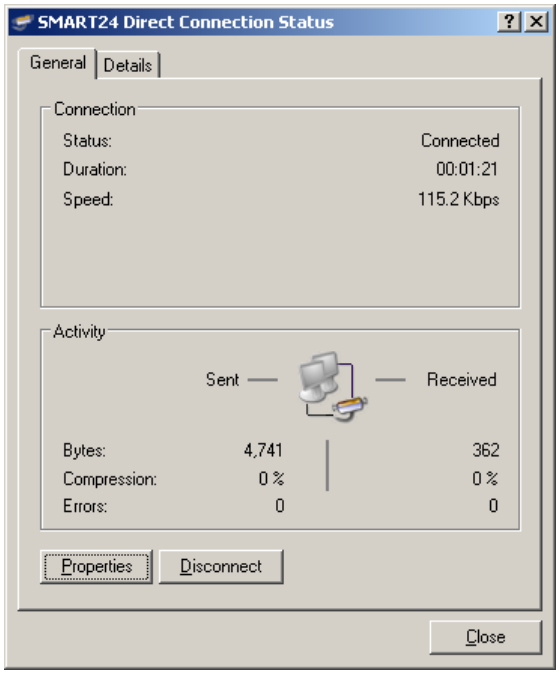
This last box may be displayed for quite some time while the connection is being registered. The user should then be notified that the connection was successful.

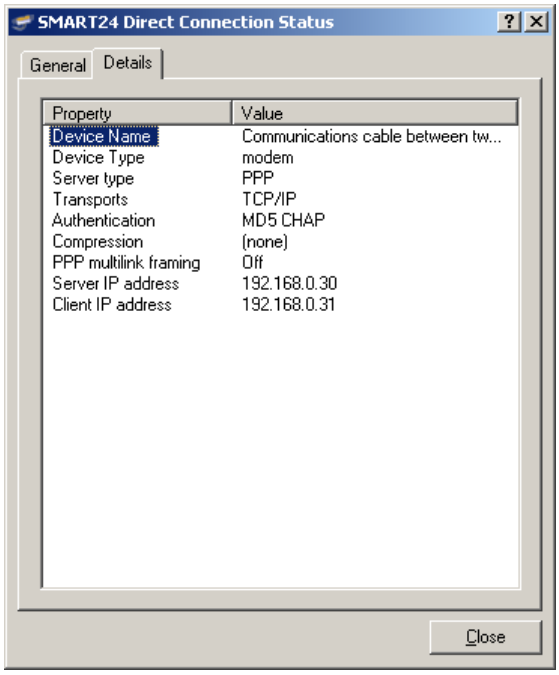


If the following dialog box appears, it means that the PC has other network protocols installed that the SMART-24 Series unit does not use. These cannot be deleted unless they are not used since deleting them will remove them from the PC. Simply check the box 'Do not request the failed protocols next time' option and click 'Accept'. The user should not see this box the next time the connection is made.



Clicking on the connection should show the Connection Status box similar to the following two screen shots.





The user must use the 'Disconnect' selection to terminate the connection when no longer needed.

4.3.3 Serial PPP Client Operation

The serial PPP client built into the SMART-24 Series instruments provides a TCP/IP connection where the unit tries to connect to a remote PPP server. Again, this mode is similar to that of a dialup Internet Service Provider (ISP) where the unit acts as the client that calls into and connects to a remote PPP server. In this mode the unit (client) attempts to make the connection immediately on power up and continuously retries until a connection is made or after a connection is dropped. The unit uses standard PPP protocols (LCP, IPCP, PAP, CHAP & IP) to connect to the remote PPP server to establish the TCP/IP connection. Currently the SMART-24 Series instruments do not support a dialup modem connection where the unit dials out to a specific number. This capability is currently under development; please consult the factory for further details. This connection can be used via direct connections such as cable, radio, leased line modems, long haul modems, etc.

When connected directly to a PC, the PC can be configured to provide a direct cable incoming serial PPP connection from the unit. Please refer to your specific operating system documentation for details (an example for Windows XP is shown later in this section). The factory defaults for this connection are:

PPP Client IP values:	Provided by the server on connection.
Baud Rate:	115200
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

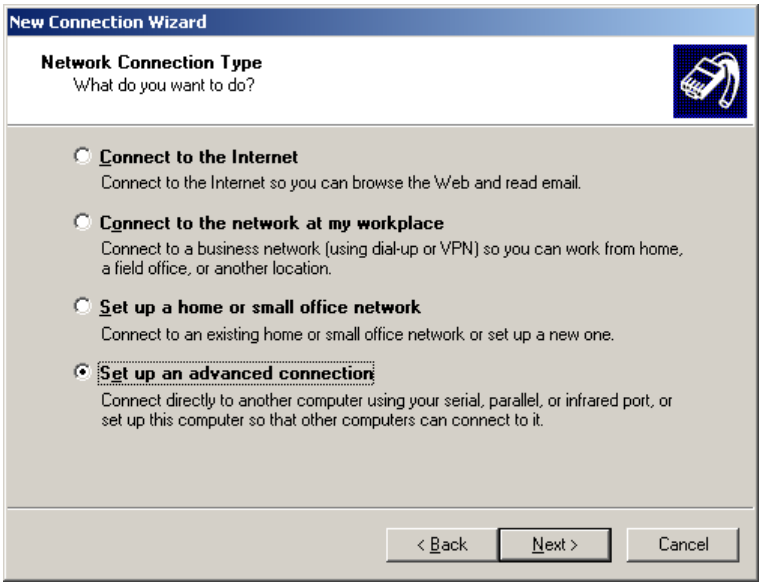
A unit must logon to the remote PPP server. The SMART-24 Series instruments provide a PPP client user name and password. Note that these are different from the unit's system user name and password and are used only when making a client PPP connection to a remote PPP server. The factory default PPP client user name and password are:

PPP Client User Name:	smart24	(lower case)
PPP Client Password:	changeme	(lower case)

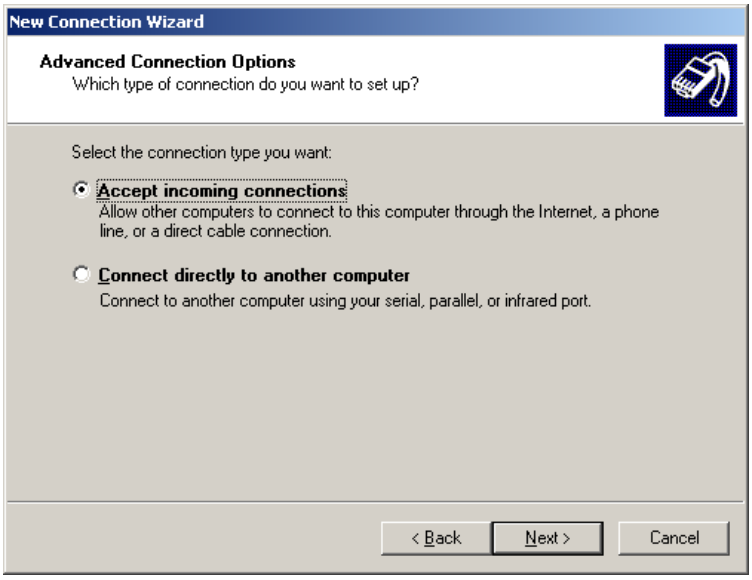
Once connected, the user can perform any of the TCP/IP based operations available in the unit such as; Telnet, FTP, HTTP and the CD-1.1 real-time data and command connections.

The following is an example of setting up Windows XP for a direct serial port cable incoming PPP connection from a SMART-24 Series instrument.

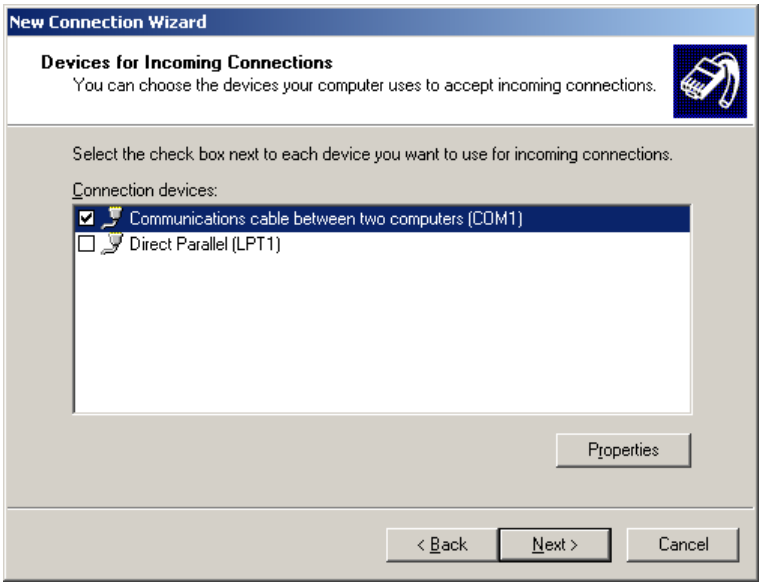
From the Network and Dial-up Connections selection in the control panel, start the New Connection Wizard and click 'Next'.



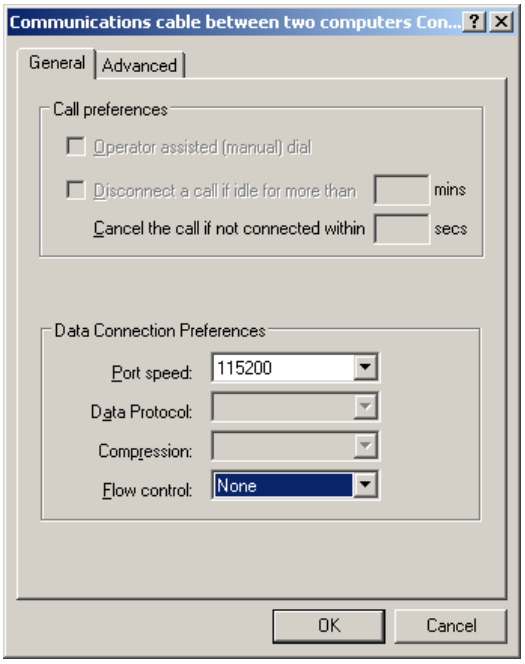
Select the 'Set up an advanced connection' option, then click 'Next'.



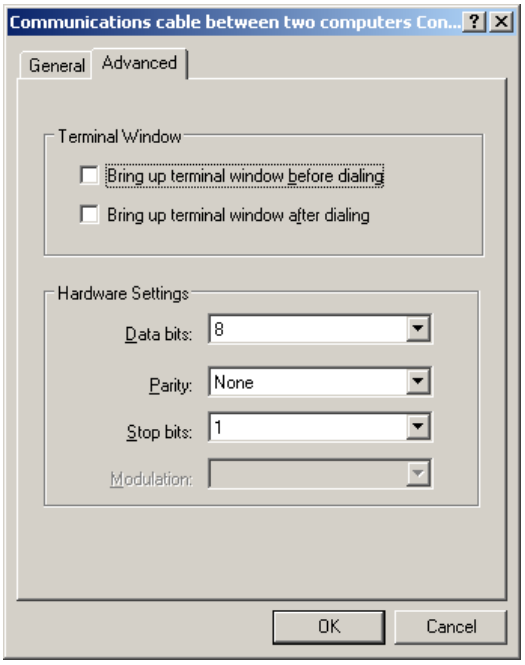
Select the 'Accept incoming connections' option, then click 'Next'.



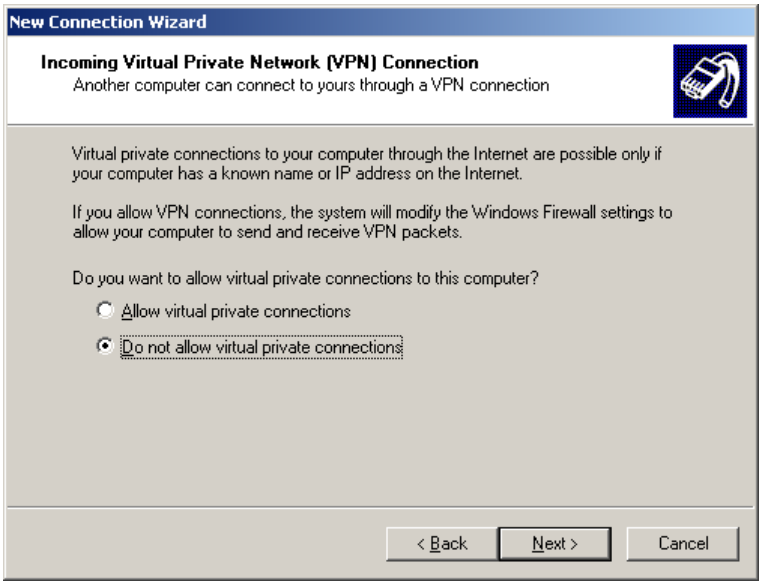
Select the 'Communications cable between two computers (COMX)' option. Select X for an available serial port on the PC to connect with. If this option is not displayed, there may not be an available serial port on the PC to use. Then click 'Properties' to set the serial port properties.



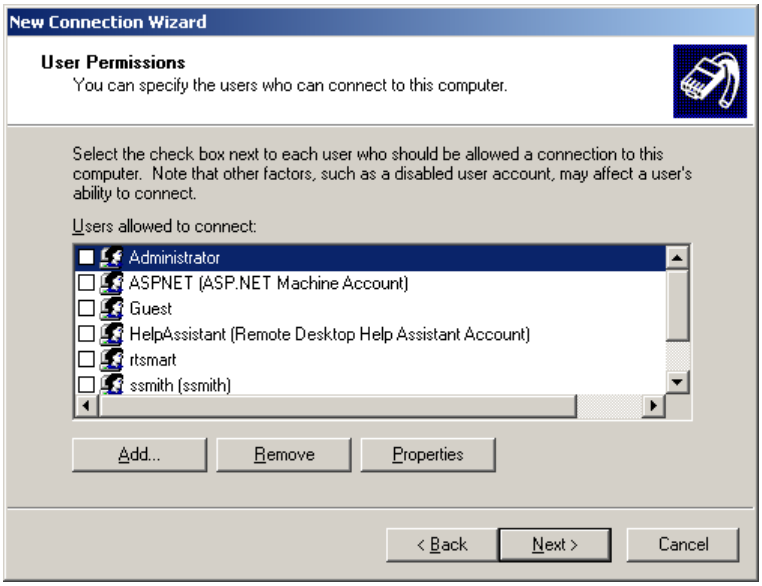
On the 'General' tab of this dialog box, select the serial port baud rate (usually 115200) and select 'None' for Flow control.



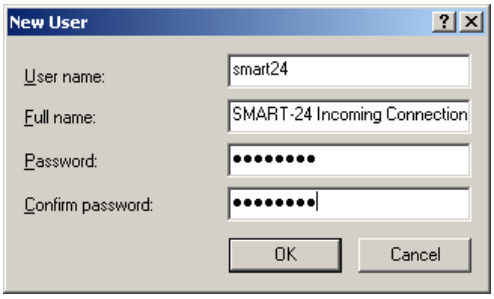
On the 'Advanced' tab, select 8 data bits, no parity and 1 stop bit as shown above. Then click 'OK' to return to the Devices For Incoming Connections box and click 'Next'.



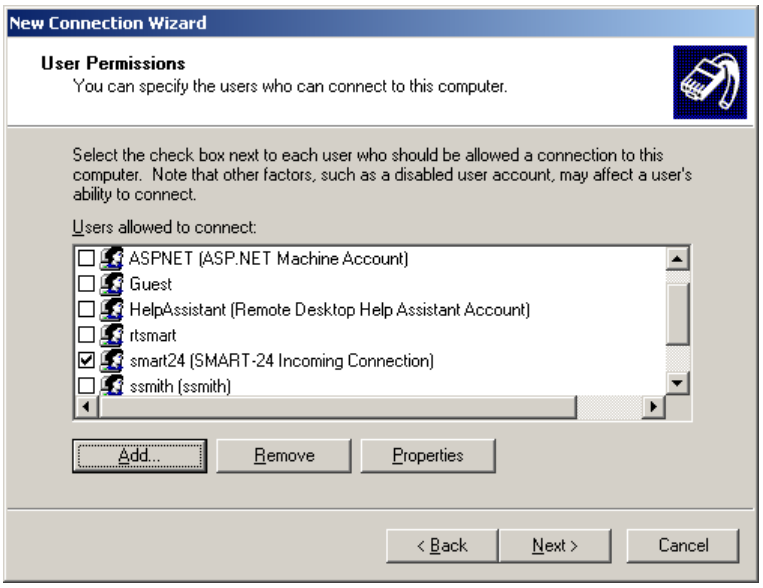
Select the 'Do not allow virtual private connections' option and click 'Next'.



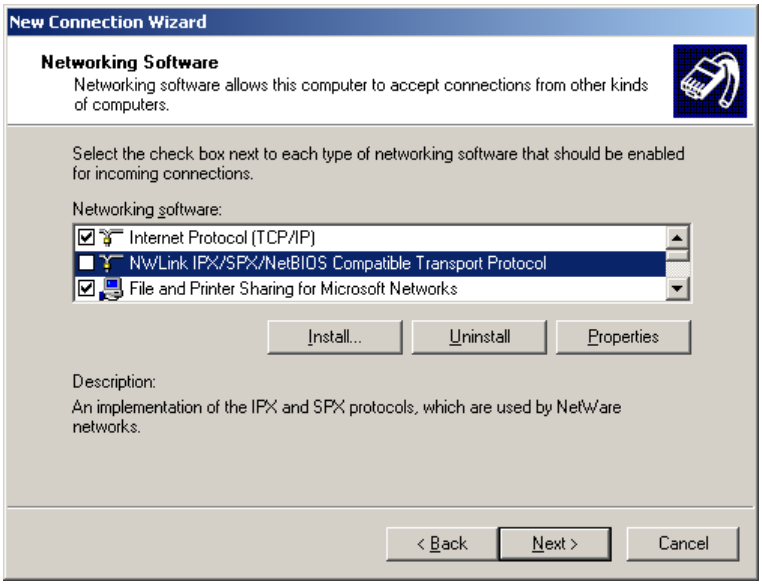
On the User Permissions box, create a new user for the incoming connection by clicking 'Add...'.



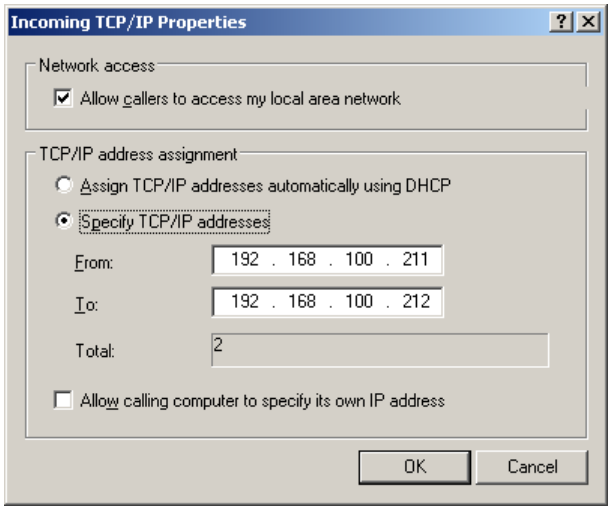
Enter the user name, full descriptive name (as needed) and password in this box. This user name and password should match the unit's PPP client user name and password, not its system user name and password. Click 'OK' to return to the User Permissions box.



The user just created should be check in the User Permissions box. The user can create other users for units that may have different user names and passwords if needed. All other users should not be checked here. When finished, click 'Next'.

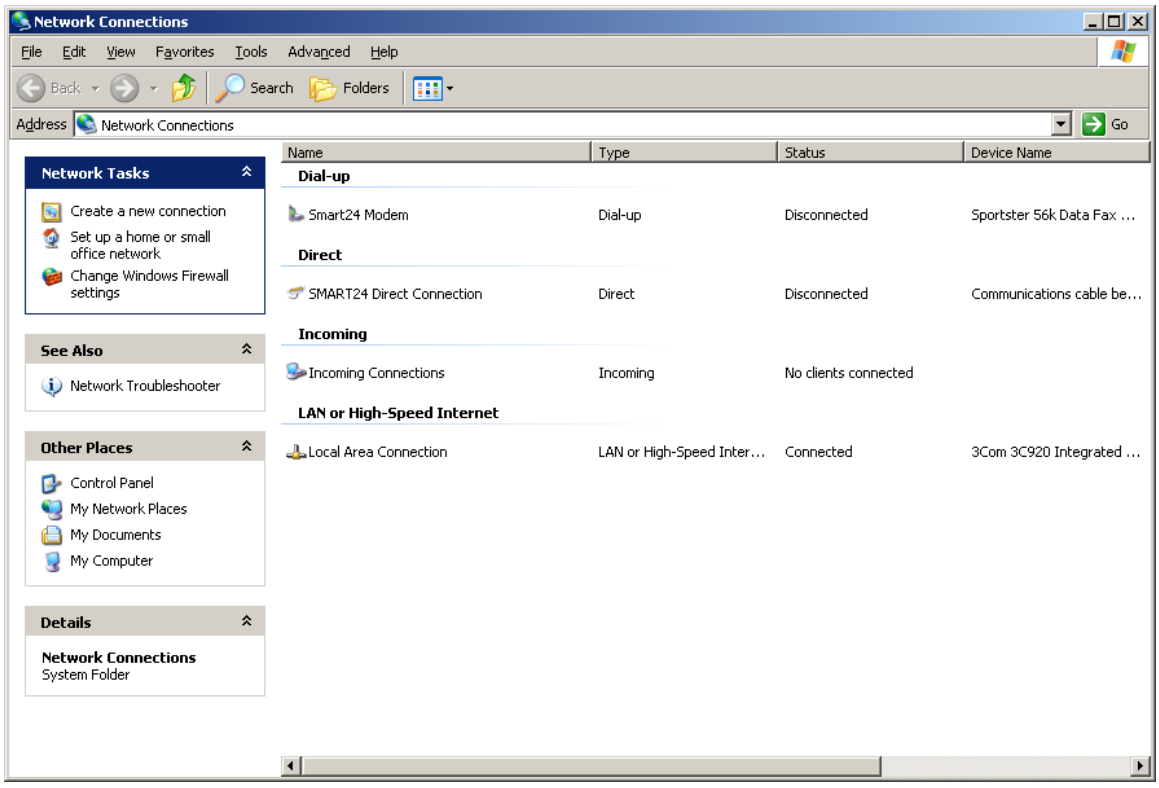


In the Networking Software box, uncheck any protocol not used by the unit such as IPX, etc. The only protocol the unit needs is TCP/IP. It is ok to leave File and Printer Sharing, Microsoft Networking, etc., checked. Select the Internet Protocol (TCP/IP) and click on 'Properties'.

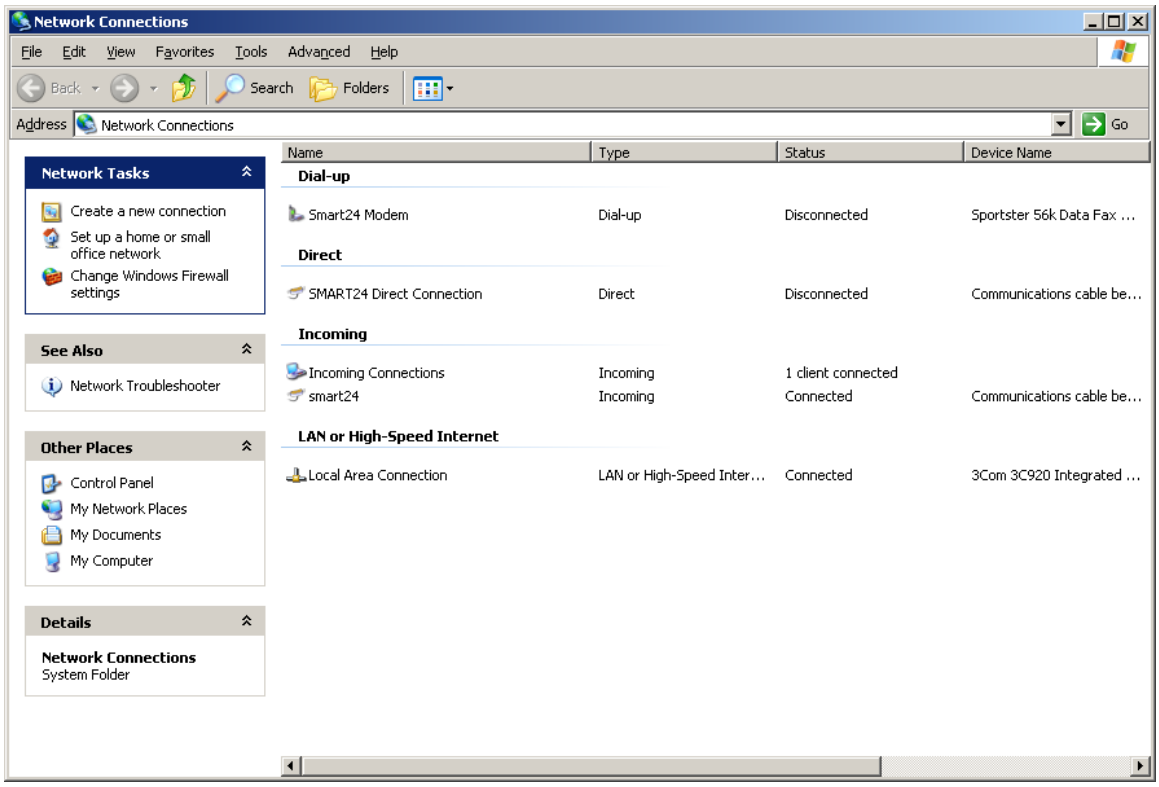


On the Incoming TCP/IP Properties box, select the 'Specify TCP/IP addresses' option and enter a valid IP address range for the PC to use when assigning IP addresses to the PPP server and client. This range must be at least two addresses in length, one for the server and one for the client. Then click on 'OK' to return to the Networking Software box. Click 'Next' to continue.

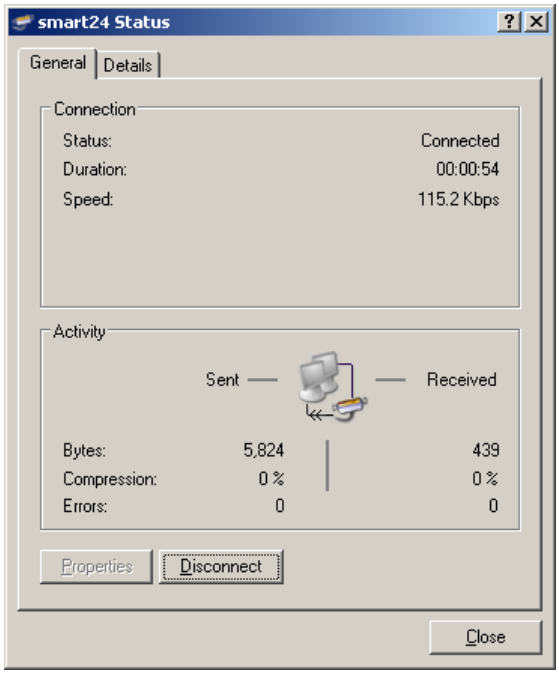
Click on 'Finish'. The incoming connection will then be started and it will wait for a SMART-24 Series instrument to attempt to connect as shown in the following screen shot.

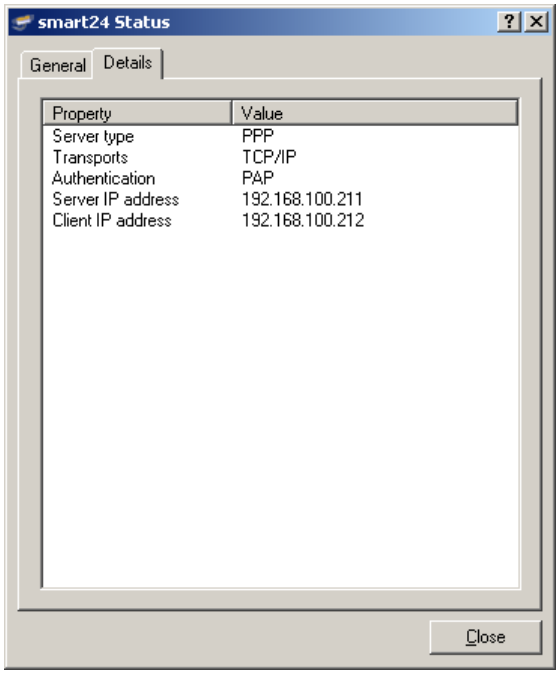


When a SMART-24 Series instrument connects, the connection will be shown as follows.

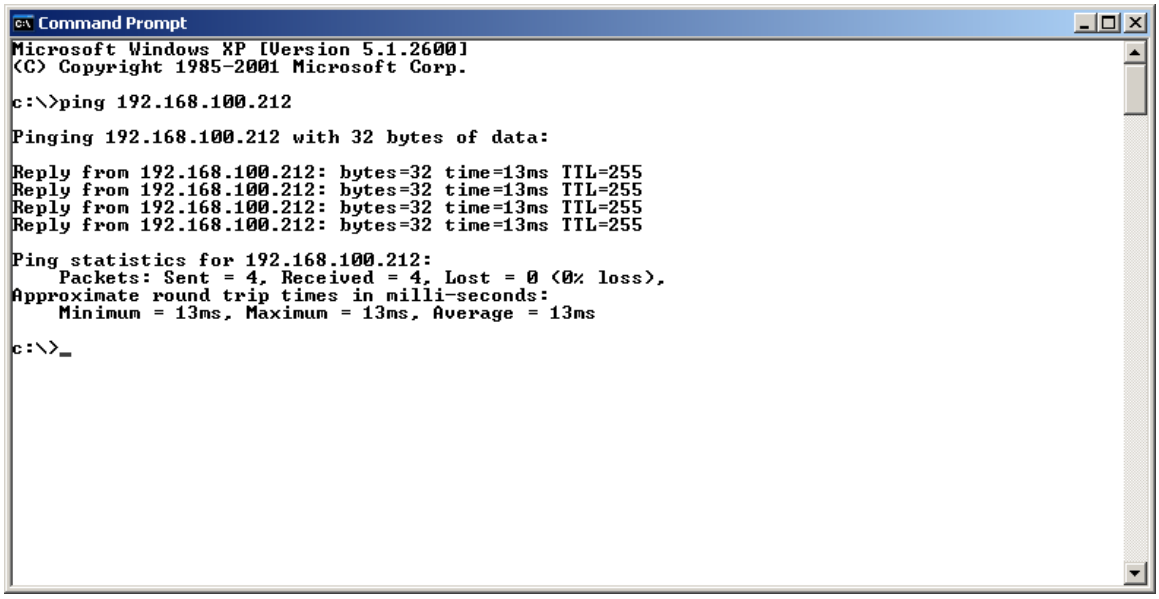


By clicking on the connection, the user can display the connection status as follows.





The connection status box 'Detail' tab will show the IP address assigned to the connected unit. The user should then be able to ping the unit's address as shown below.



4.3.4 USGS Real Time Data (RTD) Operation

The USGS Real Time Data (RTD) data stream output provides digitized three channel (channels 1, 2 & 3 only, even on a six channel unit) 16-bit data at 200, 100, 50, 40, 25 or 10 samples per second at baud rates of 115200 to 1200 baud. The data is output in eight byte blocks immediately upon completion of a sample conversion (and filtering if necessary) of all three data channels.

The USGS RTD data stream can be enabled on either of the SMART-24's I/O 1 or I/O 2 serial ports (or both at the same time). The following CSP low-level commands (see Appendix C) would be needed to set serial port 2 to output the USGS RTD stream:

SPB 2,4800	[sets the baud rate, see below for limitations]
SPP 2,1	[set the protocol to character]
SPC 2,3	[set the character mode to data]
SPM 2,4	[sets the data mode to USGS RTD output]
URT 50,0D,0,0,0,0,0,0A,0	[sets the RTD sample rate and format]
ASR	[to save and restart the unit with the new setup]

The SMART24Config application can also be used to setup the USGS RTD data stream.

Note that the USGS RTD stream will only be output if enabled as above and the primary sample rate of ADC board 1 (channels 1, 2 & 3) is set to 200 sps. Also the serial format is always 8-bits, no parity and 1 stop bit. The default byte format is shown in Table 4-1.

Table 4-1. RTD Output Data Format

BYTE	DESCRIPTION	DEFAULT
1	Sync character (user programmable)	0D hex (CR)
2	MSB Ch. 1 (16-bit 2's comp. data)	
3	LSB Ch. 1 (16-bit 2's comp. data)	
4	MSB Ch. 2 (16-bit 2's comp. data)	
5	LSB Ch. 2 (16-bit 2's comp. data)	
6	MSB Ch. 3 (16-bit 2's comp. data)	
7	LSB Ch. 3 (16-bit 2's comp. data)	
8	Auxiliary byte (user programmable)	Parity/Timing Byte

The following RTD parameters are user programmable through the URT command:

1) **Output Sample Rate** - The USGS RTD can output at 200, 100, 50, 40, 25 or 10 samples per second. The default is 50 sps. Note that the lower data rates are derived from decimation of the main 200 sps data (the 200 sps data is passed through to the serial port directly with no further filtering needed). Using the FIR filter decimation mode, only 200, 100 and 50 sps rates can be used. All sample rates can be used with the simple divide by N decimation mode. This mode does not provide any anti-alias protection though. Also note that the sample rates have minimum baud rate requirements. For each sample rate there is a minimum baud rate requirement as shown below.

200 sps	19200 baud
100 sps	9600 baud
50 & 40 sps	4800 baud
25 sps	2400 baud
10 sps	1200 baud

When a sample rate selection is made, if the current selected baud rate is set to a lower value than the minimum required baud rate, the USGS RTD will be automatically disabled.

2) **Sync Character** - The USGS RTD sync character (the first byte of the data block) is user selectable in the range 00 to FF hex. The default is a carriage return (CR) - 0D hex.

3) **Output Data Format** - The USGS RTD can output data in either 16-bit 2's complement or offset binary formats as shown below. The default is 16-bit 2's complement.

2's Complement Format

+Full Scale -	0111 1111 1111 1111	(7FFFh)	(32767)
+1 bit -	0000 0000 0000 0001	(0001h)	(1)
0 -	0000 0000 0000 0000	(0000h)	(0)
-1 bit -	1111 1111 1111 1111	(FFFFh)	(-1)
-Full Scale -	1000 0000 0000 0000	(0000h)	(-32768)

Offset Binary Format

+Full Scale -	1111 1111 1111 1111	(FFFFh)	(65535)
0 -	1000 0000 0000 0000	(8000h)	(32768)
-Full Scale -	0000 0000 0000 0000	(0000h)	(0)

Note that the SMART-24 is a 24-bit instrument. The unit internally compensates and scales the data to 16-bits for this output in such a way as to correct for internal calibration data, gain, etc. to utilize the full 16-bit dynamic range. So for a +/-2g accelerometer, the full scale will be a true 16-bit full scale value (+2g = 32767, -2g = -32768).

4) **Output Data Byte Order** - The USGS RTD can output each 16-bit data word in either MSB/LSB or LSB/MSB byte orders. The default is MSB/LSB.

5) **Auxiliary Byte Type** - The USGS RTD auxiliary byte (the last byte of the data block) is a dual-purpose byte that can be programmed to be a simple End of Block (EOB) character (similar to the sync character) or a Parity/Timing check byte. The default is the Parity/Timing byte type.

   As a Timing/Parity check byte, the auxiliary byte contains parity check bits (programmable for even or odd parity) in data bits 0 to 5 for the six data bytes (bytes 2 to 7 respectively). Bit 6 and Bit 7 are used for timing information as described below.

   As an EOB character, the auxiliary byte character is user selectable in the range 00 to FF hex.

6) **Auxiliary Byte Parity Mode** - If the Auxiliary Byte Type is set to the Timing/Parity type, this parameter sets the parity type used for bits 0 to 5. Even or odd parity can be selected. The default is even parity.

7) **Auxiliary Byte Timing Mode** - If the Auxiliary Byte Type is set to the Timing/Parity type, this parameter sets the timing used for bits 6 & 7 as follows:

   - Mode 0 – Bit 7 is set to a 1 for the sample block that represents the first sample of a second. At all other times it will be a 0. Bit 6 is not used and set to 0.

   - Mode 1 - Bit 7 is set to a 1 for the sample block that represents the first sample of a second. At all other times it will be a 0. Bit 6 is set to a 1 for the sample block that represents the first sample of the hour. At all other times it will be a 0. On the first sample of the first second of the hour, both bits 6 & 7 will be a 1 at the same time.

   - Mode 2 - Bit 7 is set to a 1 for the sample block that represents the first sample of a second. At all other times it will be a 0. Bit 6 is used to transmit a 32-bit unsigned integer value representing the number of seconds since January 1, 1970. When bit 7 is set a 1, bit 6 will be data bit 0 (LSB) of this 32-bit value. Then for the next 31 sample blocks, bit 6 will contain the value of data bits 1 to 31 of the time code. For

the remainder of the sample blocks, this bit will be a 0. Note that this mode should not be used for sample rates lower than 40 sps.

8) **Auxiliary Byte Character** - If the Auxiliary Byte Type is set to the EOB Character type, this parameter sets the Auxiliary Byte Character and is user selectable in the range 00 to FF hex. The default is a line feed (LF) - 0A hex.

9) **Sample Rate Decimation Mode** – To generate the USGS RTD data, the samples must be decimated (except for 200 sps output). This parameter allows the user to select either FIR filter decimation or simple divide by N decimation.

   With FIR filter decimation, full anti-aliasing protection is provided, but with a time delay of 495mS for 100 sps and 830mS for 50 sps from real time. Also only 100 sps and 50 sps can be generated with the current FIR decimation filter.

   With the simple divide by N decimation, all output sample rates can be used down to 10 sps with a fixed time delay of 175mS for each. However no anti-aliasing protection is provided for frequencies below 80 Hz.

4.4 10/100BASE-T ETHERNET OPERATION

The SMART-24 Series instruments provide for an optional 10/100Base-T Ethernet interface I/O card to be installed. This board is typically installed in the I/O 1 Board position with the Ethernet signals on the I/O1 connector. Standard Geotech supplied cabling provides a circular mating connector to the I/O1 connector on the unit wired with CAT5 cable to a standard RJ45 network plug. This cabling is wired in a crossover configuration so that the RJ45 may be plugged directly into a RJ45 network receptacle on a PC. It can also be used with network hubs or switches that have auto MDI/MDIX crossover detection.

The SMART-24 Ethernet card supports auto 10/100Base-T detection and can be connected directly to a 10Base-T or 100Base-T network.

4.5 TCP/IP OPERATION

The SMART-24 Series instruments use TCP/IP as the transport protocol over the 10/100Base-T Ethernet or Serial PPP connections. The TCP/IP stack built into the unit provides standard TCP/IP protocols such as Telnet, FTP and HTTP as well as the real-time data and command access via the CD-1.1 protocol. These protocols are described in the following sections.

4.5.1 Factory Default Settings

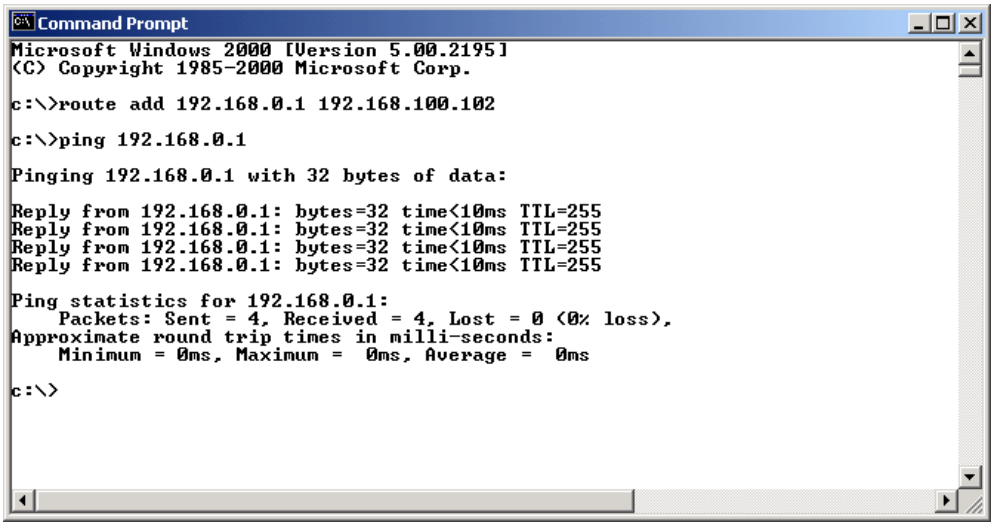
Each TCP/IP interface in the SMART-24 Series instruments are initially setup with the following factory defaults:

I/O1 Ethernet [1E]:	IP Address:	192.168.0.1
	Subnet Mask:	255.255.255.0
	Default Gateway:	192.168.0.255
I/O2 Ethernet [2E]:	IP Address:	192.168.0.2
	Subnet Mask:	255.255.255.0
	Default Gateway:	192.168.0.255
I/O1 Serial PPP [1S]: (Server Mode)	Server IP Address:	192.168.0.30
	Server Subnet Mask:	255.255.255.0
	Client IP Address:	192.168.0.31
I/O2 Serial PPP [2S]: (Server Mode)	Server IP Address:	192.168.0.40
	Server Subnet Mask:	255.255.255.0
	Client IP Address:	192.168.0.41

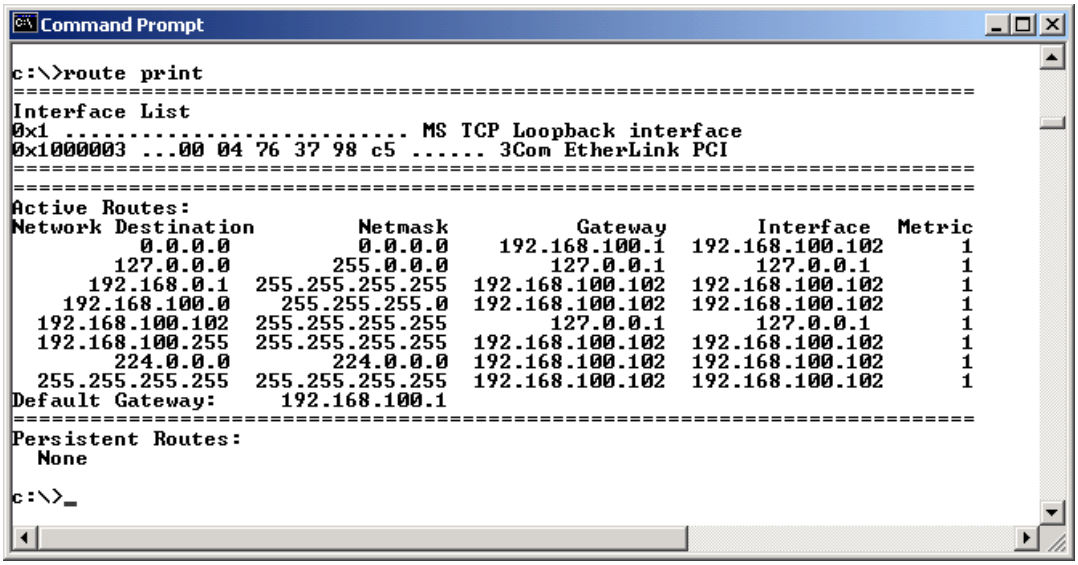
4.5.2 TCP/IP Over Ethernet Operation

The SMART-24 Series instruments allow for TCP/IP connections over the optional 10/100Base-T Ethernet ports on I/O1 or I/O2. By using the standard Geotech I/O cabling, the user can easily connect directly to a network connection on a PC to communicate with the unit. If the default IP address does not conflict with the user's network, a route can be added to the connected PC to allow the two to communicate by using the 'route add' command as shown below:

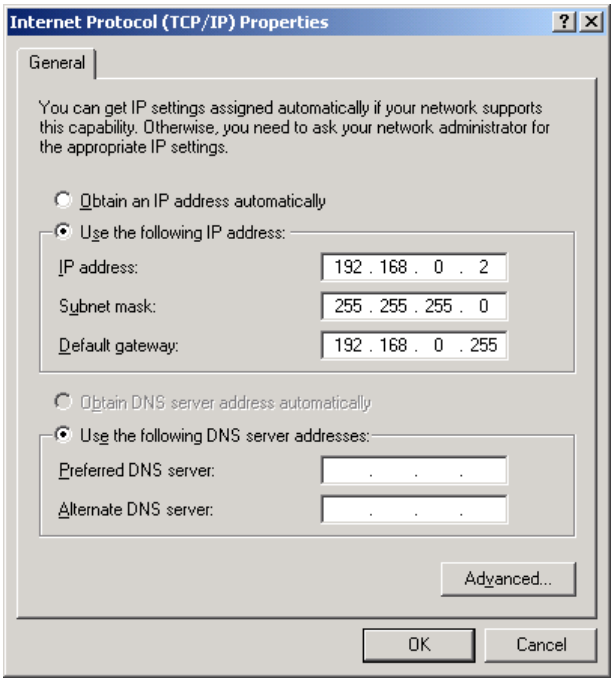
route add [SMART-24 IP Address] [PC IP Address]



The routing table for the PC should look something like the following:



If the unit's default IP setting conflict with the user's network settings, the PC's TCP/IP will have to be modified to allow connection to the unit similar to that shown below:



In the above example, the unit's I/O1 Ethernet port is used with its default IP address of 192.168.0.1 and the PC's IP address is 192.168.0.2.

Once connected via the 10/100Base-T Ethernet port, the user can perform any of the TCP/IP based operations available in the unit such as; Telnet, FTP, HTTP and the CD-1.1 real-time data and command connections.

4.5.3 TCP/IP Over Serial PPP Operation

The SMART-24 Series instruments allow for TCP/IP connections over a serial PPP link via either of the unit's two external serial ports on I/O1 or I/O2. The serial ports can be setup to operate in either PPP server or client modes. See sections 4.3.2 (PPP Server Operation) and 4.3.3 (PPP Client Operation) for a full description of these modes of operation.

Once connected via the serial PPP port, the user can perform any of the TCP/IP based operations available in the unit such as; Telnet, FTP, HTTP and the CD-1.1 real-time data and command connections.

4.5.4 SMART Series Software Operation Over TCP/IP

The SMART-24 Series instruments provide real time data and command access via the CD-1.1 protocol as defined in the IDC document; "Formats and Protocols for Continuous Data CD-1.1, 3.4.3 Revision 0.2". These functions are executed over a TCP/IP based network connection to the SMART-24 Series instrument.

For the real time data, the SMART-24 Series instruments provide four independent CD-1.1 data servers that can send data to four different destinations simultaneously. Each data server (designated as CD Profiles 1, 2, 3 & 4) can be independently setup to connect to and send data, continuous or event only, to a SMARTServer data base running on any computer accessible to the unit via its network connection.

For setup and command functions, the SMART-24 Series instruments provide one CD-1.1 command server interface that listens on a specific port (default port is 8000) for incoming command connections and requests. The user can use the SMART24Config program running on any computer accessible to the unit via its network connection.

4.5.4.1 SMART24Config

SMART24Config is a JAVA based application running on a user's computer that allows setup and command access to the SMART-24 Series instrument via its TCP/IP network connection. This application provides an intuitive graphical user interface to the unit so that the user does not have to be concerned with the details of the low level SMART-24 Series Command & Setup Protocol ASCII commands. The SMART24Config application is discussed in full detail in the SMARTGeoHub documentation.

Note that if there is an unexpected TCP/IP connection lost (the physical connection is cut, etc.), the CD-1.1 command server in the SMART-24 may require a 10 minute

timeout period to detect the loss, close the connection on its side and reset so it can accept new connections. This may or may not occur depending on the exact nature of the connection loss. If the user loses the CD-1.1 command connection and then cannot reconnect, simply wait more than 10 minutes then try again.

4.5.4.2 SMARTServer

SMARTServer is a JAVA based application running on a user's computer that accepts incoming real time data connections from SMART-24 Series instruments and writes received data into a database via a TCP/IP network connection. The SMARTServer application is discussed in full detail in the SMARTGeoHub documentation.

Note that the SMART-24 CD-1.1 data servers, when enabled to send continuous data, will attempt connect to the SMARTServer once every two minutes. They will continue to attempt a connection indefinitely. Upon starting the SMARTServer application it may take 2 minutes or more before data will be seen being received by the SMARTServer.

Real time data is provided via the CD-1.1 protocol as defined in the IDC document; "Formats and Protocols for Continuous Data CD-1.1, 3.4.3 Revision 0.2". Each CD1.1 data packet consists of one Frame Header (Table 3 of the IDC Documentation) and one Channel Subframe Header (Table 9 of the IDC Documentation) followed by a number of Channel Subframes (Table 10 of the IDC Documentation), organized in data blocks kept in time sequence. Each 1 minute data block contains a number of Channel Subframes that matches the number of channels recorded as specified in the Channel Subframe Header.

Each raw data file contains all data channels recorded (primary, secondary, auxiliary and mass position) for the specified recording time period. The raw data file consists
---
Also note that if there is an unexpected TCP/IP connection lost (the physical connection is cut, etc.), the CD-1.1 data servers in the SMART-24 may require a 10 minute timeout period to detect the loss, close the connection on their side and reset so they can retry new connections to the SMARTServer. This may or may not occur depending on the exact nature of the connection loss. In any case, the real-time data connection should restore itself without user intervention after some period of time. The CD-1.1 data servers buffer real-time data internally to the unit when not connected. Once the connection is restored, buffered data is then sent along with current data in a normal CD 1.1 LIFO (last in, first out) or FIFO (first in, first out) manner as quickly as the connection bandwidth will allow. It this way the user should not see any data loss due to a temporary connection loss. The amount of data buffering in the unit depends on the sample rates used, but can be as much as 12 hours for 3 channels at 100 sps.

As an option, the SMART-24 CD-1.1 data servers can be enabled to send in real time event triggered data on the primary channels. At the same time the continuous data can be sent using the secondary channels. When sending only event triggered data, the SMART-24 will attempt connect to the SMARTServer once an event is triggered, send in

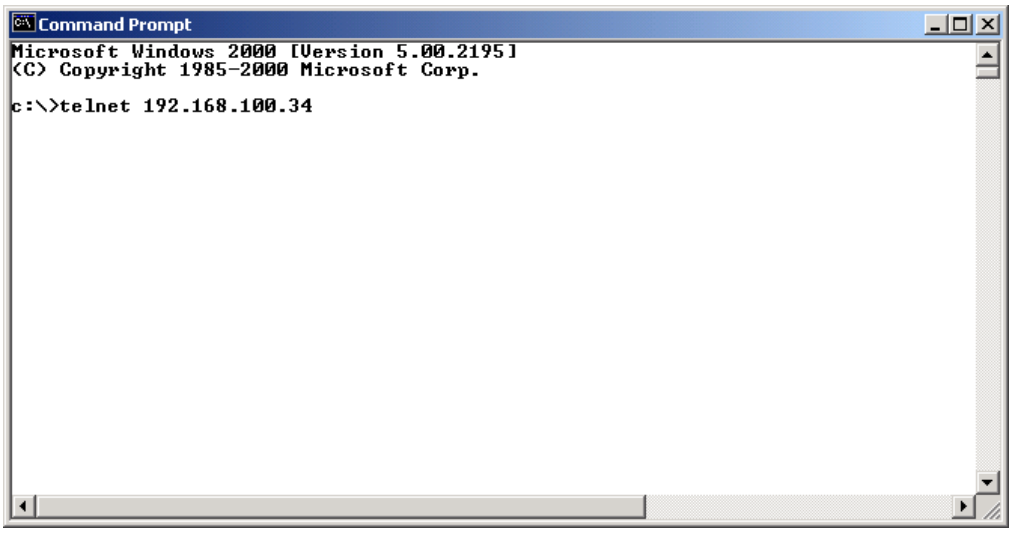
real time the event data (including pre-event and post-event), then close the connection. To operate in this mode event recording must be enabled (see section 4.7.11.3).

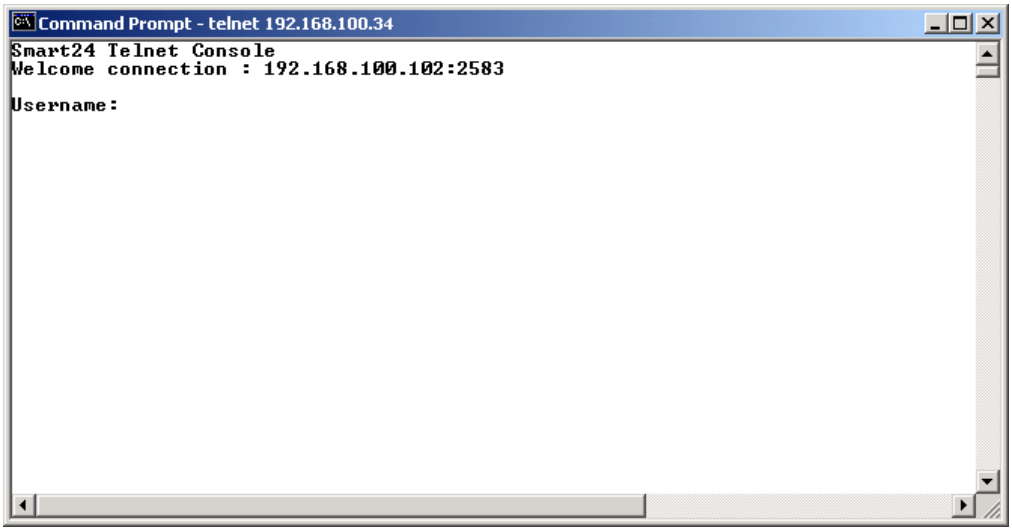
4.5.4.3 Earthworm

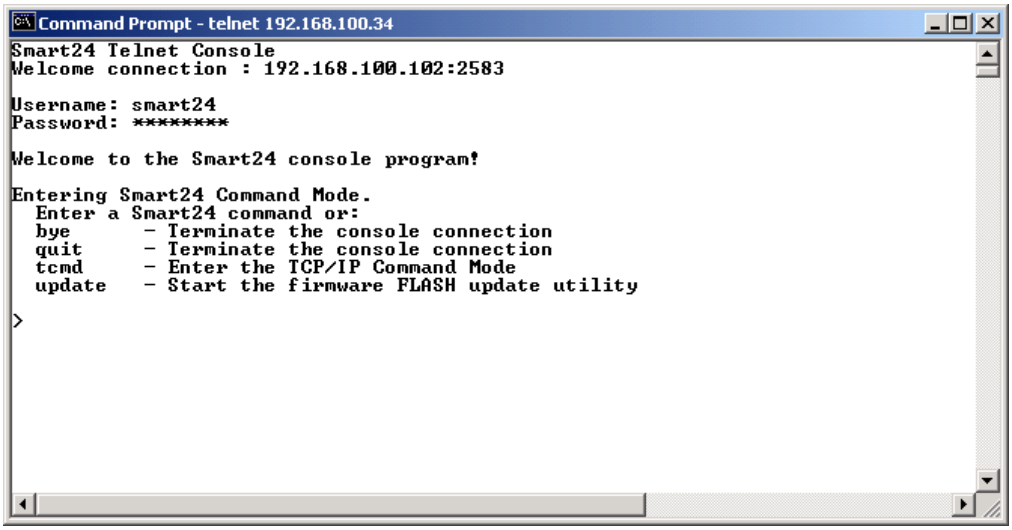
The first of the four SMART-24 CD-1.1 data servers can be enabled to send continuous real time data using the Earthworm export protocol to an Earthworm system. The SMART-24 initiates the data connection to Earthworm, acting like an active Earthworm export. As in the CD 1.1 mode, the SMART-24 will attempt connect to the destination once every two minutes, and will continue to attempt a connection indefinitely. Upon starting the Earthworm application it may take 2 minutes or more before data will be seen being received by the Earthworm import module. The SMART-24 data server buffers real-time data internally to the unit when not connected. Once the connection is restored, buffered data is then sent along with current data, typically using the FIFO (first in, first out) manner, as quickly as the connection bandwidth will allow.

4.5.5 Telnet Operation

The SMART-24 Series instruments provide Telnet access to the unit's character command console interface. Any Telnet compatible program can be used to access the unit remotely for setup, control and status. After the Telnet connection is made, the user must log into the console program using the unit's system user name and password. Starting the Telnet connection (using the Windows Telnet program) and logging into the console program is shown in the following three screen captures.







The factory default system user name and password are:

User Name:	smart24	(lower case)
Password:	changeme	(lower case)

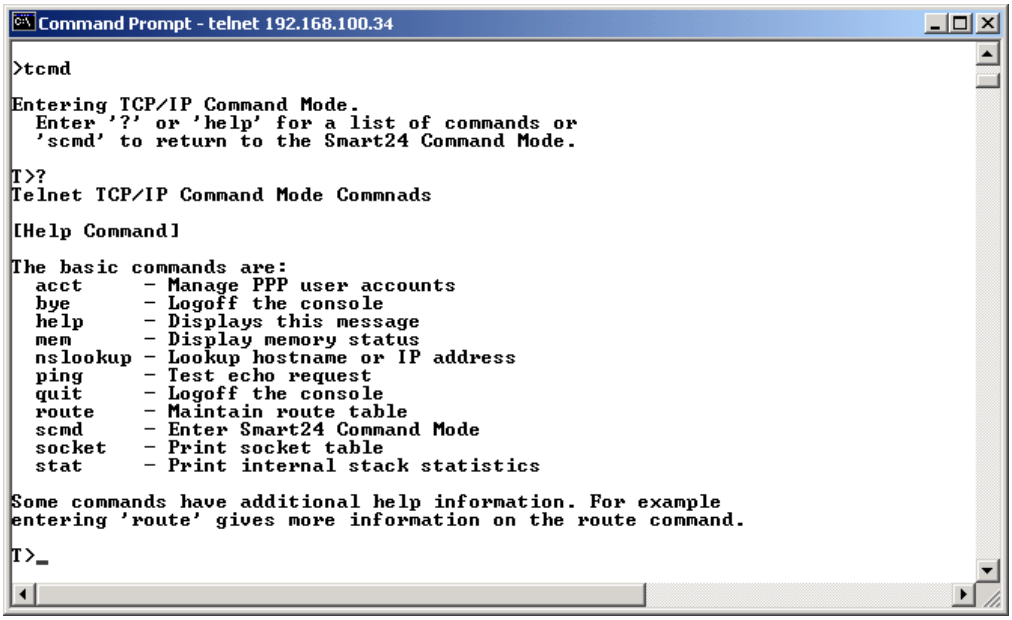
Once logged in, the console program is in the SMART24 Command Mode (as indicated by the '>' prompt). In this mode the user can enter any of the SMART-24 commands as described in Appendix C, the SMART-24 Series Command & Setup Protocol Interface Control Document.

When in the SMART24 Command Mode, a few additional Telnet only commands are also available. These are:

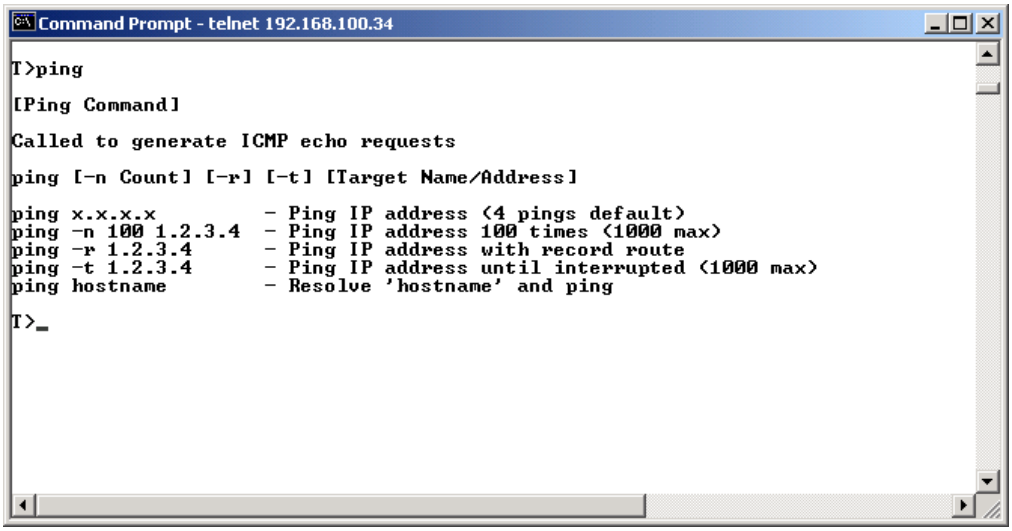
- bye - Exits the console program and closes the Telnet connection.
- help (?) - Display help.

- quit - Exits the console program and closes the Telnet connection.
- tcmd - Puts the console program into the TCP/IP Command Mode.
- update - Starts the firmware update process (see section 4.8.2 for a full description of this process).
- level - Starts the level test utility (SMART-24A® only, see section 4.5.5.1).
- tilt - Starts the tilt test utility (SMART-24A® only, see section 4.5.5.2).
- cal - Starts the cal test utility (SMART-24A® only, see section 4.5.5.3).
- report - Dump test reports (SMART-24A® only, see section 4.5.5.4).
- timesync - View and debug the time synchronization process (see section 4.5.5.5)

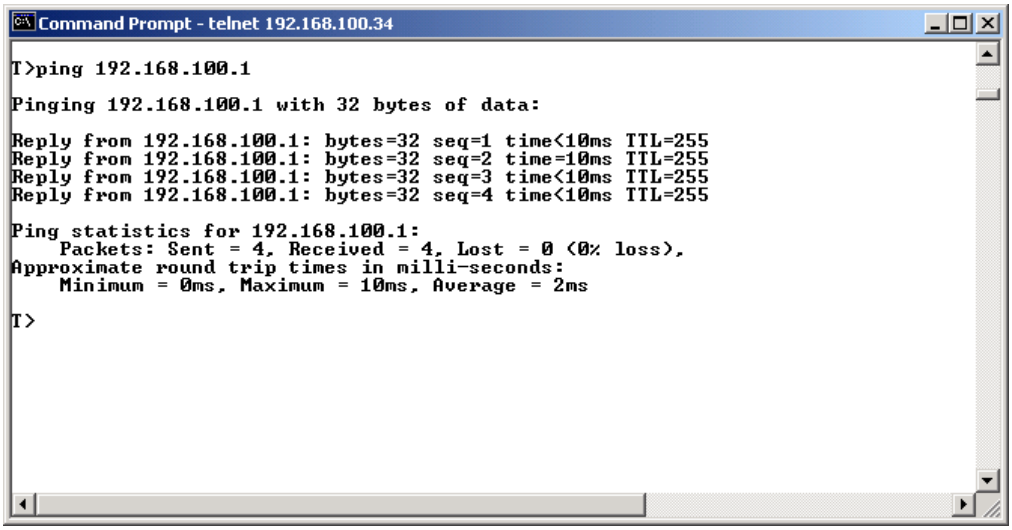
When the console program is in the TCP/IP Command Mode (by using the 'tcmd" command and as indicated by the 'T>' prompt), the user has access to various TCP/IP low level commands as shown below:

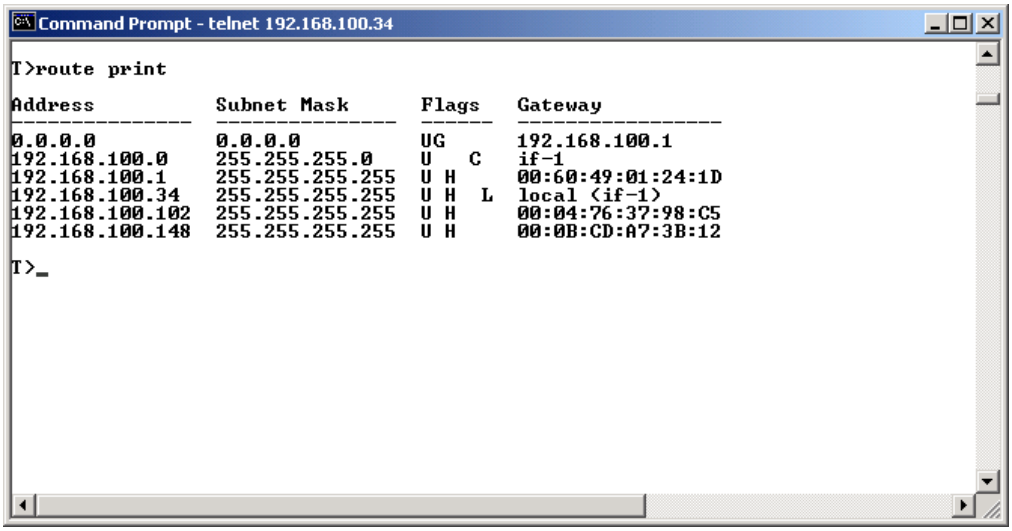


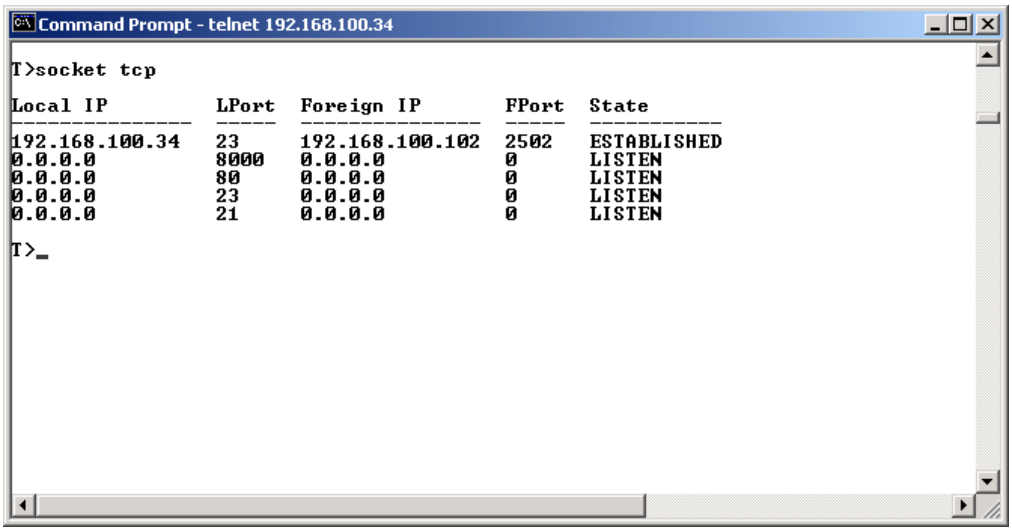
In general, typing a TCP/IP Command Mode command by itself will display more information on the usage of that command as shown below for the ping command.



Note that not all commands will be fully functional depending on the networking configuration. The most useful of these commands to user will be the ping, route and socket commands. Examples of these commands are shown in the next three screen captures.







If there is an unexpected loss of the TCP\IP connection (the physical connection is cut, etc.), the Telnet server in the SMART-24 may require a 10-minute timeout period to detect the loss, close the connection on its side and reset so it can accept new connections. This may or may not occur depending on the exact nature of the connection loss. If the user loses the Telnet connection and then gets a busy error message when trying to reconnect, simply wait more than 10 minutes then try again.

4.5.5.1 LEVEL Telnet Command

Note: This command is only available in the SMART-24A®.

At the '>' Telnet prompt, type 'level' to start the Level Test Utility. This will display the average sensor output values in counts, volts and g. The display averages and updates every two seconds (the number in parentheses shows the number of seconds the utility has been running). The ESC key is used to exit the utility and return to the Telnet prompt.

```
>level


Starting SMART-24A Level Test Utility!

Values: Vert =      -978 c   N-S =     +4420 c   E-W =    +14511 c   (2)
        Vert = -0.000399 V   N-S = +0.001807 V   E-W = +0.005938 V
        Vert = -0.000319 g   N-S = +0.001446 g   E-W = +0.004750 g
```

This command can be used as an aid in installing the unit to level the enclosure by minimizing the average offset in each channel while adjusting the mounting points.

It can also be used to aid in adjusting the mechanical mass center offset adjust of each sensor. To do this the unit should be mounted and leveled first. While the absolute maximum allowable value is ±12500 counts or ±0.005 V, the test technician should try to adjust the offset value to less than ±2500 counts or ±0.001 V if possible. To adjust the sensor offsets, the test technician must open the unit (carefully with the power still on) and using a small plastic straight slot screw driver he must trim the mechanical offset adjust points accessible through the holes in the sensor cover (vertical on top, north-south on the handle side and east-west on the right side). Clockwise rotation will adjust the offset in the negative direction and counter-clockwise rotation will adjust the offset in the positive direction. Note that this trim can be sensitive and any value less than ±2500 counts or ±0.001 V should be left alone.

4.5.5.2 TILT Telnet Command

Note: This command is only available in the SMART-24A®.

To use this test, the unit must be mounted and leveled on a Geotech compatible tilt test table that can rotate the unit in fixed 45° increments.

At the '>' Telnet prompt, type 'tilt' to start the Tilt Test Utility. Enter the required information (test technician's initials, sensor serial numbers, etc.) and follow the instructions given by the tilt test utility. The unit is tested first by rotating it on the north-south axis in 45° position increments. Then the unit is re-mounted with the east-west axis aligned with tilt table's rotation axis (handle to the left when standing in front of the tilt table) and rotated again. Be careful to follow the directions given exactly, if the utility and the tilt table get out of synchronization, the test will fail and have to be run again. Note that at the 0° position, two measurements are taken at the start of each rotation rather than one measurement at all other positions. The ESC key on the PC can be used to abort the tilt test if needed (in this case it will have to be restarted from the beginning).

```
>tilt


Starting SMART-24A Tilt Test Utility!

SMART-24A TILT TEST UTILITY.
Sample rate = 200 sps.

Enter your name or initials ==> PBA

Enter vertical sensor serial number =====> 345

Enter north-south sensor serial number ==> 267

Enter east-west sensor serial number ====> 321

************************************************************************

Test conducted by.: PBA
Test Date/Time....: 2005-08-31 20:54:40
Unit Under Test...: S/N 1168
Vertical Sensor...: S/N 345
North-South Sensor: S/N 267
East-West Sensor..: S/N 321

------------------------------------------------------------------------
------------------------------------------------------------------------

Tilting on NORTH-SOUTH axis.

Mount the SMART-24A under test on the tilt table with its North-South
axis aligned with the tilt table axis.
Hit any key when ready . . .

------------------------------------------------------------------------

Set the tilt table to 0 degrees.
Hit any key when ready . . .

Calculating channel offsets . . . 1 2 3 4 5
Offsets: Vert = -0.000168 g     N-S = +0.001313 g     E-W = +0.001473 g
         Vert =      -515 cnt   N-S =     +4014 cnt   E-W =     +4504 cnt


Calculating 0 degree values . . . 1 2 3 4 5
Values:  Vert = +0.000010 g     N-S = -0.000009 g     E-W = +0.000001 g
         Vert =       +31 cnt   N-S =       -28 cnt   E-W =        +5 cnt

------------------------------------------------------------------------

Set the tilt table to 45 degrees.
Hit any key when ready . . .

CONTINUES ON . . . . . .
```

When complete, the utility will generate a report indicating the pass/fail results. If the unit passes, the report is written to FLASH memory internally and the calculated sensor g/count sensitivity values displayed as follows:

```
Vertical Sensitivity    = +0.326248E-06 g/c
North-South Sensitivity = +0.325448E-06 g/c
East-West Sensitivity   = +0.327678E-06 g/c
```

If the tilt test fails, the problem must be corrected before proceeding with this test procedure.

A tilt test report file is also generated (whether it passes or fails) in the root directory of drive A that can be uploaded via FTP if desired. DO NOT TURN THE UNIT OFF UNTIL THIS FILE HAS BEEN UPLOADED OR IT WILL BE LOST! The last successful report can be retrieved from FLASH memory using the REPORT command at any time.

4.5.5.3 CAL Telnet Command

Note: This command is only available in the SMART-24A®.

The unit must be mounted and leveled before using this command. At the '>' Telnet prompt, type 'cal' to start the Calibrator Sensitivity Test Utility. Enter the required information (test technician's initials, etc.) and follow the instructions given by the tilt test utility. Note that this test picks up some of its required information from the tilt test report stored in FLASH memory. This means that the tilt test MUST be successfully completed before running this test.

```
>cal


Starting SMART-24A Calibrator Sensitivity Test Utility!

Vertical Sensor Sensitivity    = +0.326248E-06 g/c
North-South Sensor Sensitivity = +0.325448E-06 g/c
East-West Sensor Sensitivity   = +0.327678E-06 g/c

Enter your name or initials ==> PBA

*************************************************************************

Test conducted by.: PBA
Test Date/Time....: 2005-08-31 20:56:01
Unit under test...: S/N 1168
Vertical Sensor...: S/N 222
North-South Sensor: S/N 256
East-West Sensor..: S/N 257

Make sure the SMART-24A under test is on a stable level surface.
Hit any key when ready . . .

-------------------------------------------------------------------------

Calculating channel offsets . . . 1 2 3 4 5
Offsets: Vert = -0.000027 g     N-S = +0.001169 g     E-W = +0.004788 g
         Vert =       -85 cnt   N-S =     +3595 cnt   E-W =    +14614 cnt

-------------------------------------------------------------------------

Enabling +2.5V calibration signal to sensors . . . 1 2 3 4 5

Calculating +2.5V calibration signal input values . . . 1 2 3 4 5
Values:  Vert = -0.946393 g     N-S = -0.958659 g     E-W = -0.956202 g
         Vert =  -2900840 cnt   N-S =  -2945662 cnt   E-W =  -2918117 cnt

-------------------------------------------------------------------------
```

```
Enabling -2.5V calibration signal to sensors . . . 1 2 3 4
CONTINUES ON . . . . . .
```

When complete, the utility will generate a report indicating the pass/fail results. If the unit passes, the report is written to FLASH memory internally and the calculated calibrator volt/g sensitivity values are displayed as follows:

```
Vertical Sensitivity    = +0.382047 g/v
North-South Sensitivity = +0.386965 g/v
East-West Sensitivity   = +0.386944 g/v
```

If the cal test fails, the problem must be corrected before proceeding with this test procedure.

A cal test report file is also generated (whether it passes or fails) in the root directory of drive A that can be uploaded via FTP if desired. DO NOT TURN THE UNIT OFF UNTIL THIS FILE HAS BEEN UPLOADED OR IT WILL BE LOST! The last successful report can be retrieved from FLASH memory using the REPORT command at any time.

4.5.5.4 REPORT Telnet Command

Note: This command is only available in the SMART-24A®.

At the '>' prompt, type 'report' to dump the last successful tilt and cal test reports from FLASH memory. If both tests passed OK, both reports will be dumped to the PC screen and look similar to the following:

```
>report
------------------------------------------------------------------------
------------------------------------------------------------------------

SMART-24A TILT TEST DATA REPORT
Geotech Instruments, LLC

Test conducted by.: PBA
Test Date/Time....: 2005-08-31 16:11:32
Unit Under Test...: S/N 1168
Vertical Sensor...: S/N 222
North-South Sensor: S/N 256
East-West Sensor..: S/N 257

Accuracy Limits: Vert = +/-0.030 g    N-S = +/-0.060 g    E-W = +/-0.060 g

North-South Tilt Axis (measured)
Angle      VERT     (Diff)          N-S      (Diff)          E-W      (Diff)

 000   +0.000002g  (+0.000g)    +0.000000g  (+0.000g)    +0.000000g  (+0.000g)
 045   -0.296632g  (-0.003g)    +0.004875g  (+0.004g)    -0.707073g  (+0.000g)
 090   -1.006616g  (-0.006g)    +0.005617g  (+0.005g)    -1.000983g  (+0.000g)
 135   -1.715614g  (-0.008g)    +0.001710g  (+0.001g)    -0.708563g  (-0.001g)
 180   -2.006387g  (-0.006g)    -0.004332g  (-0.004g)    -0.002427g  (-0.002g)
 225   -1.708342g  (-0.001g)    -0.009480g  (-0.009g)    +0.703846g  (-0.003g)
 270   -0.997065g  (+0.002g)    -0.010555g  (-0.010g)    +0.997541g  (-0.002g)
 315   -0.290255g  (+0.002g)    -0.006308g  (-0.006g)    +0.705884g  (-0.001g)
 360   -0.000190g  (+0.000g)    +0.000069g  (+0.000g)    -0.000230g  (+0.000g)
```

```
East-West Tilt Axis (measured)
Angle      VERT     (Diff)          N-S      (Diff)          E-W      (Diff)

 000   +0.000000g  (+0.000g)    +0.000000g  (+0.000g)    +0.000001g  (+0.000g)
 045   -0.284912g  (+0.007g)    +0.710469g  (+0.003g)    -0.005332g  (-0.005g)
 090   -0.991404g  (+0.008g)    +1.003817g  (+0.003g)    -0.008929g  (-0.008g)
 135   -1.704983g  (+0.002g)    +0.708182g  (+0.001g)    -0.008801g  (-0.008g)
 180   -2.006180g  (-0.006g)    -0.003481g  (-0.003g)    -0.004767g  (-0.004g)
 225   -1.717626g  (-0.010g)    -0.713617g  (-0.006g)    +0.000314g  (+0.000g)
 270   -1.012194g  (-0.012g)    -1.006815g  (-0.006g)    +0.003613g  (+0.003g)
 315   -0.301962g  (-0.009g)    -0.711242g  (-0.004g)    +0.003811g  (+0.003g)
 360   -0.000047g  (+0.000g)    -0.000181g  (+0.000g)    -0.000050g  (+0.000g)

Vertical Sensitivity    = +0.326248E-06 g/c
North-South Sensitivity = +0.325448E-06 g/c
East-West Sensitivity   = +0.327678E-06 g/c

North-South Tilt Axis (corrected)
Angle      VERT     (Diff)          N-S      (Diff)          E-W      (Diff)

 000   +0.000002g  (+0.000g)    +0.000000g  (+0.000g)    +0.000000g  (+0.000g)
 045   -0.295781g  (-0.002g)    +0.004849g  (+0.004g)    -0.707713g  (+0.000g)
 090   -1.003727g  (-0.003g)    +0.005587g  (+0.005g)    -1.001889g  (-0.001g)
 135   -1.710691g  (-0.003g)    +0.001701g  (+0.001g)    -0.709205g  (-0.002g)
 180   -2.000629g  (+0.000g)    -0.004309g  (-0.004g)    -0.002429g  (-0.002g)
 225   -1.703439g  (+0.003g)    -0.009429g  (-0.009g)    +0.704484g  (-0.002g)
 270   -0.994204g  (+0.005g)    -0.010499g  (-0.010g)    +0.998444g  (-0.001g)
 315   -0.289422g  (+0.003g)    -0.006274g  (-0.006g)    +0.706523g  (+0.000g)
 360   -0.000189g  (+0.000g)    +0.000068g  (+0.000g)    -0.000230g  (+0.000g)

East-West Tilt Axis (corrected)
Angle      VERT     (Diff)          N-S      (Diff)          E-W      (Diff)

 000   +0.000000g  (+0.000g)    +0.000000g  (+0.000g)    +0.000001g  (+0.000g)
 045   -0.284095g  (+0.008g)    +0.706702g  (+0.000g)    -0.005336g  (-0.005g)
 090   -0.988559g  (+0.011g)    +0.998495g  (-0.001g)    -0.008938g  (-0.008g)
 135   -1.700090g  (+0.007g)    +0.704427g  (-0.002g)    -0.008809g  (-0.008g)
 180   -2.000423g  (+0.000g)    -0.003462g  (-0.003g)    -0.004771g  (-0.004g)
 225   -1.712697g  (-0.005g)    -0.709834g  (-0.002g)    +0.000314g  (+0.000g)
 270   -1.009290g  (-0.009g)    -1.001477g  (-0.001g)    +0.003617g  (+0.003g)
 315   -0.301095g  (-0.008g)    -0.707471g  (+0.000g)    +0.003814g  (+0.003g)
 360   -0.000046g  (+0.000g)    -0.000180g  (+0.000g)    -0.000050g  (+0.000g)

*** END OF REPORT ***

------------------------------------------------------------------------
------------------------------------------------------------------------

SMART-24A CALIBRATION SENSITIVITY TEST DATA REPORT
Geotech Instruments, LLC

Test conducted by.: PBA
Test Date/Time....: 2005-08-31 16:29:57
Unit under test...: S/N 1168
Vertical Sensor...: S/N 222
North-South Sensor: S/N 256
East-West Sensor..: S/N 257

Accuracy Limits: 0.360 to 0.440 g/v

+2.5V calibration signal input values:

Values:  Vert = -0.946660 g     N-S = -0.958937 g     E-W = -0.958808 g
         Vert =  -2901660 cnt   N-S =  -2946514 cnt   E-W =  -2926070 cnt

-2.5V calibration signal input values:

Values:  Vert = +0.963575 g     N-S = +0.975888 g     E-W = +0.975914 g
         Vert =  +2953506 cnt   N-S =  +2998599 cnt   E-W =  +2978273 cnt

Calculated calibration input sensitivities:

Vertical Sensitivity    = +0.382047 g/v
North-South Sensitivity = +0.386965 g/v
East-West Sensitivity   = +0.386944 g/v
```

```
*** END OF REPORT ***

------------------------------------------------------------------------
------------------------------------------------------------------------
```

4.5.5.5 TIMESYNC Telnet Command

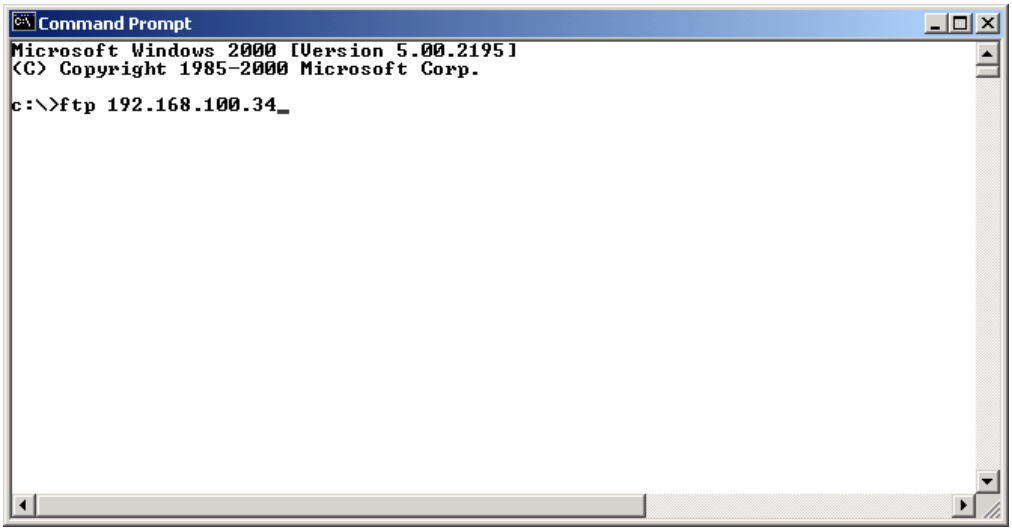
The "TIMESYNC" command utility (only available in the Telnet server access) allows the user to view the time synchronization process in real time as it is updated every 30 seconds. This command utility is only intended to be used by experienced users trying to debug time synchronization issues.

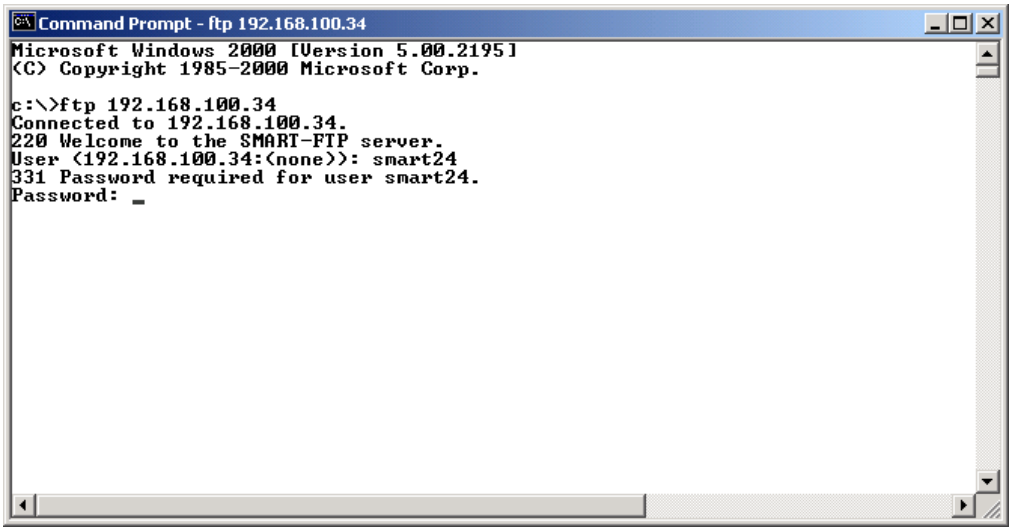
At the '>' Telnet prompt, type 'timesync' to start the utility. Any key can then be used to exit the utility back to the Telnet prompt as shown below:

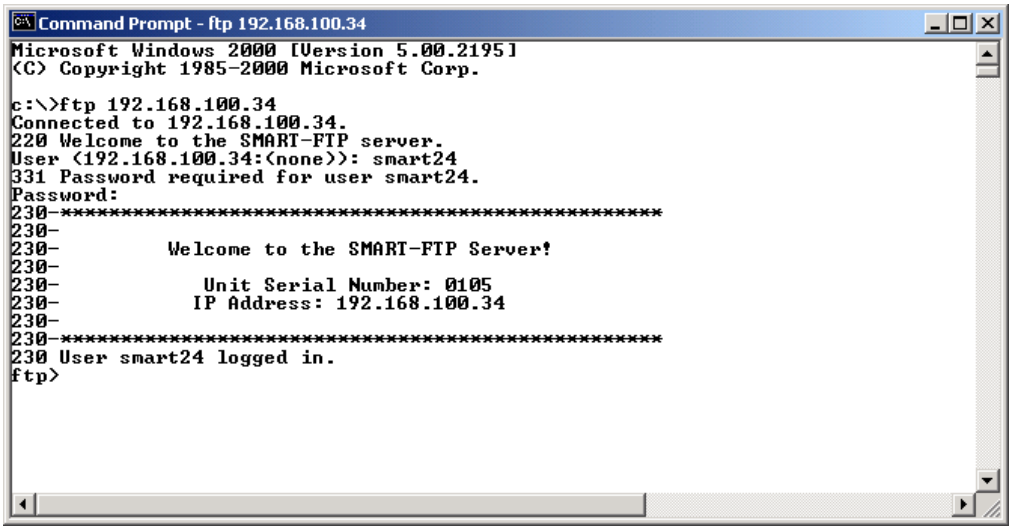
```
>timesync


Starting SMART-24 Time Sync Status Utility!

SMART-24 TIME SYNC STATUS UTILITY.

Hit any key to exit.

Parameters:
Time,HeartBeat,GPSLock,PPS,Jamset,ClkLock,TD-2,TD-1,TD-0,FreqErr,AdjVal,Bias,DacAdjVal,DacVal,Temp

2006-02-28 22:39:53, 115, 1, 1, 0, 1, +6, +6, +8, -1, +0, +0, +0, +1777, +30.271
2006-02-28 22:40:23, 116, 1, 1, 0, 1, +9, +14, +17, -4, -2, +1, -3, +1774, +30.271
2006-02-28 22:40:53, 117, 1, 1, 0, 1, +19, +17, +17, +1, +0, +1, -1, +1773, +30.271
2006-02-28 22:41:23, 118, 1, 1, 0, 1, +19, +17, +18, +0, +0, +1, -1, +1772, +30.271
2006-02-28 22:41:53, 119, 1, 1, 0, 1, +16, +13, +13, +1, +0, +1, -1, +1771, +30.271
2006-02-28 22:42:23, 120, 1, 1, 0, 1, +9, +4, +0, +4, +2, +0, +2, +1773, +30.271

Exiting . . .

>
```

4.5.6 FTP Server Operation

The SMART-24 Series instruments provide FTP access to the files stored on a unit's disk drives. Most FTP compatible client programs can be used to access the unit remotely for retrieving and managing data files. An example of starting a FTP connection (using the Windows FTP program) and logging into the SMART-24 FTP server is shown in the following three screen captures.


Command Prompt
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.
c:\>ftp 192.168.100.34_


Command Prompt - ftp 192.168.100.34
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.
c:\>ftp 192.168.100.34
Connected to 192.168.100.34.
220 Welcome to the SMART-FTP server.
User (192.168.100.34:(none)): smart24
331 Password required for user smart24.
Password: _

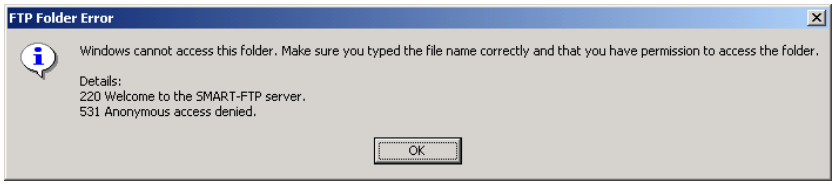

Command Prompt - ftp 192.168.100.34
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.
c:\>ftp 192.168.100.34
Connected to 192.168.100.34.
220 Welcome to the SMART-FTP server.
User (192.168.100.34:(none)): smart24
331 Password required for user smart24.
Password:
230-**********
230-
230- Welcome to the SMART-FTP Server!
230-
230- Unit Serial Number: 0105
230- IP Address: 192.168.100.34
230-
230-**********
230 User smart24 logged in.
ftp>

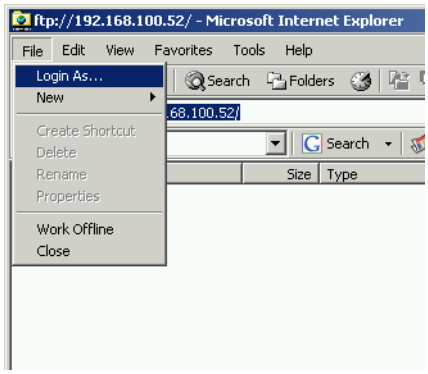
The user must log into the FTP server using the unit's system user name and password. The factory default system user name and password are:

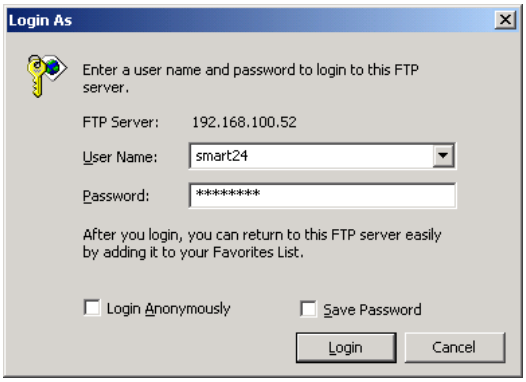
User Name:	smart24	(lower case)
Password:	changeme	(lower case)

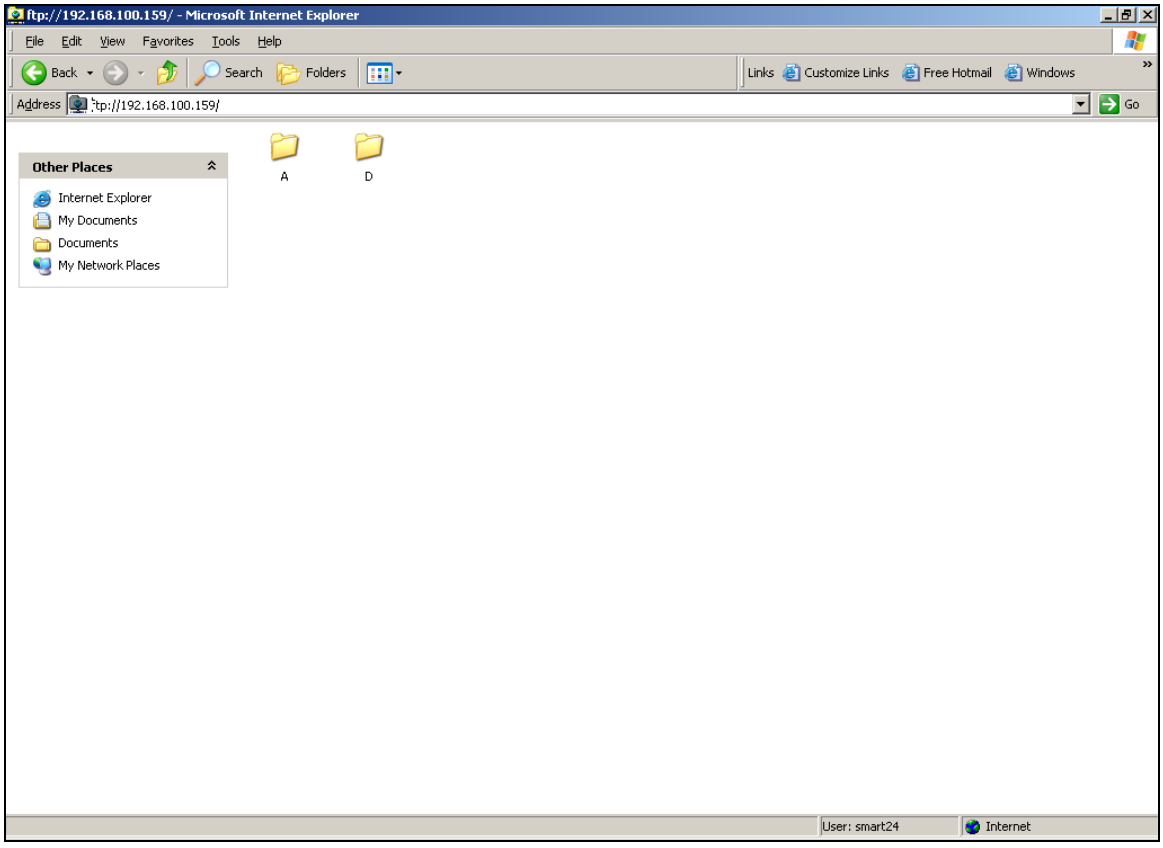
When logged in under the system user name and password, the user has full access to read files and to delete them. The FTP server can also support anonymous login where the user can only read files, but this is disabled in the factory default setup state. The user can enable anonymous login by using the ANO command (see Appendix C).

Most FTP compatible client programs can be used to access the unit remotely for retrieving and managing data files. A Web browser like Microsoft Internet Explorer can be used by entering 'ftp://' followed by the SMART-24 IP address in the address line. Note that Internet Explorer will try an anonymous login first and if anonymous login is disabled in the SMART-24 unit, an error message will be received. The user can then use the File menu and Login As to log into the FTP server. An example is shown in the following screen captures.

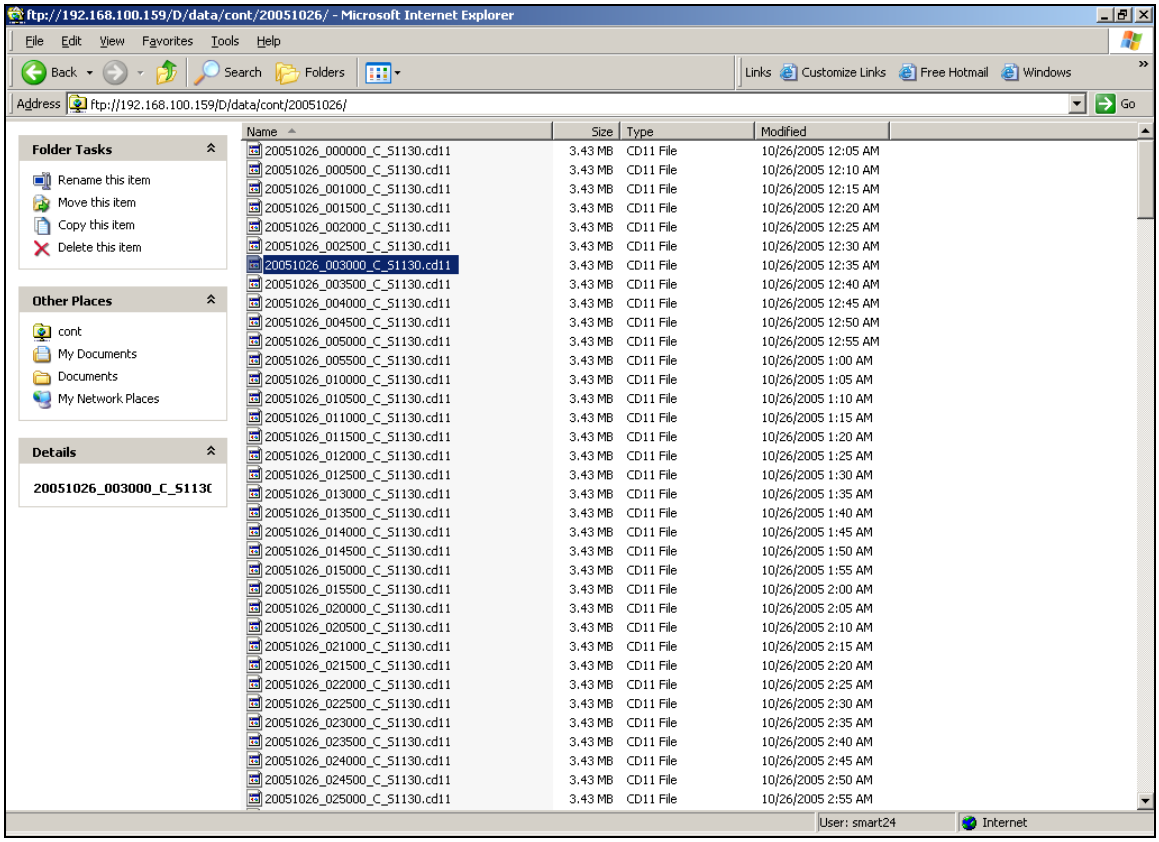








At the top level, the SMART-24's disk drives are shown as directories 'A' (internal RAMDISK), 'B' (internal PCMCIA drive if installed), 'C' (internal PCMCIA drive if installed) and 'D' (external removable USB drive if installed). The directory structure used by the SMART-24 Series instruments is described in section 4.7.12.2.

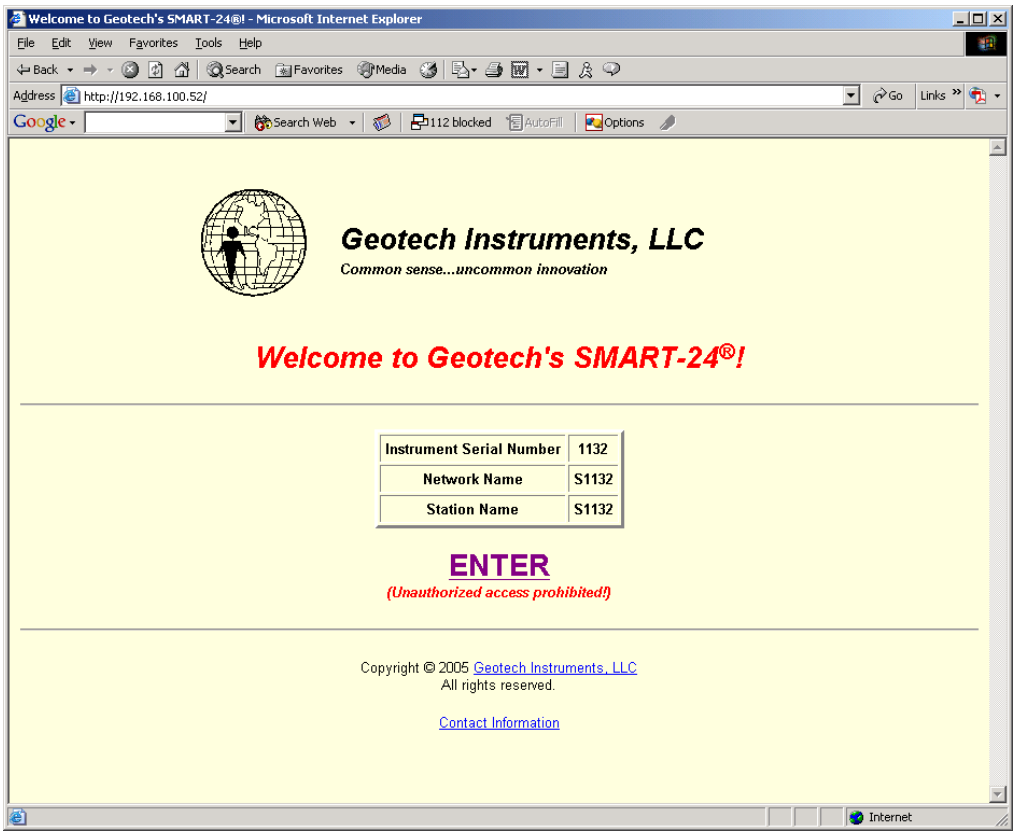


Note that if the SMART-24 unit is recording files (adding new files to the drives), most FTP client programs will require the user to use a REFRESH command to read any new files in a given directory.

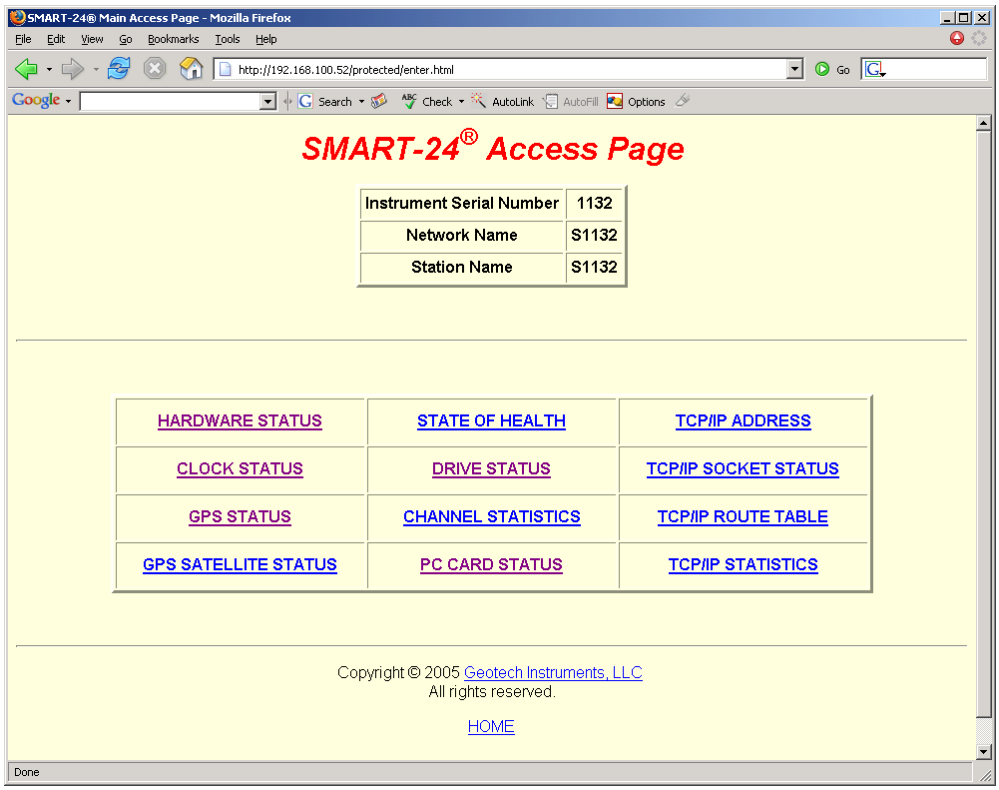
Also note that the FTP server in the SMART-24 unit has a built-in timeout of 2 minutes. If there is no user activity for 2 minutes or the connection is lost, the unit will close the connection automatically. Most FTP client programs can be configured to issue a FTP NOOP command at some interval to keep the connection open if desired.

4.5.7 HTTP Operation

The SMART-24 Series instruments provide HTTP access to Web pages stored in a unit by Web browser programs such as Internet Explorer or Netscape. The Web based interface displays various status information pages as shown in the following screen captures.



On click "ENTER", user name and password authentication is required. This is the same as that used for FTP and Telnet access. Some pages do an auto-refresh after 10 seconds.


SMART-24® Main Access Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://192.168.100.52/protected/enter.html
SMART-24® Access Page
Instrument Serial Number 1132
Network Name S1132
Station Name S1132
HARDWARE STATUS
STATE OF HEALTH
TCP/IP ADDRESS
CLOCK STATUS
DRIVE STATUS
TCP/IP SOCKET STATUS
GPS STATUS
CHANNEL STATISTICS
TCP/IP ROUTE TABLE
GPS SATELLITE STATUS
PC CARD STATUS
TCP/IP STATISTICS
Copyright © 2005 Geotech Instruments, LLC
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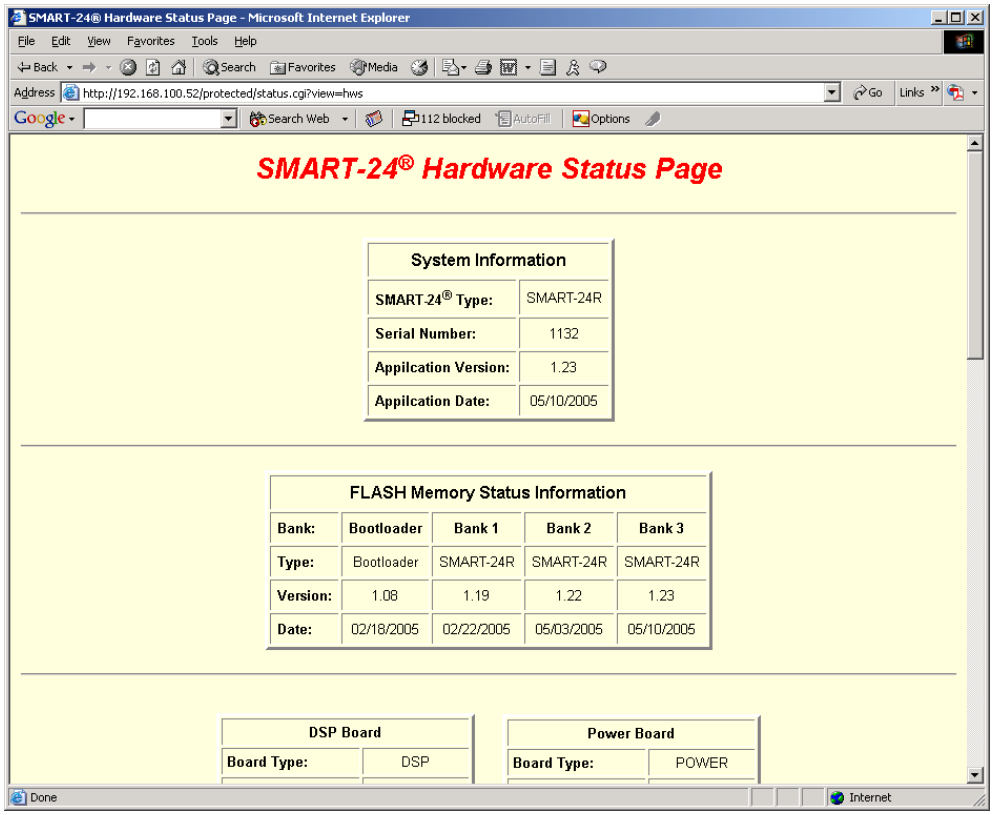
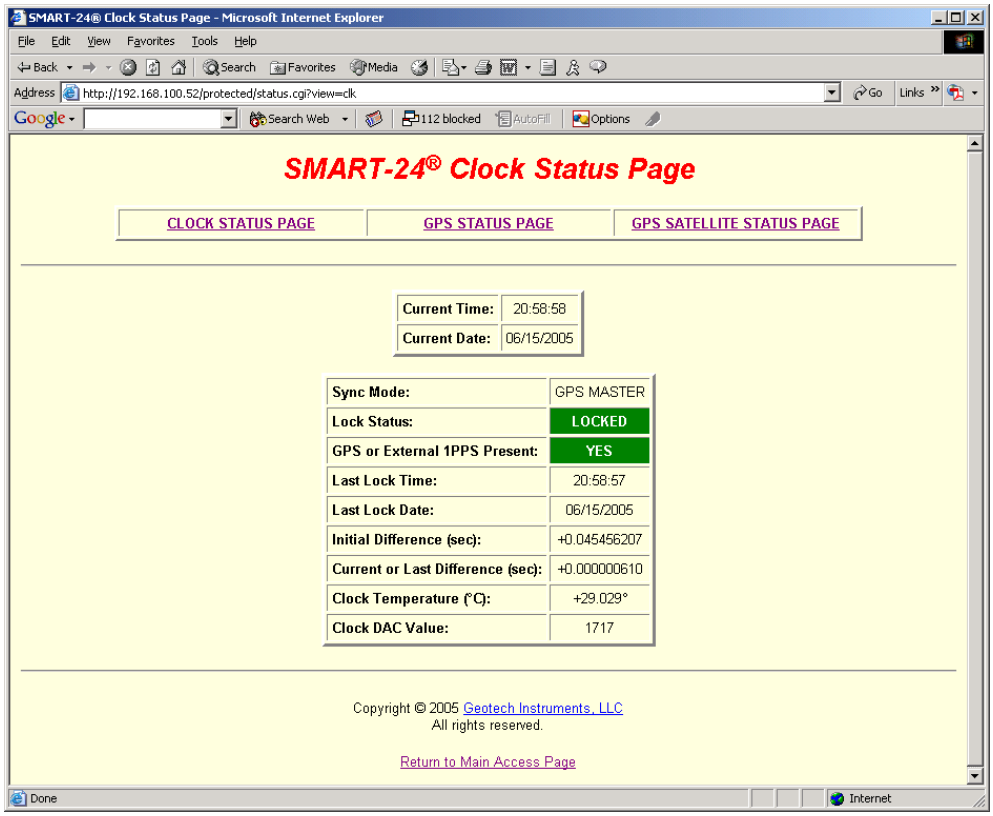
HOME
Done


SMART-24® Hardware Status Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://192.168.100.52/protected/status.cgi?view=hws
SMART-24® Hardware Status Page
System Information
SMART-24® Type: SMART-24R
Serial Number: 1132
Appilcation Version: 1.23
Appilcation Date: 05/10/2005
FLASH Memory Status Information
Bank: Bootloader Bank 1 Bank 2 Bank 3
Type: Bootloader SMART-24R SMART-24R SMART-24R
Version: 1.08 1.19 1.22 1.23
Date: 02/18/2005 02/22/2005 05/03/2005 05/10/2005
DSP Board
Board Type: DSP
Power Board
Board Type: POWER
Done
Internet


SMART-24® Clock Status Page
CLOCK STATUS PAGE
GPS STATUS PAGE
GPS SATELLITE STATUS PAGE
Current Time: 20:58:58
Current Date: 06/15/2005
Sync Mode: GPS MASTER
Lock Status: LOCKED
GPS or External 1PPS Present: YES
Last Lock Time: 20:58:57
Last Lock Date: 06/15/2005
Initial Difference (sec): +0.045456207
Current or Last Difference (sec): +0.000000610
Clock Temperature (°C): +29.029°
Clock DAC Value: 1717
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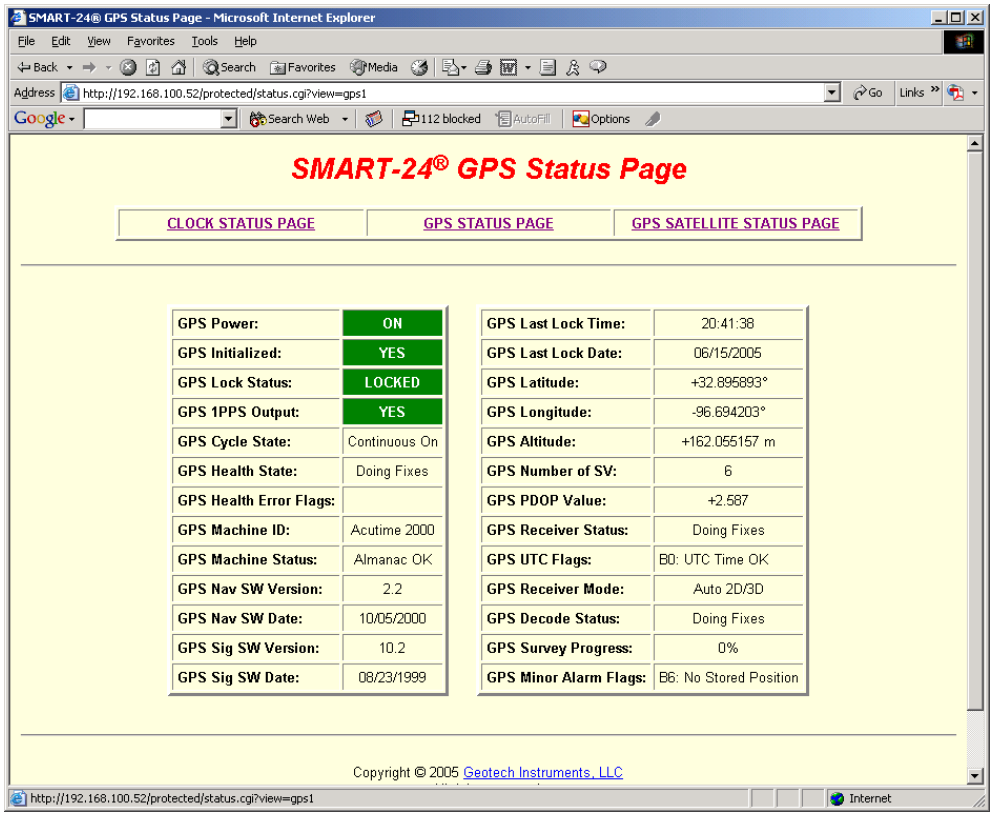
Return to Main Access Page


SMART-24® GPS Status Page
CLOCK STATUS PAGE
GPS STATUS PAGE
GPS SATELLITE STATUS PAGE
GPS Power: ON
GPS Initialized: YES
GPS Lock Status: LOCKED
GPS 1PPS Output: YES
GPS Cycle State: Continuous On
GPS Health State: Doing Fixes
GPS Health Error Flags:
GPS Machine ID: Acutime 2000
GPS Machine Status: Almanac OK
GPS Nav SW Version: 2.2
GPS Nav SW Date: 10/05/2000
GPS Sig SW Version: 10.2
GPS Sig SW Date: 08/23/1999
GPS Last Lock Time: 20:41:38
GPS Last Lock Date: 06/15/2005
GPS Latitude: +32.895893°
GPS Longitude: -96.694203°
GPS Altitude: +162.055157 m
GPS Number of SV: 6
GPS PDOP Value: +2.587
GPS Receiver Status: Doing Fixes
GPS UTC Flags: B0: UTC Time OK
GPS Receiver Mode: Auto 2D/3D
GPS Decode Status: Doing Fixes
GPS Survey Progress: 0%
GPS Minor Alarm Flags: B6: No Stored Position
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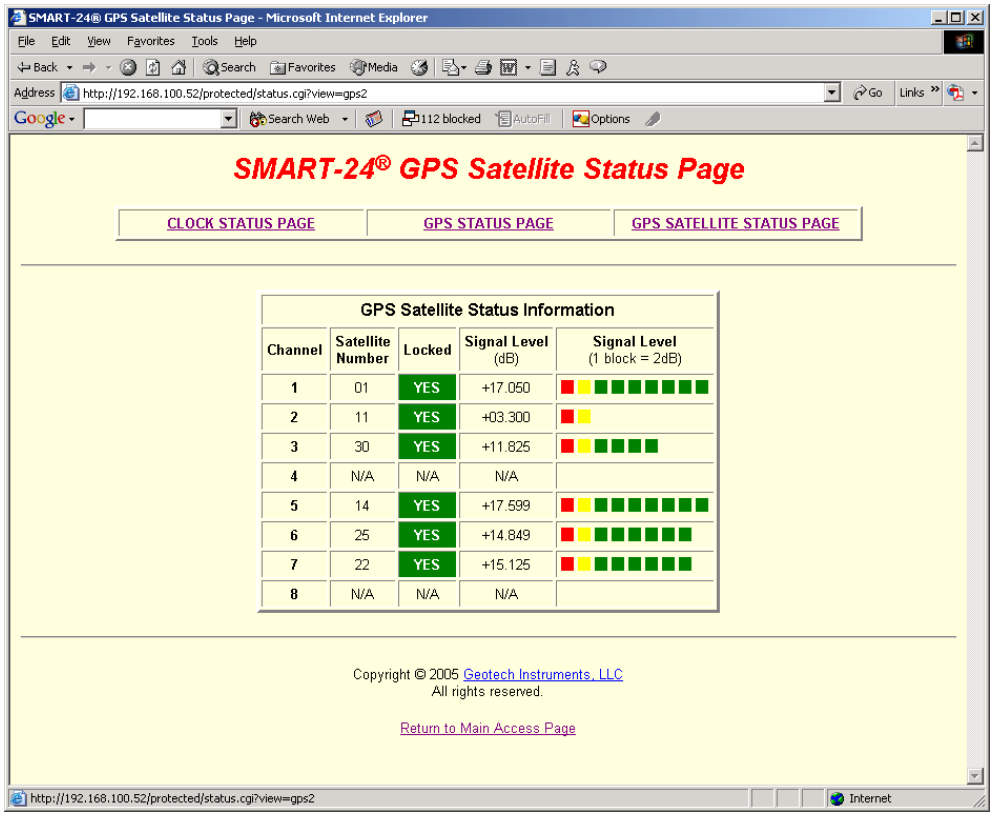
SMART-24® GPS Satellite Status Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=gps2
SMART-24® GPS Satellite Status Page
CLOCK STATUS PAGE
GPS STATUS PAGE
GPS SATELLITE STATUS PAGE
GPS Satellite Status Information
Channel | Satellite Number | Locked | Signal Level (dB) | Signal Level (1 block = 2dB)
1 | 01 | YES | +17.050
2 | 11 | YES | +03.300
3 | 30 | YES | +11.825
4 | N/A | N/A | N/A
5 | 14 | YES | +17.599
6 | 25 | YES | +14.849
7 | 22 | YES | +15.125
8 | N/A | N/A | N/A
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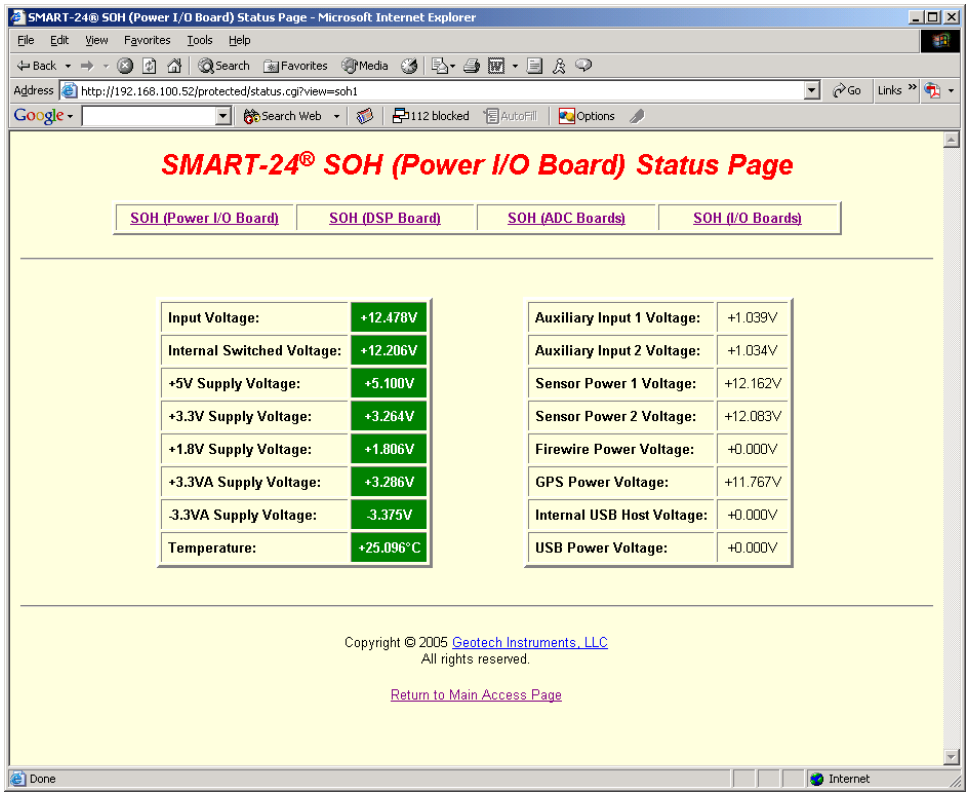
Return to Main Access Page


SMART-24® SOH (Power I/O Board) Status Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=soh1
SMART-24® SOH (Power I/O Board) Status Page
SOH (Power I/O Board)
SOH (DSP Board)
SOH (ADC Boards)
SOH (I/O Boards)
Input Voltage: +12.478V
Internal Switched Voltage: +12.206V
+5V Supply Voltage: +5.100V
+3.3V Supply Voltage: +3.264V
+1.8V Supply Voltage: +1.806V
+3.3VA Supply Voltage: +3.286V
.3.3VA Supply Voltage: -3.375V
Temperature: +25.096°C
Auxiliary Input 1 Voltage: +1.039V
Auxiliary Input 2 Voltage: +1.034V
Sensor Power 1 Voltage: +12.162V
Sensor Power 2 Voltage: +12.083V
Firewire Power Voltage: +0.000V
GPS Power Voltage: +11.767V
Internal USB Host Voltage: +0.000V
USB Power Voltage: +0.000V
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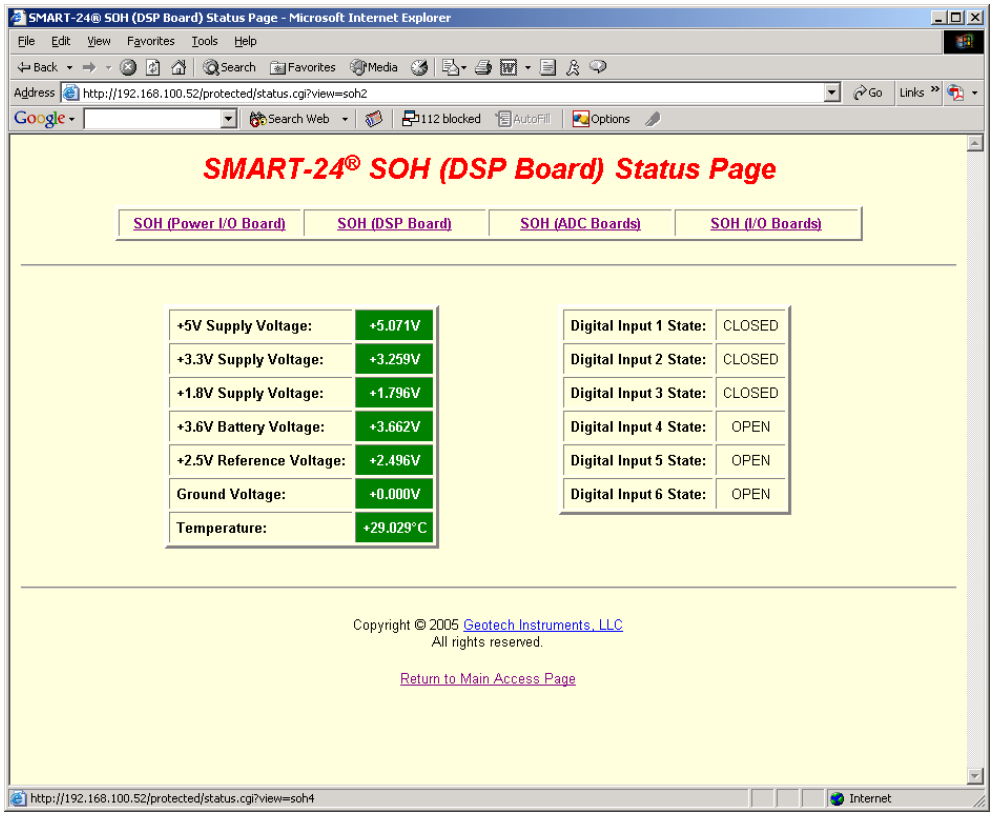
Return to Main Access Page


SMART-24® SOH (DSP Board) Status Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=soh2
SMART-24® SOH (DSP Board) Status Page
SOH (Power I/O Board)
SOH (DSP Board)
SOH (ADC Boards)
SOH (I/O Boards)
+5V Supply Voltage: +5.071V
+3.3V Supply Voltage: +3.259V
+1.8V Supply Voltage: +1.796V
+3.6V Battery Voltage: +3.662V
+2.5V Reference Voltage: +2.496V
Ground Voltage: +0.000V
Temperature: +29.029°C
Digital Input 1 State: CLOSED
Digital Input 2 State: CLOSED
Digital Input 3 State: CLOSED
Digital Input 4 State: OPEN
Digital Input 5 State: OPEN
Digital Input 6 State: OPEN
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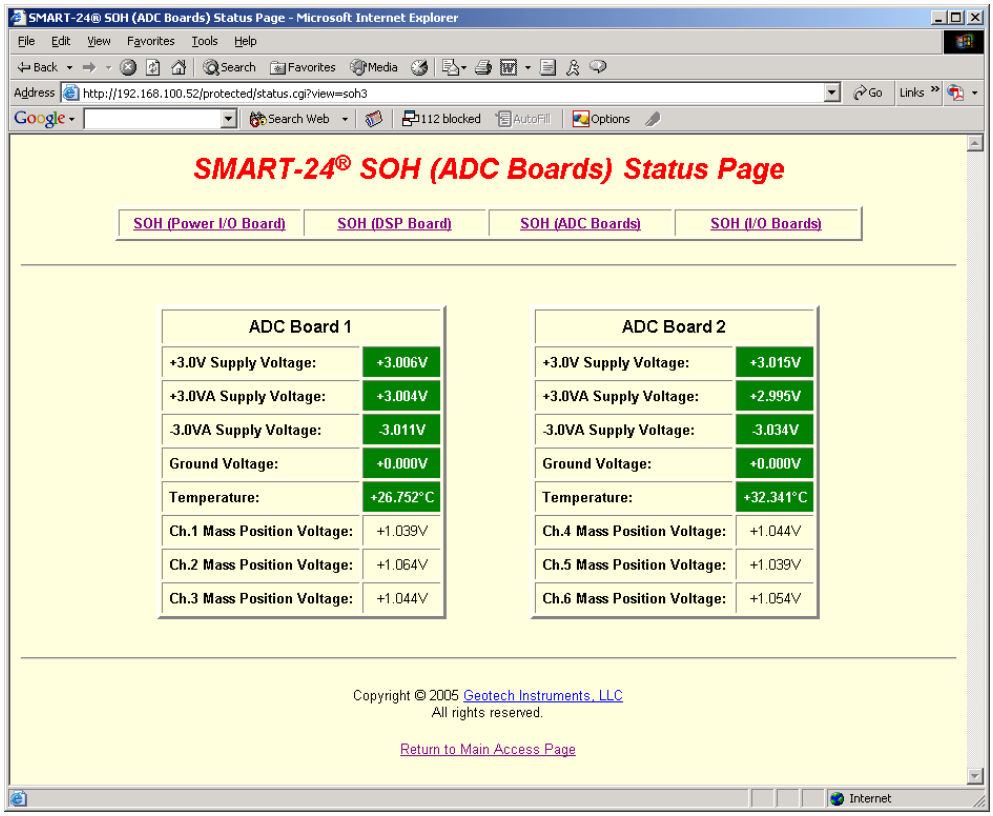
Return to Main Access Page
http://192.168.100.52/protected/status.cgi?view=soh4
Internet


SMART-24® SOH (ADC Boards) Status Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=soh3
SMART-24® SOH (ADC Boards) Status Page
SOH (Power I/O Board)
SOH (DSP Board)
SOH (ADC Boards)
SOH (I/O Boards)
ADC Board 1
+3.0V Supply Voltage: +3.006V
+3.0VA Supply Voltage: +3.004V
-3.0VA Supply Voltage: -3.011V
Ground Voltage: +0.000V
Temperature: +26.752°C
Ch.1 Mass Position Voltage: +1.039V
Ch.2 Mass Position Voltage: +1.064V
Ch.3 Mass Position Voltage: +1.044V
ADC Board 2
+3.0V Supply Voltage: +3.015V
+3.0VA Supply Voltage: +2.995V
-3.0VA Supply Voltage: -3.034V
Ground Voltage: +0.000V
Temperature: +32.341°C
Ch.4 Mass Position Voltage: +1.044V
Ch.5 Mass Position Voltage: +1.039V
Ch.6 Mass Position Voltage: +1.054V
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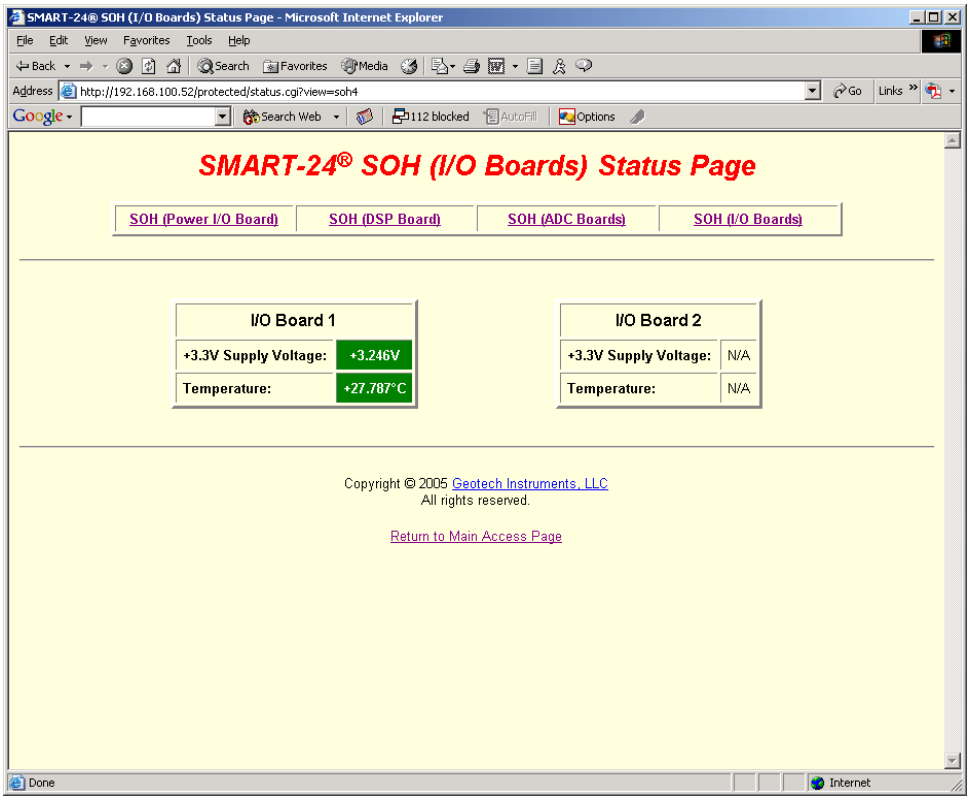
Return to Main Access Page
Internet


SMART-24® SOH (I/O Boards) Status Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://192.168.100.52/protected/status.cgi?view=soh4
Go Links
Google Search Web 112 blocked AutoFill Options
SMART-24® SOH (I/O Boards) Status Page
SOH (Power I/O Board) SOH (DSP Board) SOH (ADC Boards) SOH (I/O Boards)
I/O Board 1
+3.3V Supply Voltage: +3.246V
Temperature: +27.787°C
I/O Board 2
+3.3V Supply Voltage: N/A
Temperature: N/A
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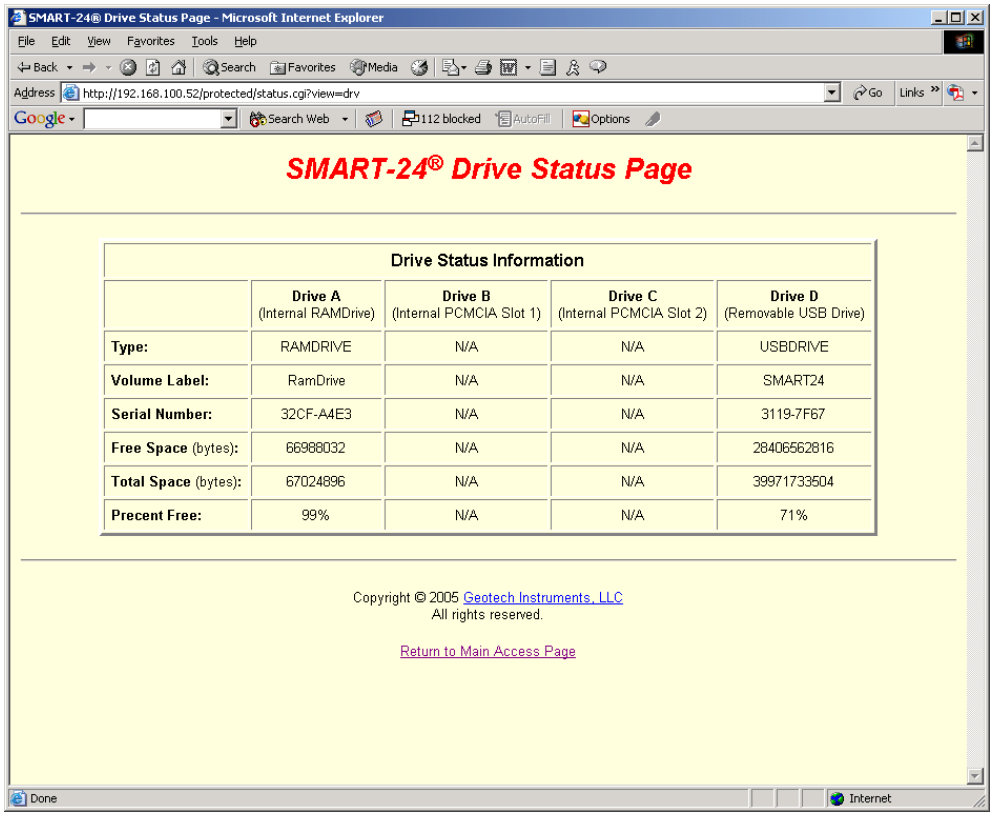
Return to Main Access Page
Done
Internet


SMART-24® Drive Status Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://192.168.100.52/protected/status.cgi?view=drv
Go Links
Google Search Web 112 blocked AutoFill Options
SMART-24® Drive Status Page
Drive Status Information
Drive A (Internal RAMDrive) | Drive B (Internal PCMCIA Slot 1) | Drive C (Internal PCMCIA Slot 2) | Drive D (Removable USB Drive)
Type: RAMDRIVE | N/A | N/A | USBDRIVE
Volume Label: RamDrive | N/A | N/A | SMART24
Serial Number: 32CF-A4E3 | N/A | N/A | 3119-7F67
Free Space (bytes): 66988032 | N/A | N/A | 28406562816
Total Space (bytes): 67024896 | N/A | N/A | 39971733504
Precent Free: 99% | N/A | N/A | 71%
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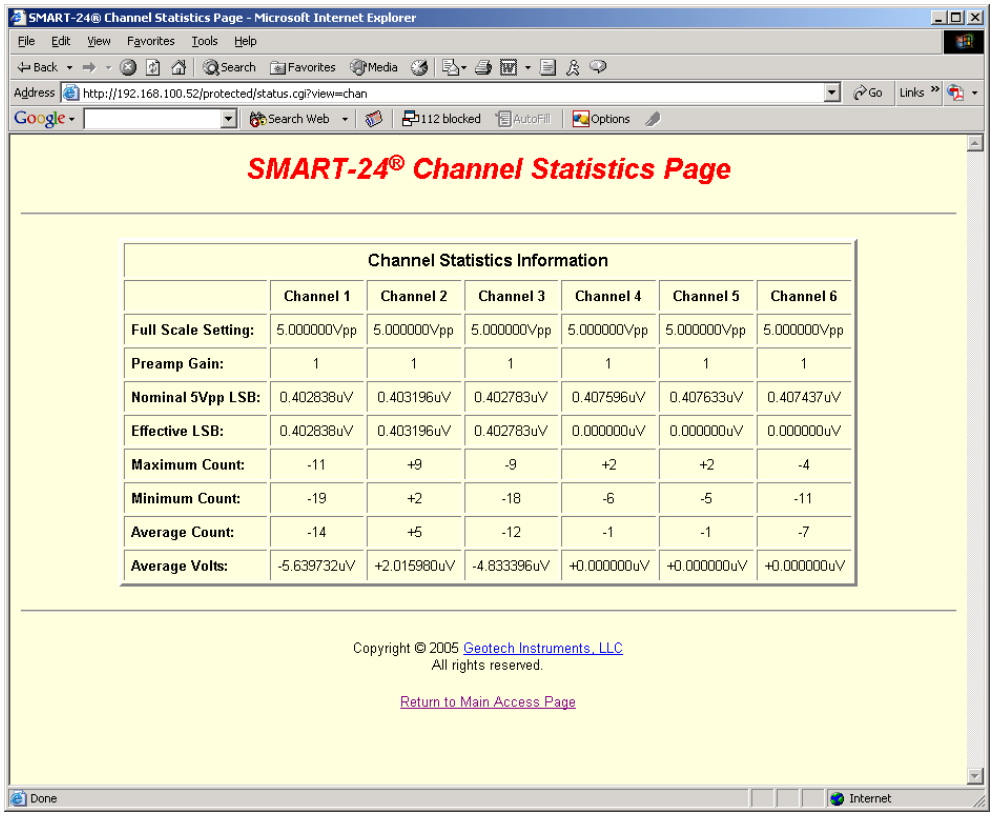
Return to Main Access Page
Done
Internet


SMART-24® Channel Statistics Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=chan
SMART-24® Channel Statistics Page
Channel Statistics Information
Channel 1 Channel 2 Channel 3 Channel 4 Channel 5 Channel 6
Full Scale Setting: 5.000000Vpp 5.000000Vpp 5.000000Vpp 5.000000Vpp 5.000000Vpp 5.000000Vpp
Preamp Gain: 1 1 1 1 1 1
Nominal 5Vpp LSB: 0.402838uV 0.403196uV 0.402783uV 0.407596uV 0.407633uV 0.407437uV
Effective LSB: 0.402838uV 0.403196uV 0.402783uV 0.000000uV 0.000000uV 0.000000uV
Maximum Count: -11 +9 -9 +2 +2 -4
Minimum Count: -19 +2 -18 -6 -5 -11
Average Count: -14 +5 -12 -1 -1 -7
Average Volts: -5.639732uV +2.015980uV -4.833396uV +0.000000uV +0.000000uV +0.000000uV
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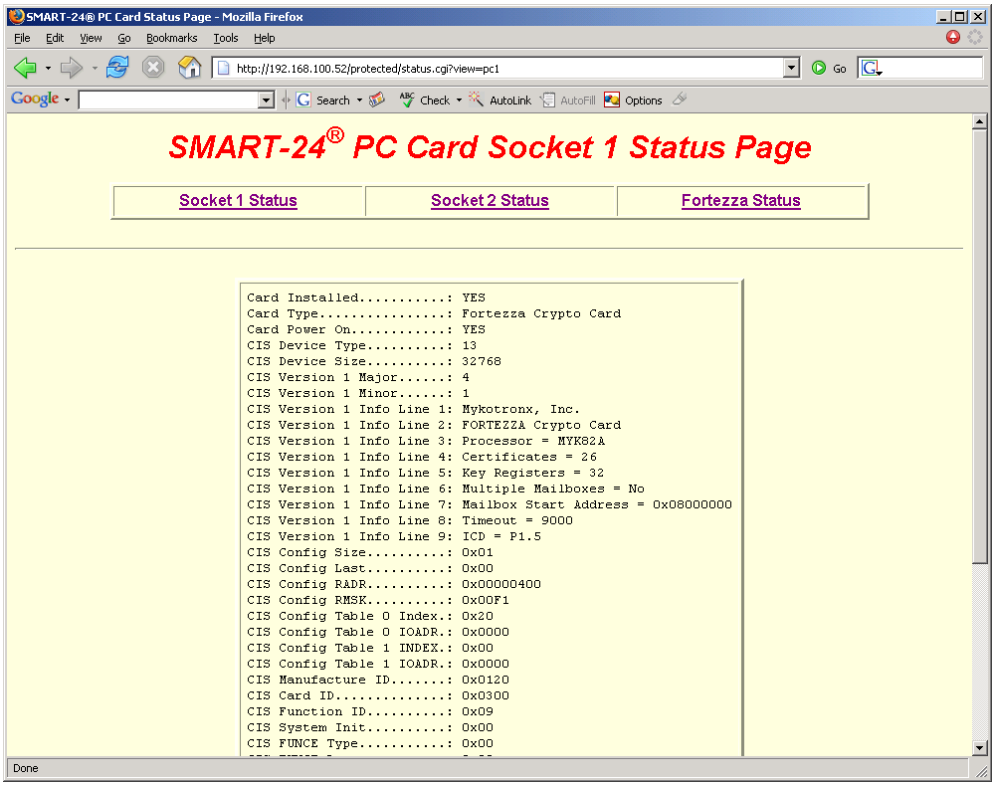
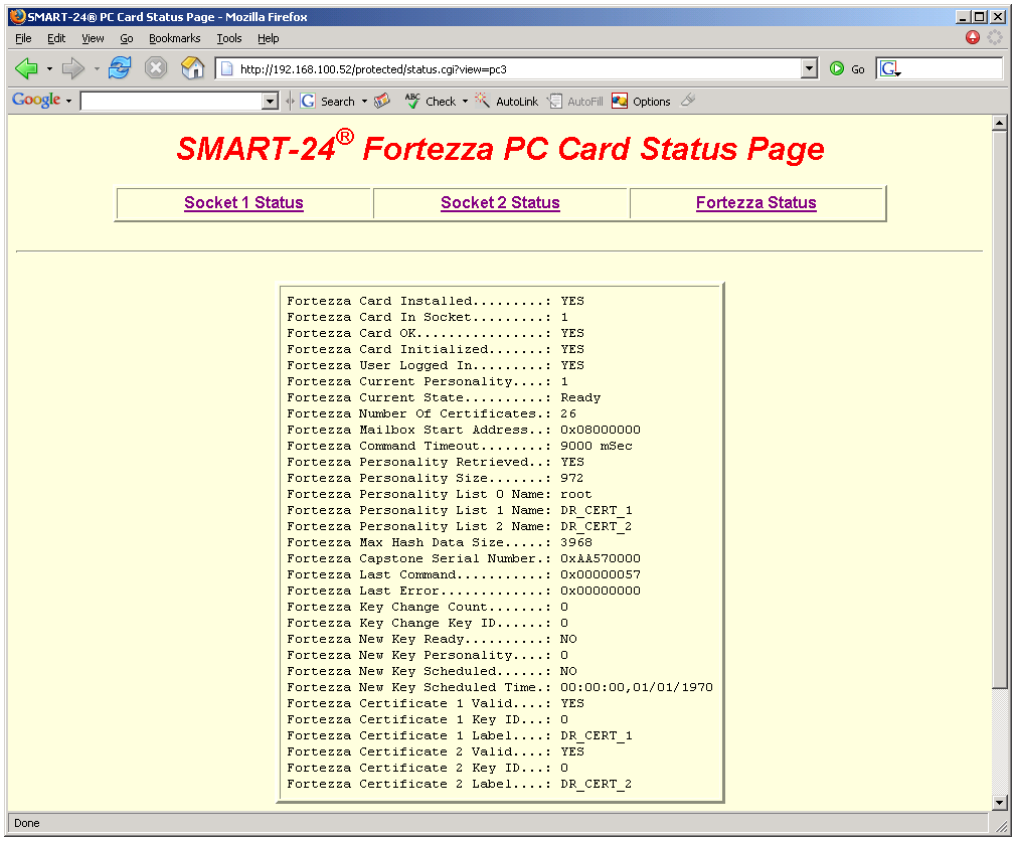
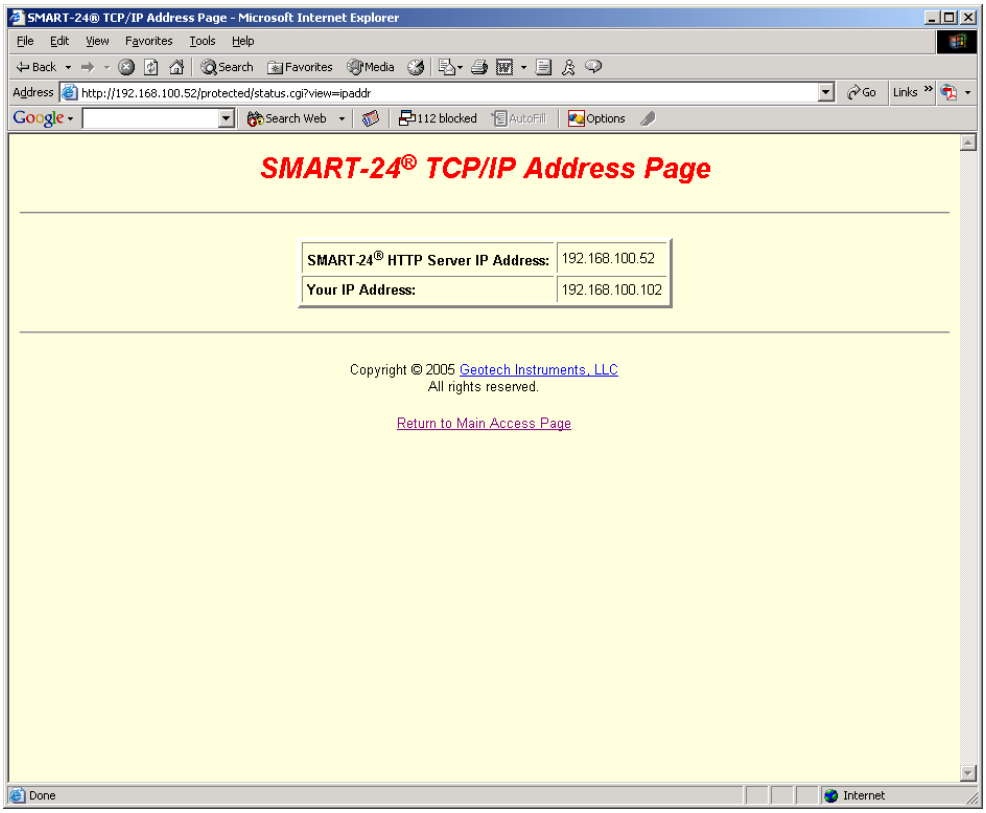
Return to Main Access Page
Done
Internet


SMART-24® PC Card Status Page - Mozilla Firefox
http://192.168.100.52/protected/status.cgi?view=pc1
SMART-24® PC Card Socket 1 Status Page
Socket 1 Status
Socket 2 Status
Fortezza Status
Card Installed.....: YES
Card Type.....: Fortezza Crypto Card
Card Power On.....: YES
CIS Device Type.....: 13
CIS Device Size.....: 32768
CIS Version 1 Major.....: 4
CIS Version 1 Minor.....: 1
CIS Version 1 Info Line 1: Mykotronx, Inc.
CIS Version 1 Info Line 2: FORTEZZA Crypto Card
CIS Version 1 Info Line 3: Processor = MYK82A
CIS Version 1 Info Line 4: Certificates = 26
CIS Version 1 Info Line 5: Key Registers = 32
CIS Version 1 Info Line 6: Multiple Mailboxes = No
CIS Version 1 Info Line 7: Mailbox Start Address = 0x08000000
CIS Version 1 Info Line 8: Timeout = 9000
CIS Version 1 Info Line 9: ICD = P1.5
CIS Config Size.....: 0x01
CIS Config Last.....: 0x00
CIS Config RADR.....: 0x00000400
CIS Config RMSK.....: 0x00F1
CIS Config Table 0 Index.: 0x20
CIS Config Table 0 IOADR.: 0x0000
CIS Config Table 1 INDEX.: 0x00
CIS Config Table 1 IOADR.: 0x0000
CIS Manufacture ID.....: 0x0120
CIS Card ID.....: 0x0300
CIS Function ID.....: 0x09
CIS System Init.....: 0x00
CIS FUNCE Type.....: 0x00
Done


SMART-24® PC Card Status Page - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://192.168.100.52/protected/status.cgi?view=pc3
Google Search Check AutoLink AutoFill Options
SMART-24® Fortezza PC Card Status Page
Socket 1 Status
Socket 2 Status
Fortezza Status
Fortezza Card Installed.....: YES
Fortezza Card In Socket.....: 1
Fortezza Card OK.....: YES
Fortezza Card Initialized.....: YES
Fortezza User Logged In.....: YES
Fortezza Current Personality....: 1
Fortezza Current State.....: Ready
Fortezza Number Of Certificates.: 26
Fortezza Mailbox Start Address..: 0x08000000
Fortezza Command Timeout.....: 9000 mSec
Fortezza Personality Retrieved..: YES
Fortezza Personality Size.....: 972
Fortezza Personality List 0 Name: root
Fortezza Personality List 1 Name: DR_CERT_1
Fortezza Personality List 2 Name: DR_CERT_2
Fortezza Max Hash Data Size.....: 3968
Fortezza Capstone Serial Number.: 0xAA570000
Fortezza Last Command.....: 0x00000057
Fortezza Last Error.....: 0x00000000
Fortezza Key Change Count.....: 0
Fortezza Key Change Key ID.....: 0
Fortezza New Key Ready.....: NO
Fortezza New Key Personality....: 0
Fortezza New Key Scheduled.....: NO
Fortezza New Key Scheduled Time.: 00:00:00,01/01/1970
Fortezza Certificate 1 Valid....: YES
Fortezza Certificate 1 Key ID...: 0
Fortezza Certificate 1 Label....: DR_CERT_1
Fortezza Certificate 2 Valid....: YES
Fortezza Certificate 2 Key ID...: 0
Fortezza Certificate 2 Label....: DR_CERT_2
Done


SMART-24® TCP/IP Address Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://192.168.100.52/protected/status.cgi?view=ipaddr
Go Links
Google Search Web 112 blocked AutoFill Options
SMART-24® TCP/IP Address Page
SMART-24® HTTP Server IP Address: 192.168.100.52
Your IP Address: 192.168.100.102
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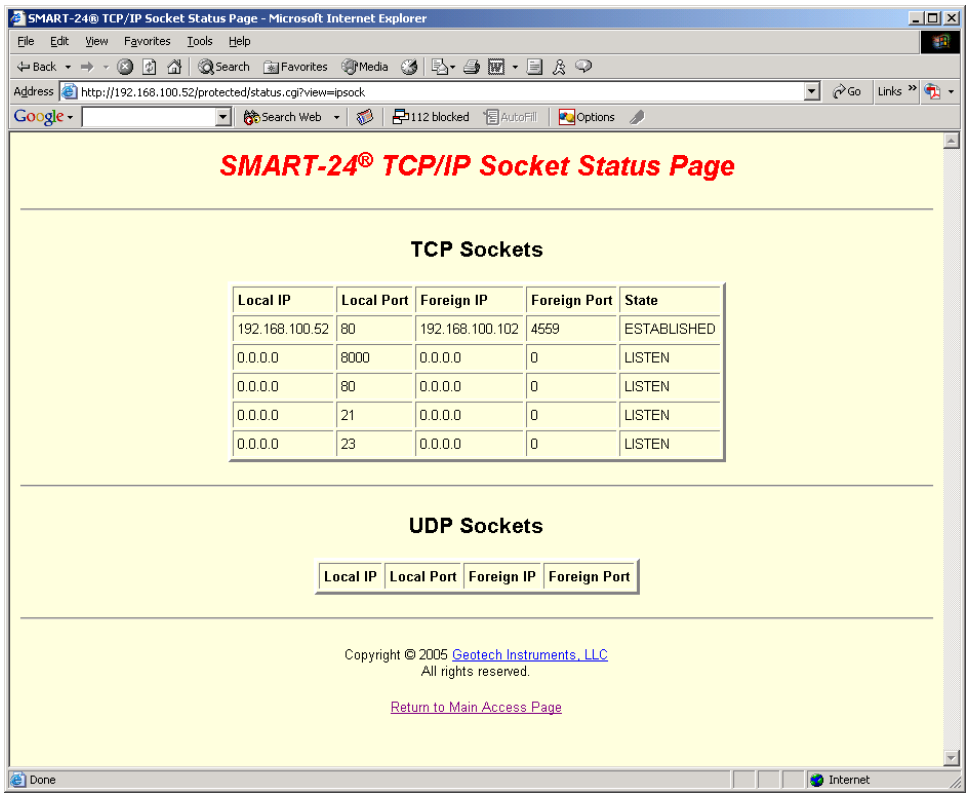
Return to Main Access Page
Done
Internet


SMART-24® TCP/IP Socket Status Page
TCP Sockets
Local IP | Local Port | Foreign IP | Foreign Port | State
192.168.100.52 | 80 | 192.168.100.102 | 4559 | ESTABLISHED
0.0.0.0 | 8000 | 0.0.0.0 | 0 | LISTEN
0.0.0.0 | 80 | 0.0.0.0 | 0 | LISTEN
0.0.0.0 | 21 | 0.0.0.0 | 0 | LISTEN
0.0.0.0 | 23 | 0.0.0.0 | 0 | LISTEN
UDP Sockets
Local IP | Local Port | Foreign IP | Foreign Port
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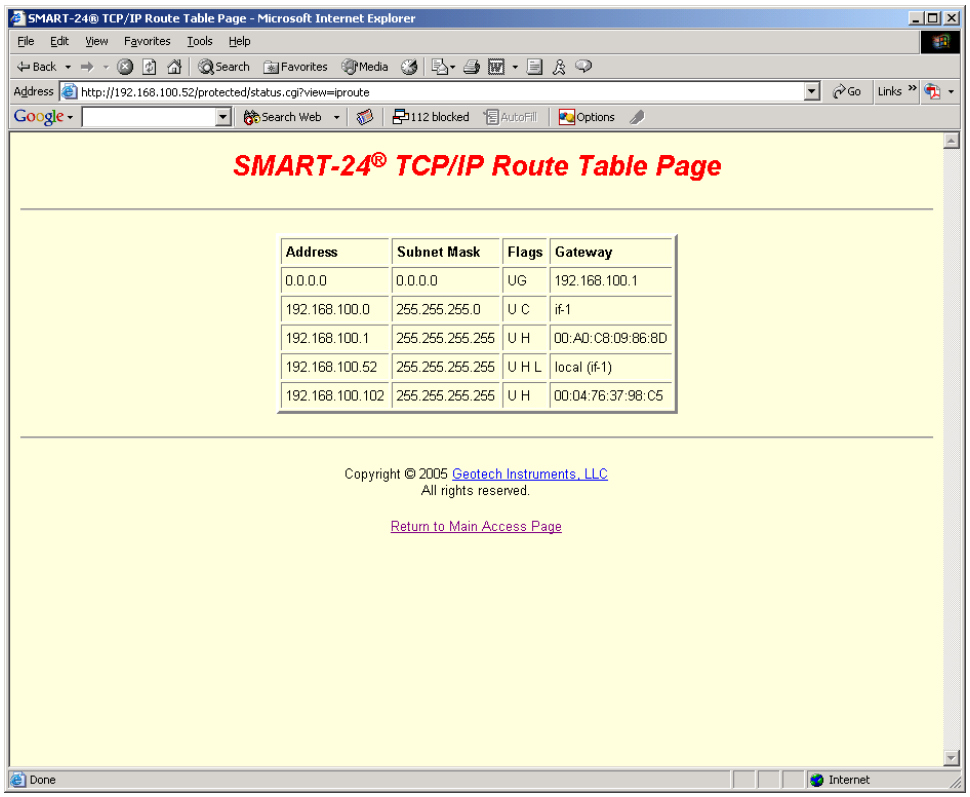
Return to Main Access Page


SMART-24® TCP/IP Route Table Page
Address | Subnet Mask | Flags | Gateway
0.0.0.0 | 0.0.0.0 | UG | 192.168.100.1
192.168.100.0 | 255.255.255.0 | U C | if-1
192.168.100.1 | 255.255.255.255 | U H | 00:A0:C8:09:86:8D
192.168.100.52 | 255.255.255.255 | U H L | local (if-1)
192.168.100.102 | 255.255.255.255 | U H | 00:04:76:37:98:C5
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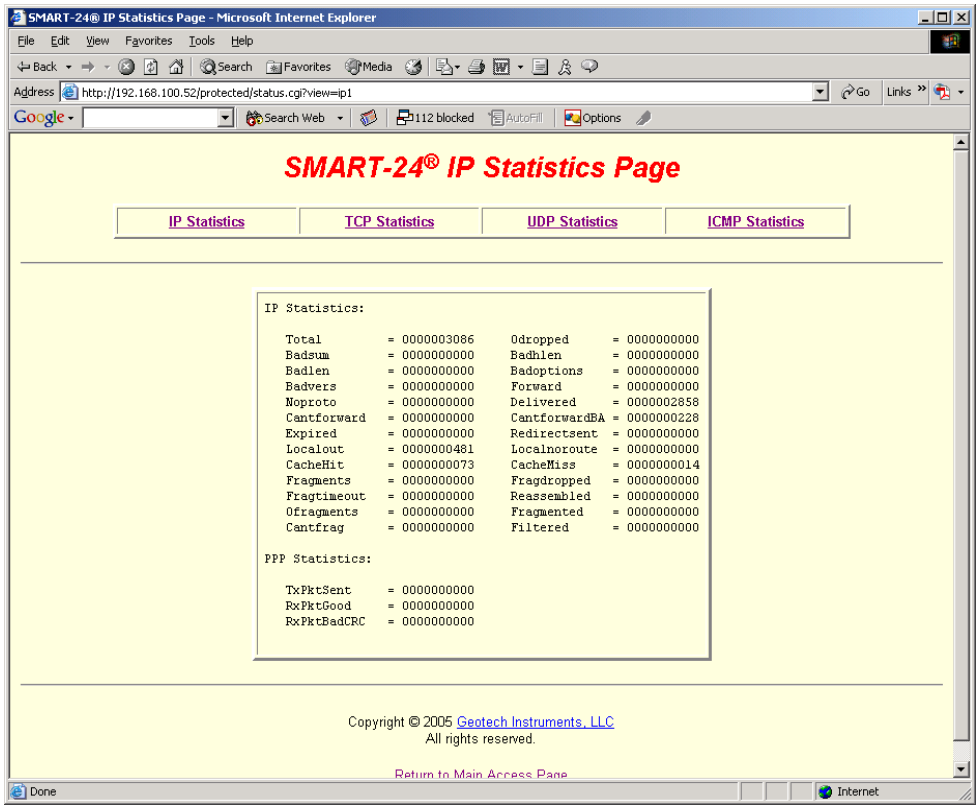
Return to Main Access Page


SMART-24® IP Statistics Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=ip1
SMART-24® IP Statistics Page
IP Statistics
TCP Statistics
UDP Statistics
ICMP Statistics
IP Statistics:
Total = 0000003086 0dropped = 0000000000
Badsum = 0000000000 Badhlen = 0000000000
Badlen = 0000000000 Badoptions = 0000000000
Badvers = 0000000000 Forward = 0000000000
Noproto = 0000000000 Delivered = 0000002858
Cantforward = 0000000000 CantforwardBA = 0000000228
Expired = 0000000000 Redirectsent = 0000000000
Localout = 0000000481 Localnoroute = 0000000000
CacheHit = 0000000073 CacheMiss = 0000000014
Fragments = 0000000000 Fragdropped = 0000000000
Fragtimeout = 0000000000 Reassembled = 0000000000
Ofragments = 0000000000 Fragmented = 0000000000
Cantfrag = 0000000000 Filtered = 0000000000
PPP Statistics:
TxPktSent = 0000000000
RxPktGood = 0000000000
RxPktBadCRC = 0000000000
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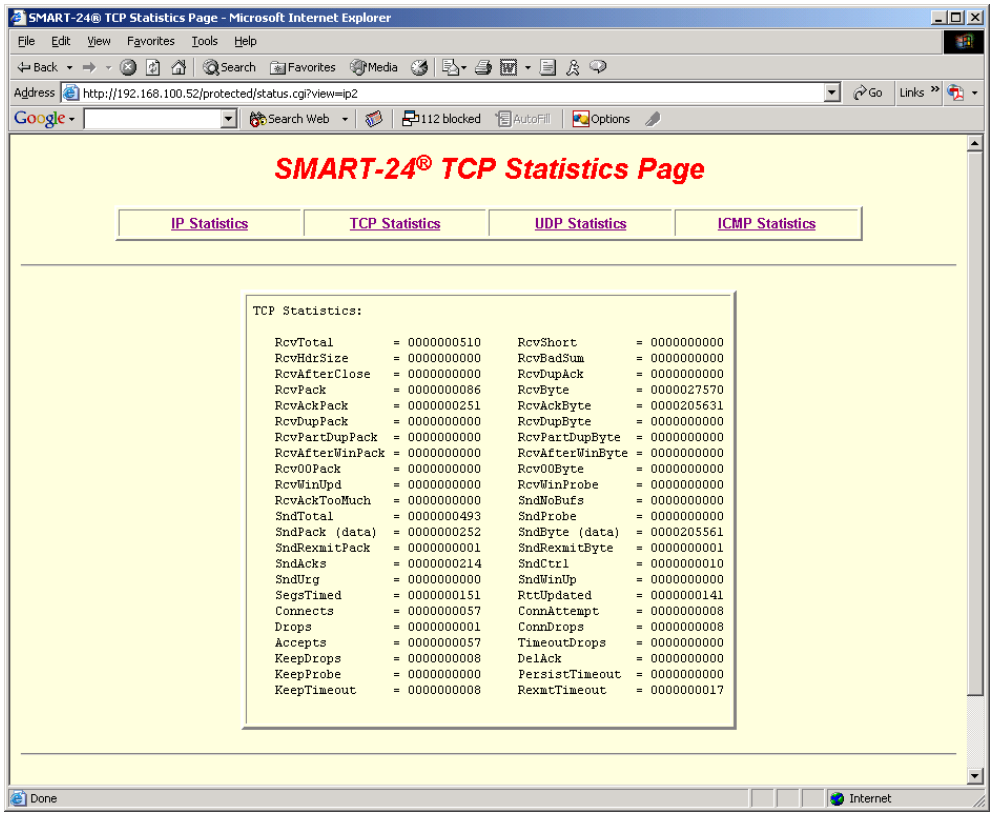
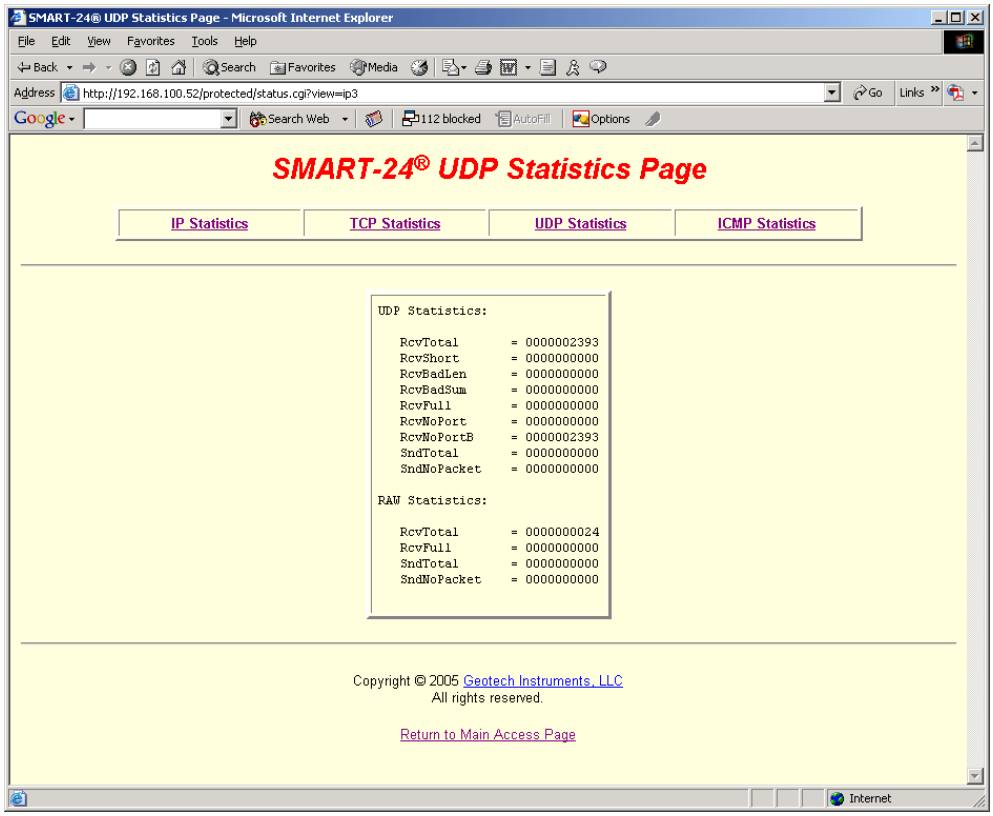
Return to Main Access Page
Done
Internet


SMART-24® TCP Statistics Page - Microsoft Internet Explorer
http://192.168.100.52/protected/status.cgi?view=ip2
SMART-24® TCP Statistics Page
IP Statistics
TCP Statistics
UDP Statistics
ICMP Statistics
TCP Statistics:
RcvTotal = 0000000510 RcvShort = 0000000000
RcvHdrSize = 0000000000 RcvBadSum = 0000000000
RcvAfterClose = 0000000000 RcvDupAck = 0000000000
RcvPack = 0000000086 RcvByte = 0000027570
RcvAckPack = 0000000251 RcvAckByte = 0000205631
RcvDupPack = 0000000000 RcvDupByte = 0000000000
RcvPartDupPack = 0000000000 RcvPartDupByte = 0000000000
RcvAfterWinPack = 0000000000 RcvAfterWinByte = 0000000000
Rcv00Pack = 0000000000 Rcv00Byte = 0000000000
RcvWinUpd = 0000000000 RcvWinProbe = 0000000000
RcvAckTooMuch = 0000000000 SndNoBufs = 0000000000
SndTotal = 0000000493 SndProbe = 0000000000
SndPack (data) = 0000000252 SndByte (data) = 0000205561
SndRexmitPack = 0000000001 SndRexmitByte = 0000000001
SndAcks = 0000000214 SndCtrl = 0000000010
SndUrg = 0000000000 SndWinUp = 0000000000
SegsTimed = 0000000151 RttUpdated = 0000000141
Connects = 0000000057 ConnAttempt = 0000000008
Drops = 0000000001 ConnDrops = 0000000008
Accepts = 0000000057 TimeoutDrops = 0000000000
KeepDrops = 0000000008 DelAck = 0000000000
KeepProbe = 0000000000 PersistTimeout = 0000000000
KeepTimeout = 0000000008 RexmtTimeout = 0000000017
Done
Internet


SMART-24® UDP Statistics Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://192.168.100.52/protected/status.cgi?view=ip3
SMART-24® UDP Statistics Page
IP Statistics
TCP Statistics
UDP Statistics
ICMP Statistics
UDP Statistics:
RcvTotal = 0000002393
RcvShort = 0000000000
RcvBadLen = 0000000000
RcvBadSum = 0000000000
RcvFull = 0000000000
RcvNoPort = 0000000000
RcvNoPortB = 0000002393
SndTotal = 0000000000
SndNoPacket = 0000000000
RAW Statistics:
RcvTotal = 0000000024
RcvFull = 0000000000
SndTotal = 0000000000
SndNoPacket = 0000000000
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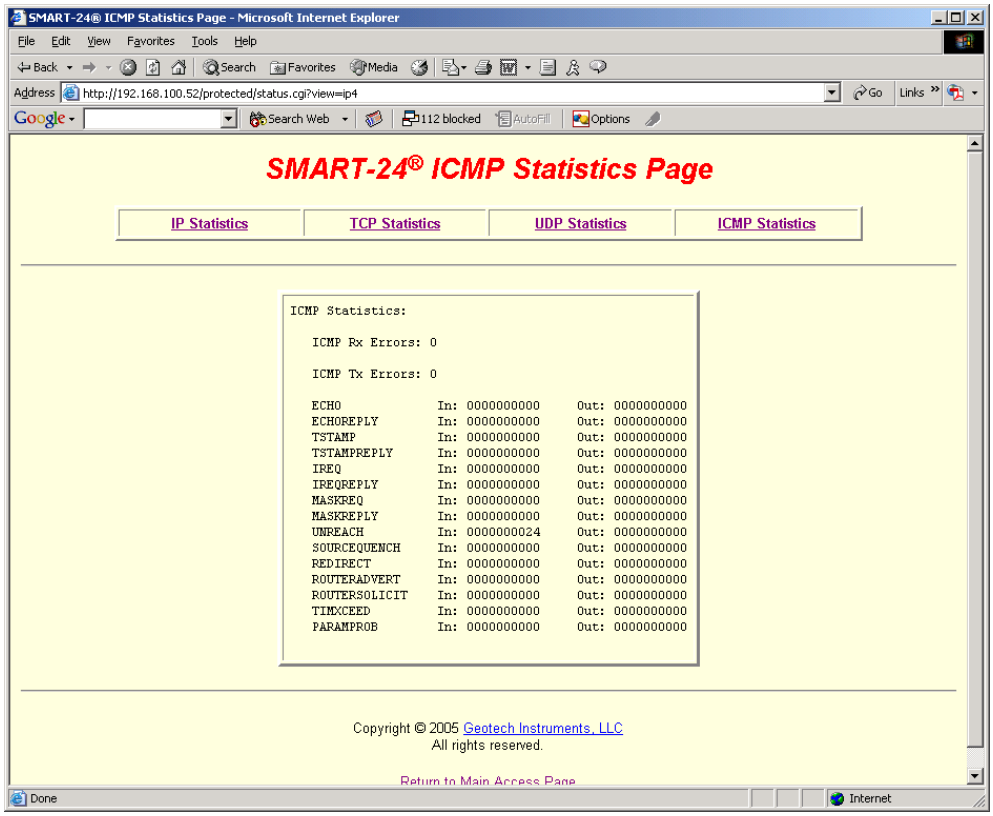
Return to Main Access Page
Internet


SMART-24® ICMP Statistics Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://192.168.100.52/protected/status.cgi?view=ip4
SMART-24® ICMP Statistics Page
IP Statistics
TCP Statistics
UDP Statistics
ICMP Statistics
ICMP Statistics:
ICMP Rx Errors: 0
ICMP Tx Errors: 0
ECHO In: 0000000000 Out: 0000000000
ECHOREPLY In: 0000000000 Out: 0000000000
TSTAMP In: 0000000000 Out: 0000000000
TSTAMPREPLY In: 0000000000 Out: 0000000000
IREQ In: 0000000000 Out: 0000000000
IREQREPLY In: 0000000000 Out: 0000000000
MASKREQ In: 0000000000 Out: 0000000000
MASKREPLY In: 0000000000 Out: 0000000000
UNREACH In: 0000000024 Out: 0000000000
SOURCEQUENCH In: 0000000000 Out: 0000000000
REDIRECT In: 0000000000 Out: 0000000000
ROUTERADVERT In: 0000000000 Out: 0000000000
ROUTERSOLICIT In: 0000000000 Out: 0000000000
TIMXCEED In: 0000000000 Out: 0000000000
PARAMPROB In: 0000000000 Out: 0000000000
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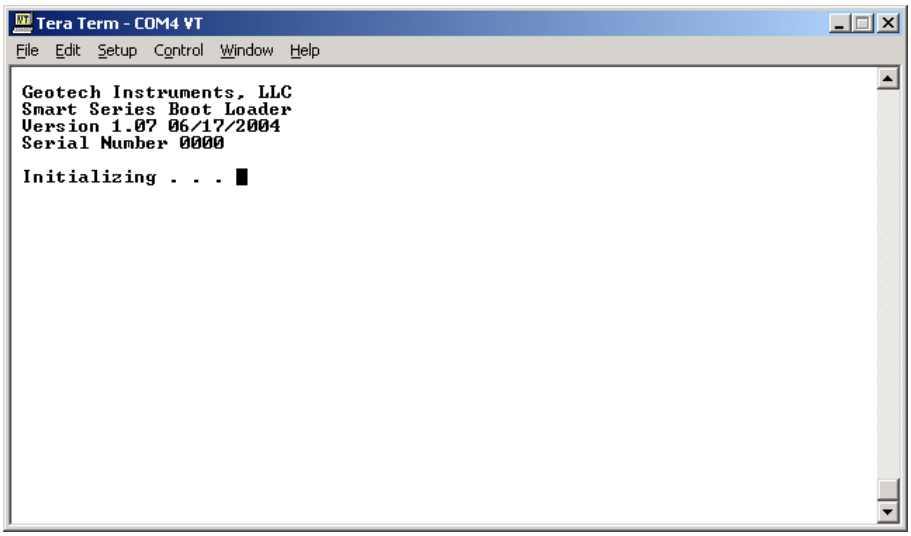
Return to Main Access Page
Done
Internet

4.6 BOOTLOADER OPERATION

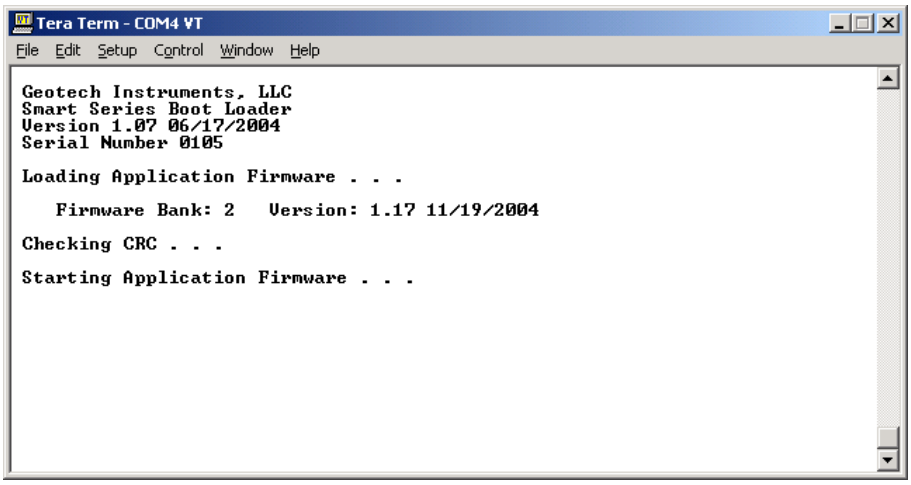
The SMART-24 Series instruments contain a Bootloader program that controls the initial boot sequence of the unit.

4.6.1 Power Up and Reset

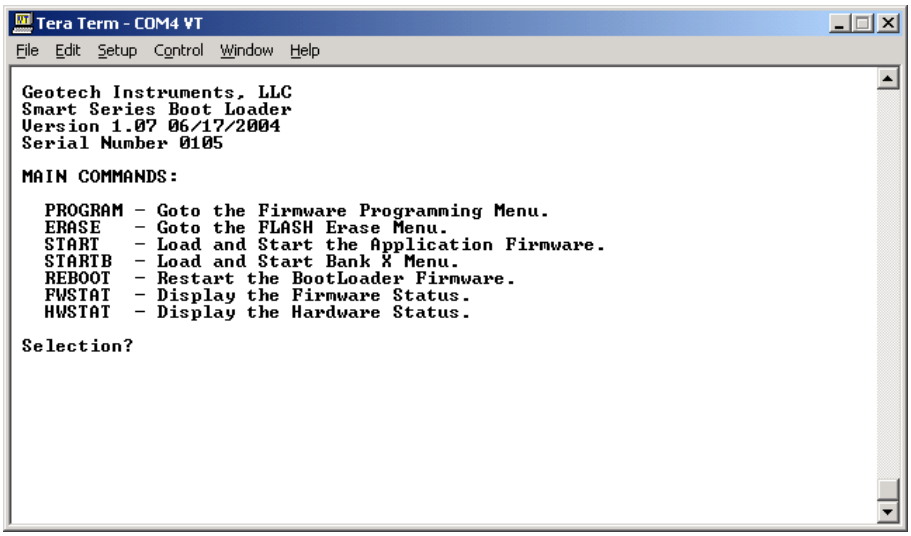
On power up or reset, the Bootloader program initializes the unit's hardware as shown in the following screen capture (this is the output of either of the unit's two I/O serial ports as viewed by a terminal program running on a PC).



After initialization, the Bootloader program checks the contents of the unit's FLASH memory to find application code that it can execute. The SMART-24 Series instruments contain three 4Mb FLASH banks to store application code. Each bank can contain a copy of the application code (usually different versions). The Bootloader looks for the newest version that passes a CRC check and copies it into the unit's main memory for execution. The following screen capture shows a successful boot of the application code.



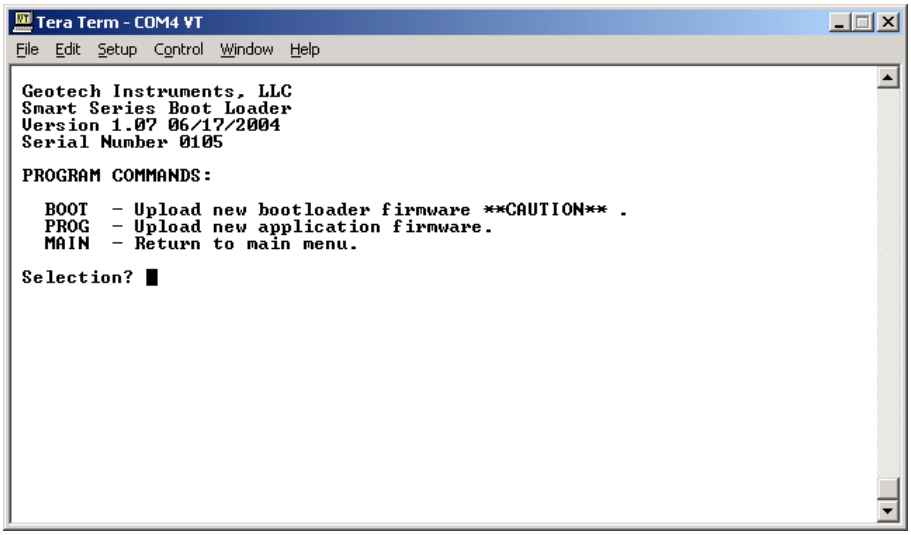
If this copy fails to load and run, the Bootloader program then falls back to the next newest application code copy it can find. If no valid application code is found, the Bootloader then goes into the Bootloader command menu mode as shown below. The Bootloader program can also be forced into the command menu mode if the USER button on the unit's front panel is pressed and held during the boot process until the Bootloader command menu appears (or '**BOOTLOADER**' is displayed on the LCD display).



Note that when in the command menu mode, if there is no user input for 1-hour period of time, the Bootloader will time out and start the application code if available. This prevents the unit from staying in the Bootloader forever if the user forgets to restart the unit.

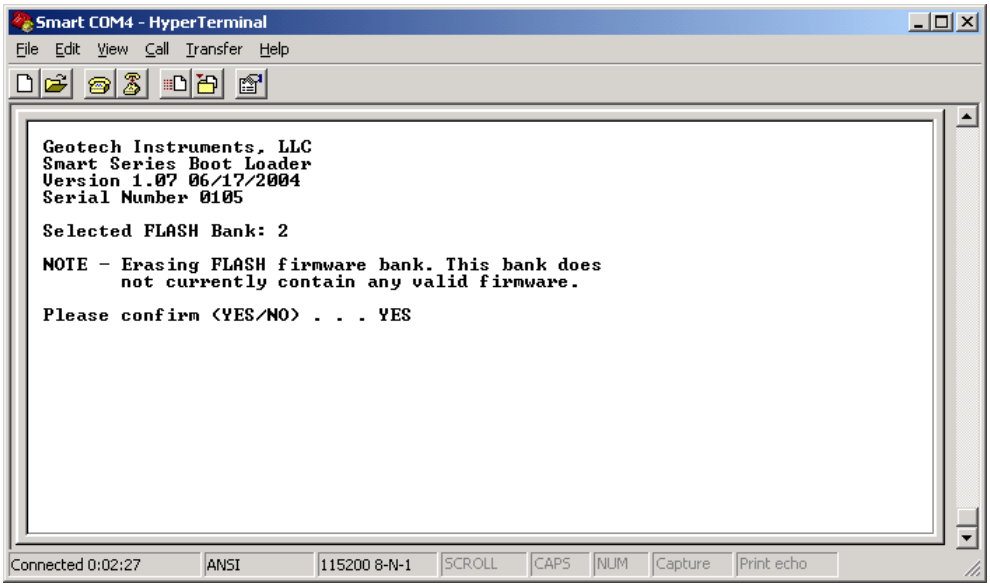
4.6.2 Main Command Menu - PROGRAM

From the Main Command Menu, the 'PROGRAM' command allows the user to write new Bootloader and application firmware to the unit's FLASH memory. When entered, the following Program Command Menu appears.

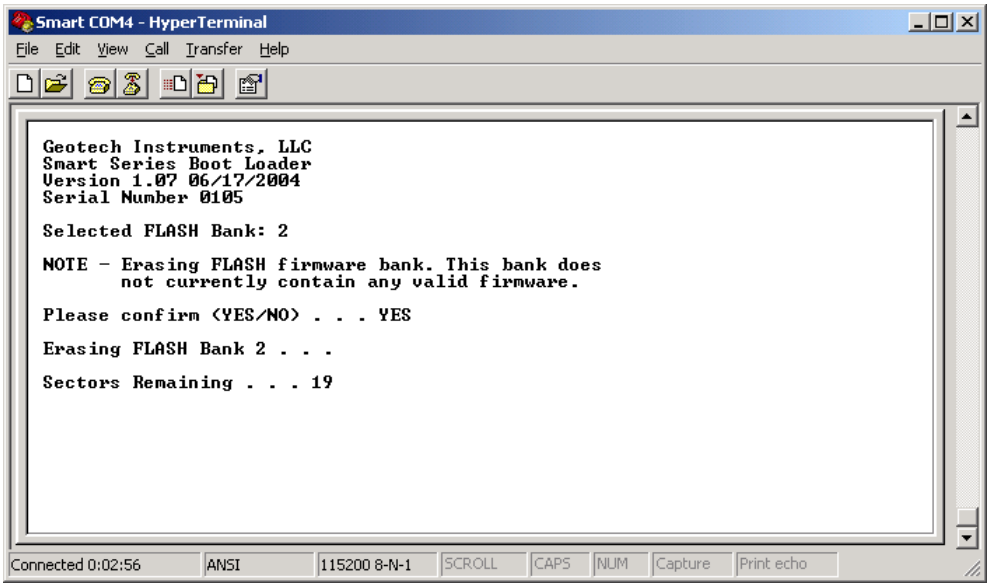


The 'BOOT' command allows new Bootloader firmware to be written to the FLASH memory. ***This command should NOT be used unless specifically directed and guided by Geotech support personnel! The unit may be rendered inoperable if improperly used!***

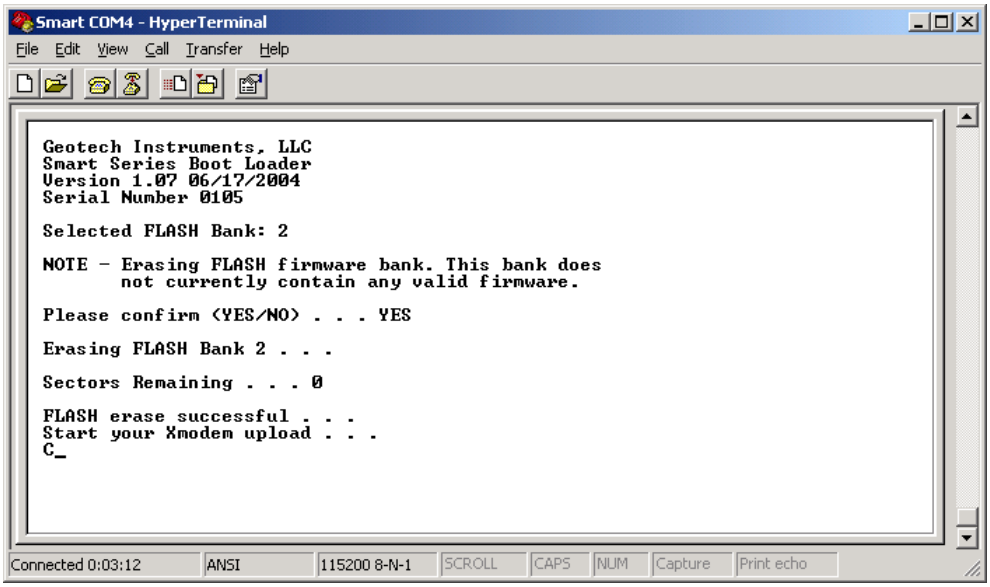
The 'PROG' command allows new application firmware to be written to the FLASH memory. When used, the following screen appears.



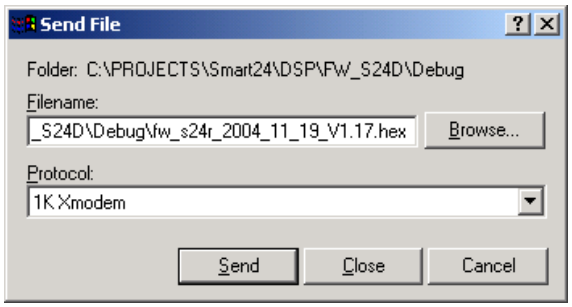
The Bootloader automatically selects an unused bank or the bank with the oldest application firmware in it to erase and program. The user is asked to confirm this before erasing the FLASH bank. Note that even if the bank is empty, the Bootloader will erase it just to be sure all bits are eased to a 1 condition. The erase process is shown in the following screen capture.



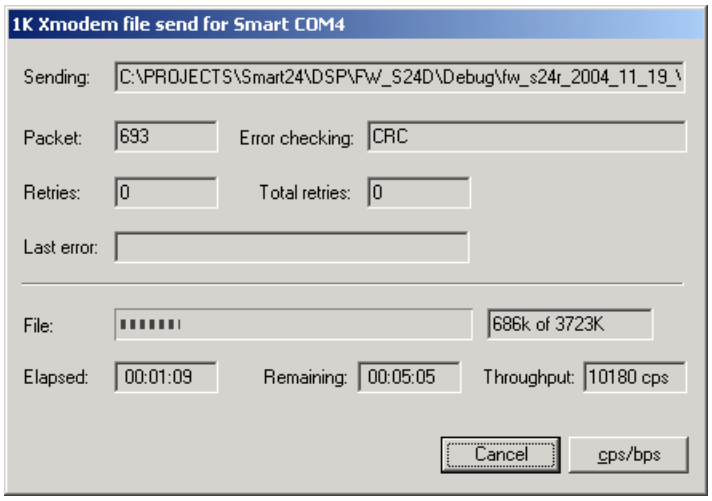
After erasure, the Bootloader will request that the user start the upload process as shown in the following screen capture. The user must wait unit the 'C' prompt is displayed before starting the transfer.



The Bootloader uses 1K Xmodem as the protocol to upload the HEX file containing the new application firmware code. HyperTerminal (supplied with Windows) supports this option and can be used for this purpose. The user selects 'Transfer' then 'Send File...' to start the transfer as shown below. Select the HEX file to send, set the Protocol to 1K Xmodem and click on the Send button.

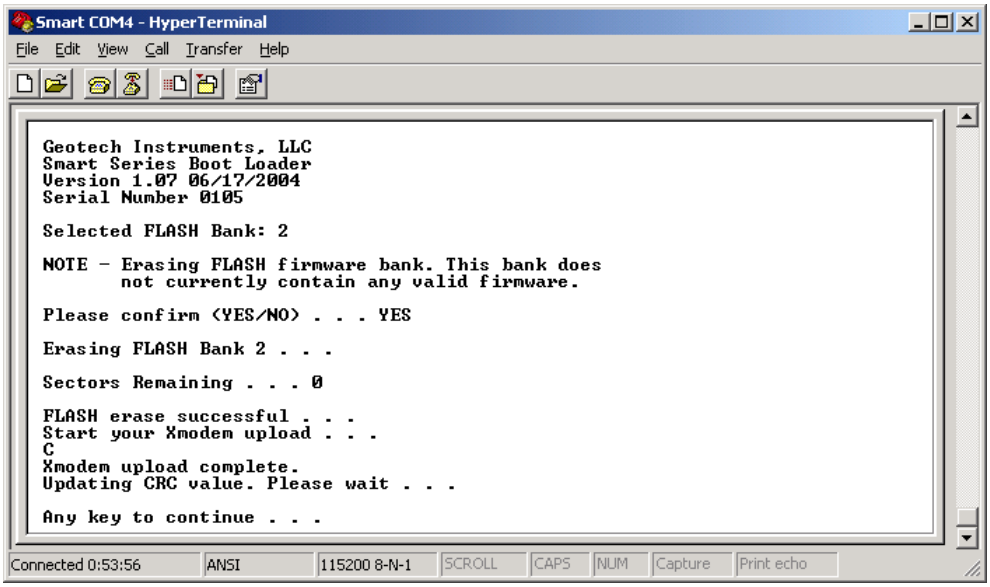


HyperTerminal will then display the transfer status as shown.



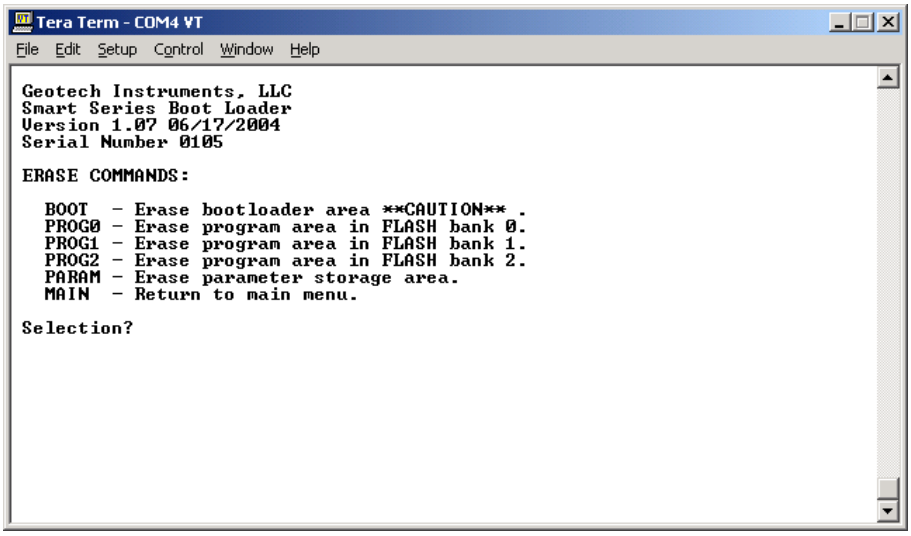
When the file transfer has finished, the Bootloader will update the CRC check value and the update procedure is complete. The user can reboot the unit or continue using the Bootloader menus as required.

Note also that when the application firmware is running, the user can update the application code using FTP and Telnet either locally or remotely without the need to use the Bootloader. The Bootloader provides more options in erasing and programming the FLASH memory.



4.6.3 Main Command Menu - ERASE

From the Main Command Menu, the 'ERASE' command allows the user to erase various parts of the FLASH memory. When entered, the following Erase Command Menu appears.



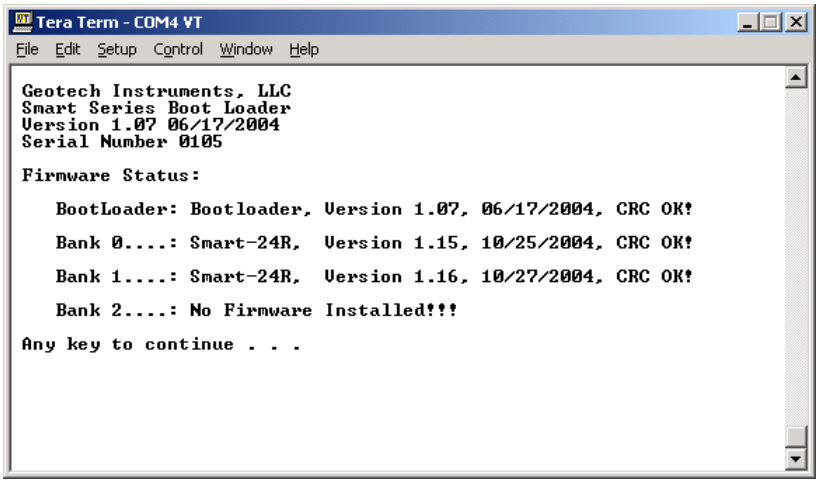
The 'BOOT' command allows the section of the FLASH memory that contains the Bootloader firmware to be erased. ***This command should NOT be used unless specifically directed and guided by Geotech support personnel! The unit may be rendered inoperable if improperly used!***

The 'PROG0', 'PROG1' and 'PROG2' command allows the three application firmware FLASH banks to be erased. The user will be asked to confirm this selection when used. Note that in the Bootloader references the FLASH banks as bank 0, 1 and 2. The application firmware references the FLASH banks as bank 1, 2 and 3 where Bootloader bank 0 corresponds to application firmware bank 1, etc.

The 'PARAM' command allows the setup parameter storage FLASH area to be erased. When used, this will clear all setup parameter back to the factory defaults. The user will be asked to confirm this selection when used.

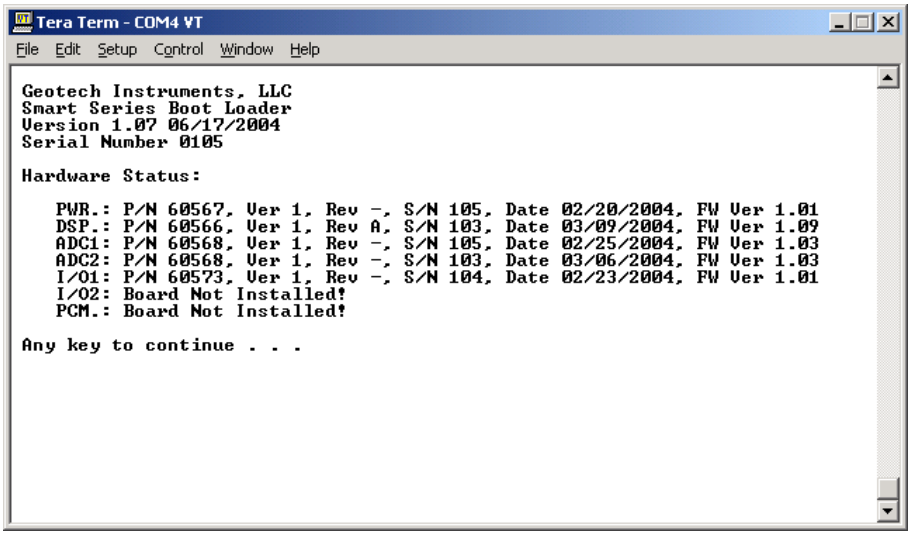
4.6.4 Main Command Menu - FWSTAT

From the Main Command Menu, the 'FWSTAT' command allows the user to view the status of the firmware stored in the FLASH memory. When entered, a display similar to the following screen should appear showing the status of the Bootloader and application firmware FLASH banks.



4.6.5 Main Command Menu - HWSTAT

From the Main Command Menu, the 'HWSTAT' command allows the user to view the status of the hardware installed in the SMART-24 Series instrument. When entered, a display similar to the following screen should appear showing the hardware status of the unit.



4.7 APPLICATION FIRMWARE OPERATION

The following sections give a general overview and operational characteristics of the major functions provided by the application firmware.

4.7.1 GPS

The SMART-24 Series instruments can be time synchronized to Geotech's GPS-3 time reference. The user can control the on/off cycle time of the receiver to reduce power requirements or it can be left powered on all the time to maintain the best timing accuracy. The unit also receives, stores and reports location information (latitude, longitude and altitude) from the GPS-3 receiver.

4.7.2 ADC

The SMART-24 Series instruments provide up to six channels of high resolution 24-bit data at sample rates from 1 to 2000 samples per second. The unit can provide up to six primary rate 24-bit channels (c1p, c2p, c3p, c4p, c5p & c6p), six secondary rate 24-bit channels (c1s, c2s, c3s, c4s, c5s & c6s all derived by digital filtering and decimation from the primary rate channels), two auxiliary I/O 12-bit channels (c1a & c2a) and six mass position 12-bit channels (c1m, c2m, c3m, c4m, c5m & c6m). This is a total of 20 possible real time and recording channels. All 12-bit channels are fixed at 10 samples per second only.

Data is internally buffered for up to 12 hours (depending on sample rate) to provide data backfill in a LIFO manner in case of communications dropouts in the real time data transmission.

The calibrated LSB bit weight for the 24-bit ADC channels is stored on the ADC boards at manufacturing time. On power up, these values are reported to the application firmware. The 5Vpp-calibrated values are reported in the log file messages during startup. To get the true LSB value for a channel, the 5Vpp LSB values are multiplied by the front-end gain factor (as set by the SFG command for each channel). The front-end gain factor corrected LSB values are recorded in the data files and reported in the header files. The following table gives the nominal (non-calibrated) LSB values and front-end gain factors for a typical unit for reference.

Input	5Vpp LSB Value (V/count)	Front-end Gain Factor	Corrected LSB Value (V/count)
5Vpp	0.408887×10^{-6}	1.0	0.408887×10^{-6}
20Vpp	0.408887×10^{-6}	4.0	1.635548×10^{-6}
40Vpp	0.408887×10^{-6}	8.0	3.271096×10^{-6}

The nominal LSB bit weight for the 12-bit ADC channels is 4.917535×10^{-3} volts/count.

4.7.3 Serial Ports

Two external serial ports are provided on the SMART-24 Series instruments. These serial ports support baud rates up to 115200 baud and either RS232 (default) or RS422 interface signals. The serial ports are used to communicate with the unit in either a low level ASCII command mode or TCP/IP over a PPP connection. The serial port operation is more fully described in section 4.3.

4.7.4 TCP/IP Stack

The SMART-24 Series instruments firmware provides a full featured commercial TCP/IP stack that handles TCP/IP communication over either the serial ports (using PPP) or the optional 10/100Base-T Ethernet board. The TCP/IP stack is more fully described in section 4.5.

4.7.5 CD-1.1 Real Time Data Servers

Four CD-1.1 real time data servers are provided by a SMART-24 Series instrument. Each of these can be configured independently to send data streams to four different destinations, as continous data, event triggered data, or both. See section 4.5.4 for further details.

4.7.6 CD-1.1 Command Server

The SMART-24 Series instruments provide a CD-1.1 based command and response server. This server allows for external TCP/IP connections to a unit to provide a command and status interface based upon the CD-1.1 protocol. See section 4.5.4 for further details.

4.7.7 State of Health

Each SMART-24 Series instrument collects a variety of state of health (SOH) information from all internal boards and GPS receiver. This SOH information is sampled once per second and buffered along with the other collected data. It can be sent in real time to the SMARTServer, retrieved on command by SMART24Config or accessed from the SMART-24 instrument Web pages via the Web browser .

The SMART-24 Series instrument also acquires a subset of channel status information and sends it in real time contained in the channel status field of the CD1.1 Data Format Frame. This Format Frame is described in the IDC Documentation "Formats and Protocols for Continuous Data CD-1.1, 3.4.3 Revison 0.3". The following table gives the list of channel status field elements provided as part of the CD1.1 frame.

Field	Format	Description
Channel status	8-byte ASCII	Data and station status as follows.
	Byte 1	Format of channel status field, 1 = this format
	Byte 2	Data status byte: Bit 2 1 = zeroed data Bit 3 1 = clipped Bit 4 1 = calibration underway Bits 1, 5-8 future use
	Byte 3	Channel security byte: Bit 1 1 = equipment housing open Bit 2 1 = digitizing equipment open Bit 3 1 = vault door opened Bit 4 1 = authentication seal broken Bits 5-8 future use Bits 2 and 4 are tied together
	Byte 4	Miscellaneous status byte: Bit 1 1 = clock unlocked Bit 2 1 = GPS receiver off Bit 3 1 = GPS receiver unlocked Bit 4 1 = digitizer analog input shorted Bit 5 1 = digitizer calibration loop back Bits 6-8 future use
	Bytes 5-8	Future use
	20-byte ASCII	Time of last GPS synchronization
	IEEE integer	Clock differential in seconds

4.7.8 Calibration

The SMART-24 Series instruments provide a calibration circuit that can be used to generate various analog calibration signals. These signals can be driven to the sensor or looped back internally for self test. For a SMART-24R® or SMART-24A®, a file will be recorded of the calibration session. Two types of calibrations are provided; immediate or scheduled. In the immediate mode, the calibration is executed asynchronously as soon as the command is received. In the scheduled mode, the calibration is executed on a periodic schedule as defined by the user. See the calibration commands in Appendix C or the SMART24Config documentation for full details on the calibration parameters.

4.7.9 Commands

The SMART-24 Series instruments executes commands received via the low level ASCII commands (as described in Appendix C using the serial ports or a Telnet connection) or via the CD-1.1 command server (using SMART24Config). See the SMART Series Command & Setup Protocol in Appendix C or the SMART24Config documentation for full details.

4.7.10 Disk Drives

The SMART-24 Series instruments provide FAT compatible disk drives for data file recording as described in the following sections. Each is either partitioned as FAT16 or FAT32 and are directly compatible with MS-DOS/Windows PC operating systems. Drives that are less than 2 GB in size should be partitioned as FAT16 to improve system performance. Drives larger than 2 GB must be partitioned as FAT32 in a single partition. The firmware does support two partitions or logical drives on a single disk drive.

4.7.10.1 Drive A

Drive A is an internal RAM based virtual drive (RAMDISK) that provides very fast temporary storage for data as it is recorded in real time. The size of drive A is 64MB and it is volatile (its contents will be lost when power is turned off). At power up, drive A is created as a FAT16 partition and formatted. Note that software or hardware resets (without turning power off) preserve the contents of drive A.

Drive A is available in all SMART-24 Series instrument types. In the case of the SMART-24D® it is only used to record log and SOH files for the user. It is also used for uploading new firmware HEX files when doing remote updates.

Initially all data, header, log and SOH files are written to drive A in real time. At some point it time, the unit is triggered to move the files to the final destination drive (B, C or D). This move trigger point is programmable and can occur as follows:

- Once per day at midnight (minimum).

- On user request by pressing and holding the USER button on the front panel for more than 2 seconds.

- On user software command ('DMI' command).

- At a programmable percent of drive A full value. Using the 'DMF' command, the user can specify the percent of drive A (from 10% to 80% full) at which to automatically start the file move process. The default is 80% full. Note that a low sample rates and with 64MB of drive A space, it could take several hours for data to fill drive A to 80% full.

- At a programmable time interval. Using the 'DMT' command, the user can specify the time interval between moves (in the range of 0 to 1439 minutes) at which to automatically start the file move process. The default is 0 (disabled). For example if 60 was entered, a file move attempt will occur once and hour, on the hour.

New data files will not appear on the destination drives until one of these file move events occur. Once moved, the data files are deleted from drive A to make room for new data files. ***Note that the removable drive D should not be removed from the unit while a file move is in progress to prevent possible drive corruption!***

When moving data files, the unit first attempts to move the file to the designated target drive for the file type being moved. If the file cannot be moved to this drive for any reason, the unit then attempts to find any other available drive in the unit to move the file to for permanent storage. It searches for available drives in the following order; target drive, D, C then B.

The user must make a trade off decision between power consumption (turning the destination drives on more often to move files) and data safety (data could be lost if power is removed and files have not been moved yet) in setting up the file move strategy.

The directory structure used for drive A is given in section 4.7.12.2.

4.7.10.2 Drive B

Drive B (if installed in the unit) is an internal PCMCIA based drive. This could be any type of ATA compatible PCMCIA (rotating or FLASH) or CompactFlash format drive cards. This drive is power controlled such that its power is turned off when not moving files to it. This drive is only available and used on SMART-24R® and SMART-24A® type instruments. The directory structure used for drive B is given in section 4.7.12.2.

4.7.10.3 Drive C

Drive C (if installed in the unit) is an internal PCMCIA based drive. This could be any type of ATA compatible PCMCIA (rotating or FLASH) or CompactFlash format drive

cards. This drive is power controlled such that its power is turned off when not writing files to it. This drive is only available and used on SMART-24R® and SMART-24A® type instruments. The directory structure used for drive C is given in section 4.7.12.2.

4.7.10.4 Drive D

Drive D (if installed in the unit) is a USB based drive module that can be removed from the SMART-24R® or SMART-24A® type instrument's case. It supports the internal USB connection to the unit as well as a standard USB 2.0 Hi Speed (480Mbit/Second) Type B peripheral receptacle for connection to a personal computer or USB hub. The USB drive module derives its power from the USB bus without the need for an external power supply when connected to a personal computer or USB hub.

Internally, this module supports 1.8-inch form factor hard drives up to 240GB as well as most types of ATA compatible PCMCIA (rotating or FLASH) and CompactFlash format drive cards (up to 64GB) with a CF-to-ATA passive adapter. This drive is power controlled such that its power is turned off when not writing files to it. This drive is only available and used on SMART-24R® and SMART-24A® type instruments. The directory structure used for drive D is given in section 4.7.12.2.

4.7.10.5 Drive E

Drive E (if present) is the second partition on the removable USB disk, available only if the removable USB disk installed in the unit is formatted with two partitions. Drive E has same directory structure as Drive D (see section 4.7.12.2). Event file and continuous file recording can be split onto different partitions (D and E) on the USB drive, and works in ring buffer mode on each of them.

4.7.11 Data File Recording

When enabled for recording, the SMART-24R® and SMART-24A® type instruments can record continuous and event files in either normal or window controlled modes as described in the following sections. Continuous and event files may be recorded simultaneously. Compression may also be enabled in recording file to reduce their size.

Note that the recorded file size may be limited by the sample rate and number of channels recorded. In general, data files are limited to roughly 10MB in total size. With compression turned on the effective non-compressed size is limited to roughly 20MB. A log message will be generated in the log file if files were limited in size from the configuration settings. The size limit can be estimated as follows:

- Multiply each enabled recording channel's sample rate by 240 and sum up for a total bytes per minute value.

- Divide 10,000,000 (or 20,000,000 with compression on) by the above value to give the maximum file size in minutes.

- The file size will be limited to the appropriate whole minute value not exceeding this value.

Example: 3 primary channels at 1000sps in continuous mode.

1000 * 240 = 240000
240000 + 240000 + 240000 = 720000 bytes/second
10,000,000 / 720,000 = 13.9 minutes non-compressed
20,000,000 / 720,000 = 27.8 minutes compressed

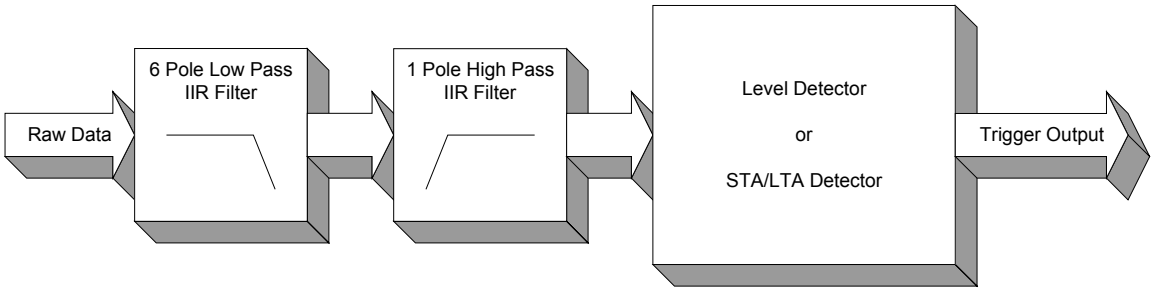
The largest continuous file size setting not exceeding the above values is 10 minutes non-compressed or 15 minutes compressed. So the file size would be limited to these values.

4.7.11.1 Continuous Recording

In the continuous recording mode, continuous data files (in lengths of 1, 5, 10, 15, 30, 60, 120 or 240 minutes) will be recorded until all drive space is exhausted or in a ring buffer mode where older files will be overwritten. Ring buffering of continuous files only works on the target drive and not across multiple drives. The user can disable continuous recording, set it to start immediately or set it to start at some time in the future. The user can also select any of the 20 possible data channels to record.

4.7.11.2 Event Triggers

The SMART-24 Series instruments provide level and STA/LTA event detection triggers. Each primary rate channel has its own independently configurable detector/trigger. The detector is preceded by a 6 pole IIR low pass filter cascaded with a 1 pole IIR high pass filter as shown in the following diagram.



The user can set the filter corners of both the low pass and high pass filters. The filter corners can be set to 0.0 (no filtering) or 0.001Hz to 100.0Hz. In general the low pass corner value should be set to a value larger than the high pass corner value. The user can select to use the level detector or the STA/LTA detector, but not both at the same time on the same channel. Different channels can be set to different detectors.

4.7.11.3 Event Recording

The SMART-24 Series instruments provide for event recording based on the output of the event triggers. The user can setup voting weights (-10 to +10) for each channel as well as for an external digital event input trigger. To declare an event, the channel votes are added up and must be equal to or exceed the total vote requirement for event declaration. This can allow for complex logical AND, OR and NOT trigger declaration possibilities.

The user can disable event recording, set it to start immediately or set it to start at some time in the future. The user can also select any of the 20 possible data channels to record.

4.7.11.4 Window Recording

Up to four time windows can be set up to allow either continuous or event files to be enabled for recording within a defined window of time. These windows can be enabled to run one time only or run multiple times at a given interval. When a window is in effect, the setups entered for continuous or event file recording is used to control the recording.

4.7.12 File Conventions

In the SMART-24R® and SMART-24A® instruments, data can be recorded to files as described in the preceding sections. The following sections give information on the conventions and formats used for file recording in the SMART-24 Series instruments.

4.7.12.1 File Naming

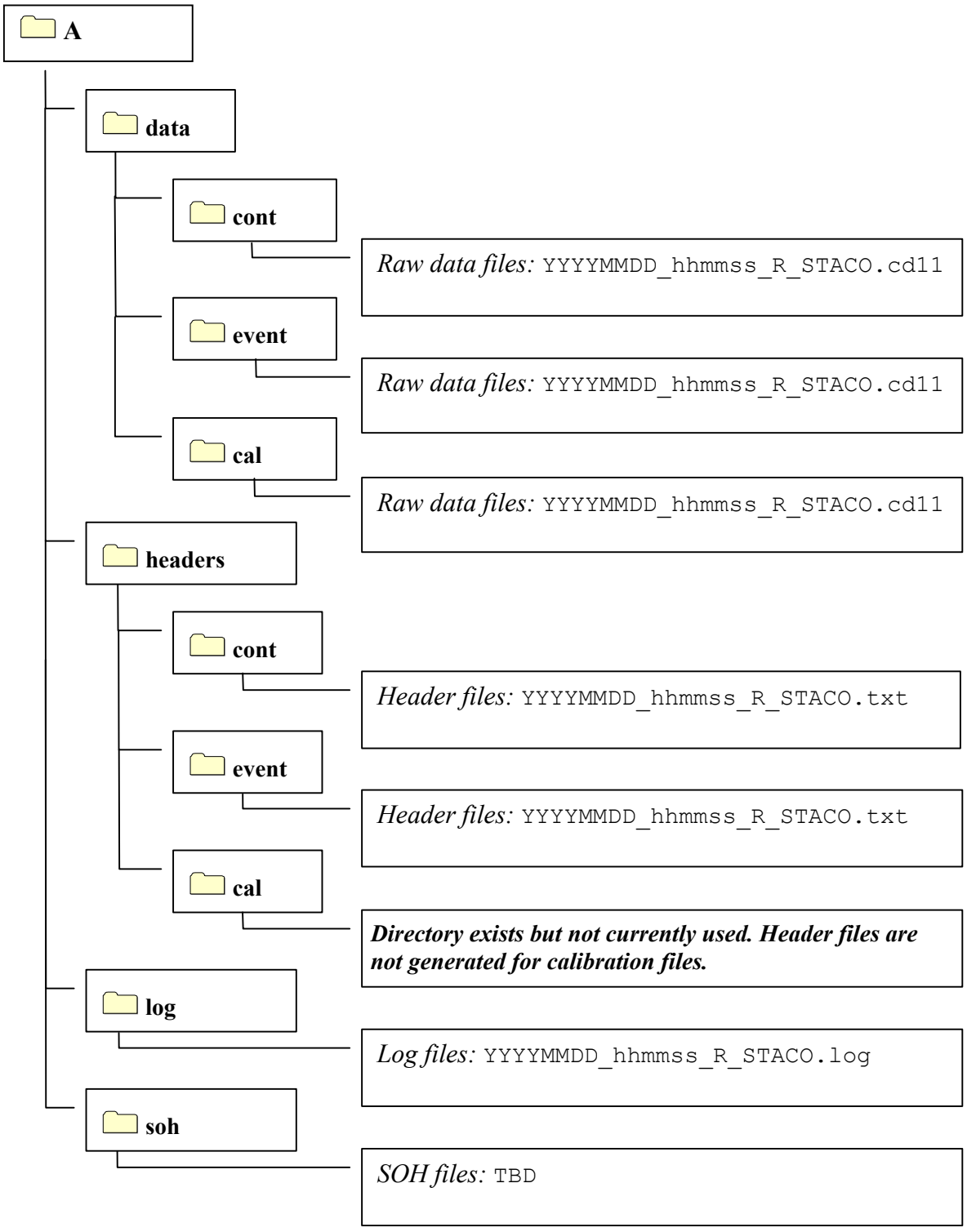
The SMART-24 file naming convention is:

```
YYYYMMDD_hhmmss_R_STACO.EXT
```

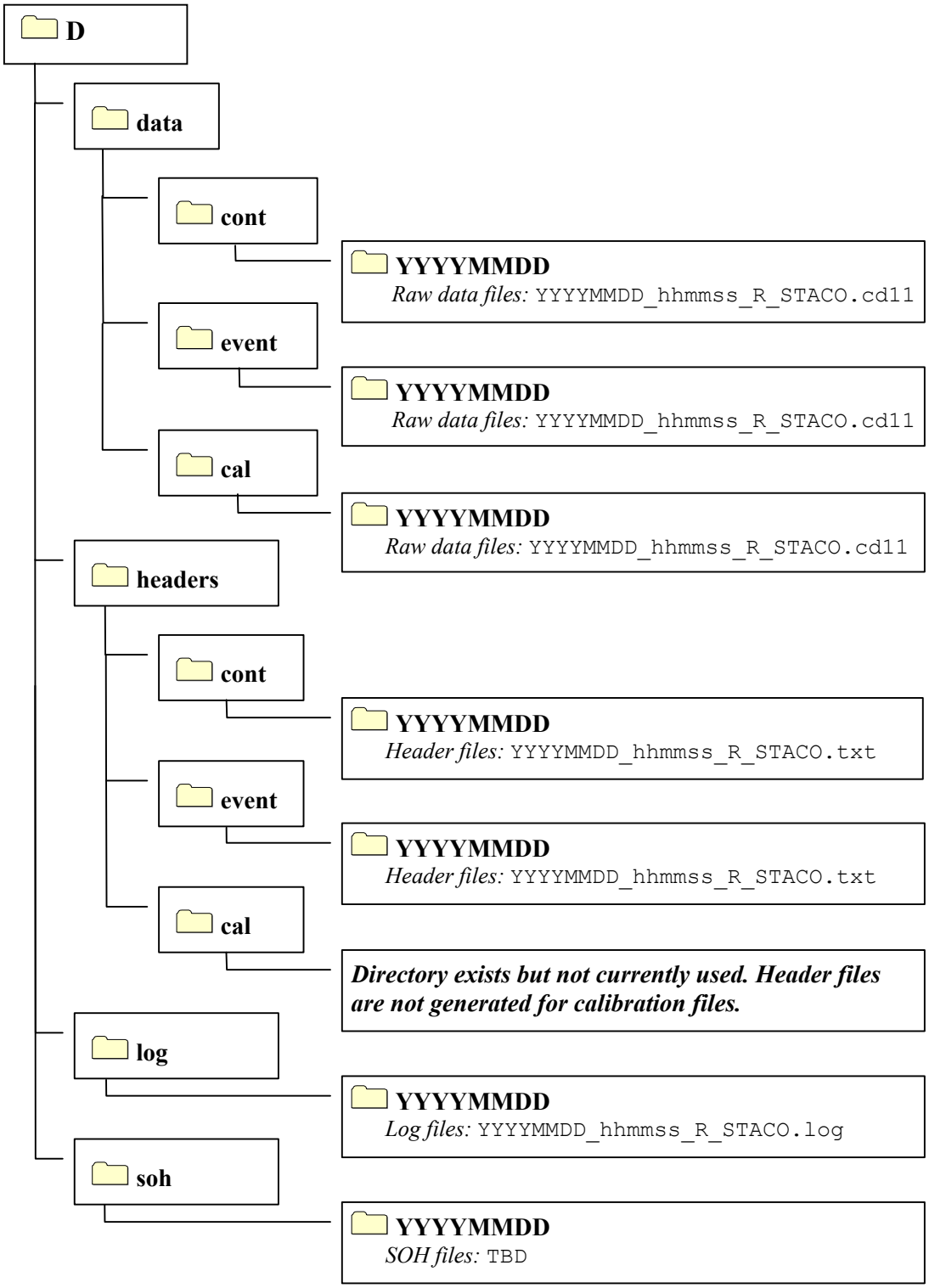
where:
- `YYYY` = year
- `MM` = month
- `DD` = day of month
- `hh` = hour
- `mm` = minute
- `ss` = second of the first sample in the data file
- `R` = 'B' for calibration data, 'C' for continuous data, 'E' for event data or 'L' for log files
- `STACO` = station code up to 5 characters (taken from the site name Defined for CD Profile 1)
- `EXT` = 'cd11' file extension for raw data files; 'txt' file extension for header files; 'log' file extension for log files

4.7.12.2 File Directory Structure

The following shows the file directory structure for drive A:



The following shows the file directory structure for drives B, C and D. Note that on the destination drives an additional directory layer is added to sort the files by date.



4.7.12.3 Raw Data File Format

SMART-24 raw data files use a modified CD-1.1 frame format described in the IDC Documentation; "Formats and Protocols for Continuous Data CD-1.1, 3.4.3 Revision 0.2" and modified as described below.

Each raw data file contains all data channels recorded (primary, secondary, auxiliary and mass position) for the specified recording time period. The raw data file consists of one Frame Header (Table 3 of the IDC Documentation) and one Channel Subframe Header (Table 9 of the IDC Documentation) followed by a number of Channel Subframes (Table 10 of the IDC Documentation), organized in 1-minute data blocks kept in time sequence. Each 1 minute data block contains a number of Channel Subframes that matches the number of channels recorded as specified in the Channel Subframe Header.

Frame Header And Channel Subframe Header	
Block 1 of 1 minute data	Channel 1 Subframe
	Channel 2 Subframe
	…
	Channel n Subframe
Block 2 of 1 minute data	Channel 1 Subframe
	Channel 2 Subframe
	…
	Channel n Subframe
…	
Block N of 1 minute data	Channel 1 Subframe
	Channel 2 Subframe
	…
	Channel n Subframe

The format of the Frame Header is as given in Table 3 of the IDC Documentation, modified as follows:

- Frame Creator (8 bytes) contains the creator name specified for CD Profile 1, left justified and padded with ASCII null bytes as required.

- Frame Destination contains one of the following identifiers (8 bytes):

  FILE_CON - for continuous recording files
  FILE_EVT - for event files
  FILE_CAL - for calibration files
  FILE_SOH - for SOH files

- Trailer Offset, Sequence Number and Series fields of the Frame Header are unused and set to zero for all files types excepting event files. For event files they are set as follows:

  Trailer Offset (4-byte integer) - Channel number causing the first trigger (1 to 6 for the six possible primary data channels or 7 for the external digital trigger input).

  Sequence Number (8-byte long integer) - split into 2 4-byte integers as follows:

  1st 4-bytes - Event sample number (0 to sample rate -1) For 50sps this would range from 0 to 49. The external digital event input is always sampled at 10sps and would range from 0 to 9.

  2nd 4-bytes - Event sample time (within a second) in milliseconds = (sample_number/sample_rate) * 1000.

  Series (4-byte integer) - Event time as an unsigned 32-bit integer, seconds since 1970 of the second that contains the event start sample.

The format of the Data Frame Header and Channel Subframe Header is as given in Table 9 of the IDC Documentation.

The format of the Channel Subframe of Data Frame is as given in Table 10 of the IDC Documentation, modified as follows:

- Byte 3 of Channel Description is sensor type: 0 = seismic; 1 = hydroacoustic; 2 = infrasonic; 3 = weather; 4 = other; 5 = velocity; 6 = acceleration.

- Subframe Time Length always equals 60,000.

- Channel Status Size is 48 bytes.

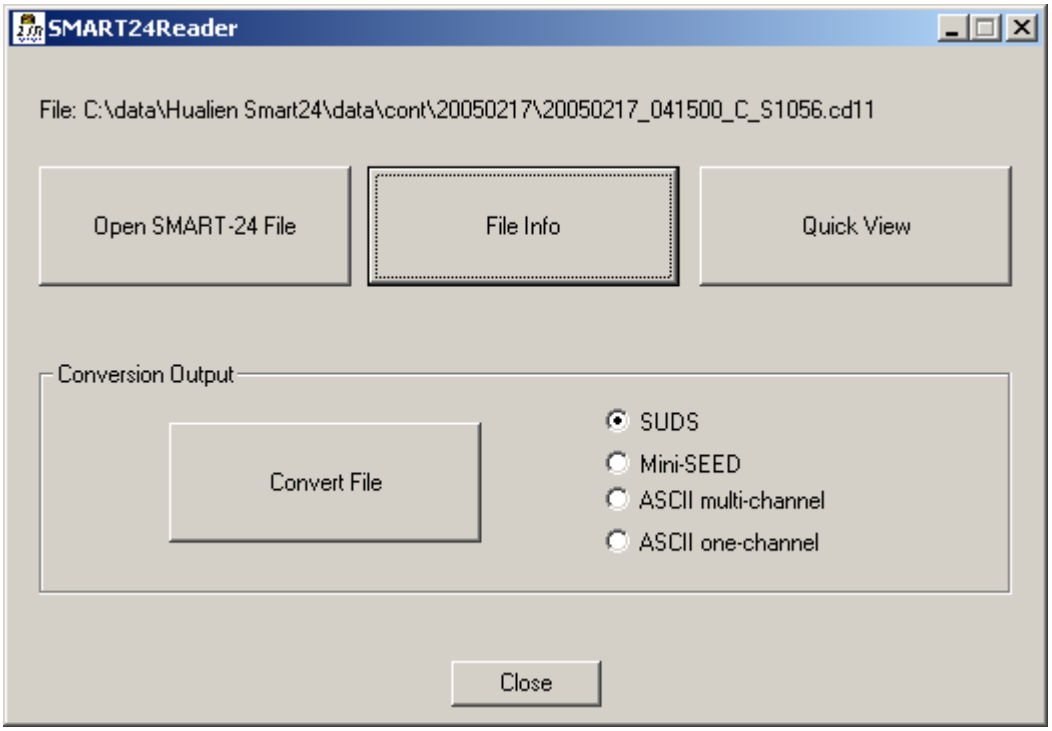
- The Channel Status Data structure has been extended from 32 to 48 bytes to include the site's coordinates and the channel's LSB value. The format of the channel status field is as given in Table 22 of the IDC Documentation, modified by adding to the end of the structure the following fields:

Field	Format	Description
Channel Status	bytes 33-36	Latitude (float)
(Continued from Table 22)	bytes 37-40	Longitude (float)
	bytes 41-44	Altitude (float)
	bytes 45-48	LSB Volts/Count (float)

4.7.12.4 SMART-24 File Reader

To access and retrieve files stored in a SMART-24 Series instrument, the user can use the FTP server in the unit to transfer and delete files as needed via a TCP\IP connection (see section 4.5.6 for further details). The user can also use the removable USB drive module to retrieve files directly by removing it from the unit and connecting it to PC USB port.

The SMART24Reader Utility allows for displaying the SMART-24 raw data files and for their conversion into MiniSEED, 32-bit SUDS and ASCII formats. It can also display a data file information window listing the data channels recorded in the file with their network, station and component names, begin date and time, duration, sample rate, sensor and motion type ('d'=displacement, 'v'=velocity, 'a'=acceleration), and units type ('d'=digital counts, 'v'=milivolts, 'n'=nanometers (/sec or /sec/sec)). The program GUI window is displayed in the following screen capture. The SMART24Reader Utility is typically supplied with a SMART-24 Series instrument (SMART-24R® and SMART-24A® type only) on the SMART-24 Series Software Disk.



The SMART24 Data File Conversion Utility is part of the SMART24Reader software package and allows for the batch-mode conversion of SMART-24 raw data files into MiniSEED, 32-bit SUDS and ASCII formats. See section 4.7.12.5 for further details.

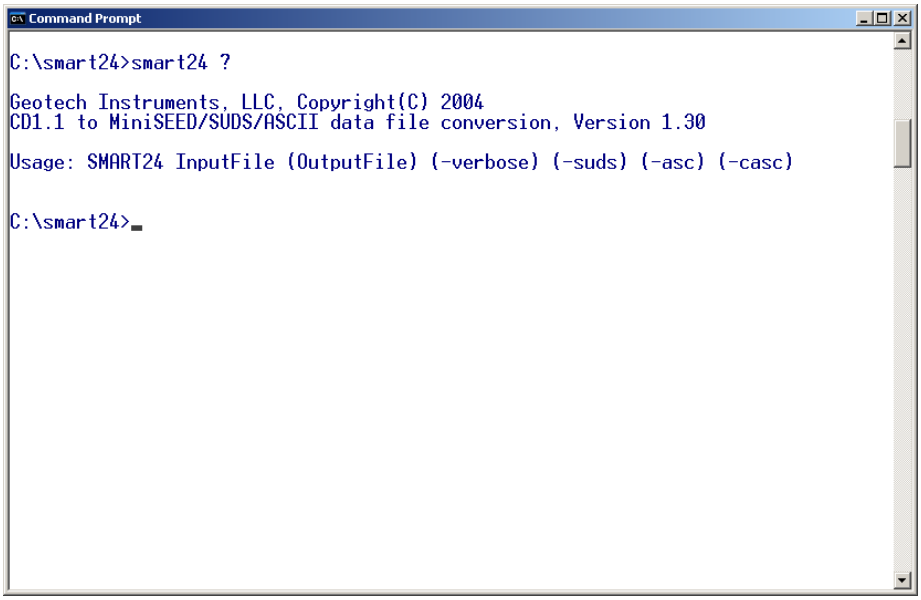
4.7.12.5 Raw Data File Conversion To Other Formats

The SMART24 Data File Conversion Utility is a C++ based application running on a user's computer that allows conversion of SMART-24 raw data files (modified CD-1.1 frame format described in section 4.7.12.3) into MiniSEED, 32-bit SUDS and ASCII formats. This conversion utility is typically supplied with a SMART-24 Series instrument (SMART-24R® and SMART-24A® type only) on the SMART-24 Series Software Disk.

SMART24 is an interactive console application that can be used to process one raw data file at a time. Multiple files can also be processed in batch mode, using the operating system batch command scripts capabilities.

For large number of files, another software tool, SMARTOffline, is available for automated data retrieval and conversion of SMART-24 raw data files in one of the following formats: SUDS, SAC, PASSCAL SEG Y, SEED, MiniSEED, CSS3.0, SEISAN, MATLAB or ASCII. Please refer to the SMARTOffline documentation for a detailed description of this application.

From a command prompt window, run the SMART24 program with "?" in the command line to get on-line help, as displayed in the following screen capture.



In the command line, '`InputFile`' is the name of the input SMART-24 raw data file. Optionally, '`OutputFile`' sets the output file name, which by default is the same as input file name with the extension '`msed`', '`suds`' or '`asc`' for MiniSEED, SUDS and ASCII format, respectively.

By default, the output format is MiniSEED. By using the '`-suds`' option, the user can set the output format to 32-bit SUDS. Two ASCII (text) output formats are supported:

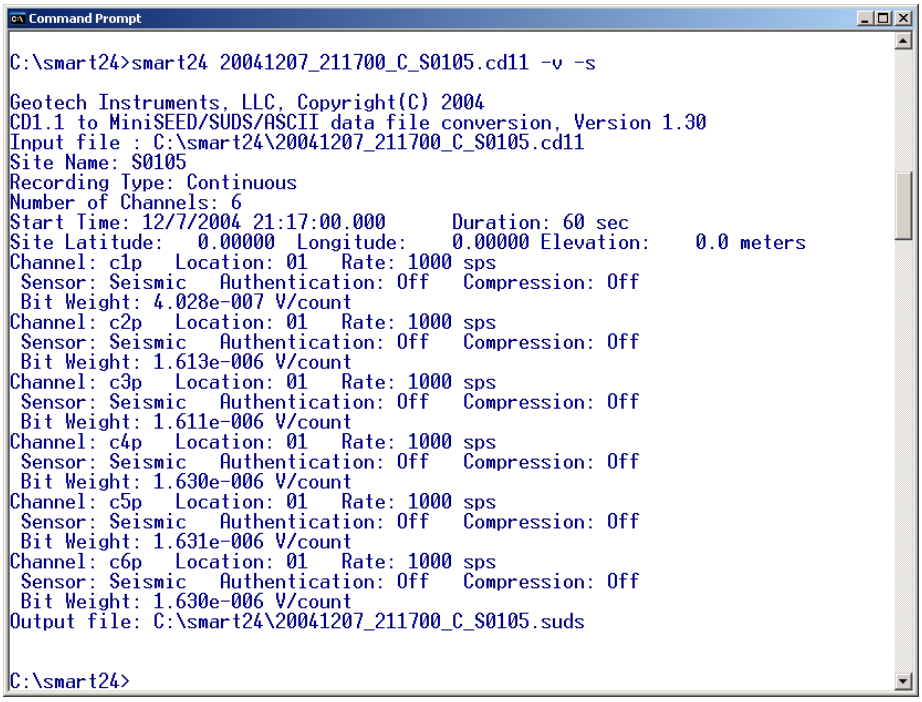
1. By using the '`-asc`' option, the user can select an ASCII multi-channel file format with all data channels following sequentially in one file. Each channel has a 4-line header followed by data values as one sample (integer number) per line. The 4-line header gives on first line the network, station and component identifiers as `NET:STACO:CMP`, where `NET` is the network code (up to 8 characters), `STACO` the station code (up to 5 characters) and `CMP` the component code (up to 3 characters); on the second line the initial sample time as `mm/dd/yy hhMMss.xxx`, where `mm` is the month, `dd` the day of month, `yy` the last two digits of the year, `hh` the hour, `MM` the minute, `ss` the second and `xxx` the millisecond corresponding to the time stamp of the first sample in the data stream; on the third line the sample rate (real number) and on the fourth line the number of samples recorded for the given channel.

2. By using the '`-casc`' option, the user can select an ASCII single channel file format. Each data file has one header line starting with 'H' followed by the initial sample time as epoch time (number of seconds since 01/01/1970, 00:00:00), the sample rate, channel number and bit weight in Volts/count. The header line is followed by the data values in counts for that channel only. The files are named by adding the component code at the end of the input file name.

In general, except for the single channel ASCII format described above, one output file is generated with all data channels. If the input file contains data channels with identical channel names, but different location codes, multiple output files are created, each file containing all data channels sharing the same location code, with the location code included in the output file name.

A verbose mode can be enabled by using the '`-verbose`' option. In this mode, file recording information (such as site and channel names, file start time and duration, sample rate, site coordinates, bit weights, etc.) is displayed on the computer screen and saved to a log file having same name as the input file and the extension '`log`'.

The following screen capture shows an example of raw file conversion to SUDS format, in verbose mode.



4.7.12.6 Header File Format

Header files are generated for continuous and event raw data files and contain parametric information about the recorded data. They are viewable ASCII text files and are rapidly accessible due to their small size. These header files are found in the header directory and have the same name as the corresponding raw data file except that the extension is 'txt' rather than 'cd11'. All data fields are ASCII characters organized into records (or lines) terminated by a CR followed by a LF. A sample header file is shown below.

Sample Header File

```
S0105    S0105  32.89589  -96.69428  156 2004/12/23 16:27:00.000     60  6 U

CHANNELS:       c1p       c2p       c3p       c4p       c5p       c6p
SAMPRATE: 1000.000  1000.000  1000.000  1000.000  1000.000  1000.000
RECSTAT:         ON        ON        ON        ON        ON        ON
PEAKVAL:        -26        39       -52       -17        16        15
TIMEPEAK:     32888     14603      5948     37272     38389     23750
OFFSET:          -9         0       -12        -3        -7        -5
LSB:       1.611352  1.612784  1.611132  1.630384  1.630532  1.629748
SENS:          0.00      0.00      0.00      0.00      0.00      0.00

CHANNELS:       c1s       c2s       c3s       c4s       c5s       c6s
SAMPRATE:     0.000     0.000     0.000     0.000     0.000     0.000
RECSTAT:        OFF       OFF       OFF       OFF       OFF       OFF
PEAKVAL:          0         0         0         0         0         0
TIMEPEAK:         0         0         0         0         0         0
OFFSET:           0         0         0         0         0         0
LSB:       1.611352  1.612784  1.611132  1.630384  1.630532  1.629748
SENS:          0.00      0.00      0.00      0.00      0.00      0.00
```

The first line gives general instrument information such as name, location, time, etc. The next section gives the parameter values for the six possible primary data channels and the third section gives the parameter values for the six possible secondary data channels. The header file fields are fixed in size and position for easy reading. Space is reserved for channels even if they are either not recorded or not installed in the system. These channels would be reported as 'OFF' in the RECSTAT line.

The current header file fields and format are described as follows:

Record	Position	Format	Description
1	1-8	a8	Network name (left justified)
	10-14	a5	Station code (left justified)
	16-24	f9.5	Latitude (degrees, South is negative, right justified)
	26-35	f10.5	Longitude (degrees, West is negative, right justified)
	37-40	i4	Elevation (meters,, right justified)
	42-51	i4,a1,i2,a1,i2	File start date (yyyy/mm/dd)
	53-64	i2,a1,i2,a1,f6.3	File start time (hh:mm:ss.sss)
	66-71	i6	File duration (seconds, right justified)
	73-74	i2	Number of channels (right justified)
	76	a1	GPS status ('L' = locked, 'U' = unlocked)
	77-78	a2	CR/LF
2	1-2	a2	Blank line, CR/LF
3	1-9	a9	"CHANNELS:" (left justified)
	11-18	a8	Primary channel 1 name (right justified)
	21-28	a8	Primary channel 2 name (right justified)
	31-38	a8	Primary channel 3 name (right justified)
	41-48	a8	Primary channel 4 name (right justified)
	51-58	a8	Primary channel 5 name (right justified)
	61-68	a8	Primary channel 6 name (right justified)
	69-70	a2	CR/LF
4	1-9	a9	"SAMPRATE:" (left justified)
	11-18	f8.3	Sample rate for prim chan 1 (right justified)
	21-28	f8.3	Sample rate for prim chan 2 (right justified)
	31-38	f8.3	Sample rate for prim chan 3 (right justified)
	41-48	f8.3	Sample rate for prim chan 4 (right justified)
	51-58	f8.3	Sample rate for prim chan 5 (right justified)
	61-68	f8.3	Sample rate for prim chan 6 (right justified)
	69-70	a2	CR/LF

5	1-9	a9	"RECSTAT:" (left justified)
	11-18	a8	Status for prim chan 1 (ON/OFF, right justified)
	21-28	a8	Status for prim chan 2 (ON/OFF, right justified)
	31-38	a8	Status for prim chan 3 (ON/OFF, right justified)
	41-48	a8	Status for prim chan 4 (ON/OFF, right justified)
	51-58	a8	Status for prim chan 5 (ON/OFF, right justified)
	61-68	a8	Status for prim chan 6 (ON/OFF, right justified)
	69-70	a2	CR/LF
6	1-9	a9	"PEAKVAL:" (left justified)
	11-18	i8	Peak value [counts] prim chan 1, offset-corrected, RJ
	21-28	i8	Peak value [counts] prim chan 2, offset-corrected, RJ
	31-38	i8	Peak value [counts] prim chan 3, offset-corrected, RJ
	41-48	i8	Peak value [counts] prim chan 4, offset-corrected, RJ
	51-58	i8	Peak value [counts] prim chan 5, offset-corrected, RJ
	61-68	i8	Peak value [counts] prim chan 6, offset-corrected, RJ
	69-70	a2	CR/LF
7	1-9	a9	"TIMEPEAK:" (left justified)
	11-18	i8	Sample num of peak value prim chan 1 (right justified)
	21-28	i8	Sample num of peak value prim chan 2 (right justified)
	31-38	i8	Sample num of peak value prim chan 3 (right justified)
	41-48	i8	Sample num of peak value prim chan 4 (right justified)
	51-58	i8	Sample num of peak value prim chan 5 (right justified)
	61-68	i8	Sample num of peak value prim chan 6 (right justified)
	69-70	a2	CR/LF
8	1-9	a9	"OFFSET:" (left justified)
	11-18	i8	Offset value [counts] prim chan 1 (right justified)
	21-28	i8	Offset value [counts] prim chan 2 (right justified)
	31-38	i8	Offset value [counts] prim chan 3 (right justified)
	41-48	i8	Offset value [counts] prim chan 4 (right justified)
	51-58	i8	Offset value [counts] prim chan 5 (right justified)
	61-68	i8	Offset value [counts] prim chan 6 (right justified)
	69-70	a2	CR/LF
9	1-9	a9	"LSB:" (left justified)
	11-18	f8.6	LSB value [µV/count] prim chan 1 (right justified)
	21-28	f8.6	LSB value [µV/count] prim chan 2 (right justified)
	31-38	f8.6	LSB value [µV/count] prim chan 3 (right justified)
	41-48	f8.6	LSB value [µV/count] prim chan 4 (right justified)
	51-58	f8.6	LSB value [µV/count] prim chan 5 (right justified)
	61-68	f8.6	LSB value [µV/count] prim chan 6 (right justified)
	69-70	a2	CR/LF

10	1-9	a9	"SENS:" (left justified)
	11-18	f8.2	Sensor sensitivity prim chan 1 (right justified)
	21-28	f8.2	Sensor sensitivity prim chan 2 (right justified)
	31-38	f8.2	Sensor sensitivity prim chan 3 (right justified)
	41-48	f8.2	Sensor sensitivity prim chan 4 (right justified)
	51-58	f8.2	Sensor sensitivity prim chan 5 (right justified)
	61-68	f8.2	Sensor sensitivity prim chan 6 (right justified)
	69-70	a2	CR/LF
11 - 19			Repeat records 2 – 10 for the six secondary channels

Notes:

- *Format: a = ASCII, f = floating point, i = integer, first number is total number of positions used, for floating point second number is positions after the decimal point.*
- *All unused positions are filled with ASCII space character ' '.*
- *The units and meaning of the Sensor Sensitivity value are user defined.*

4.7.12.7 Log File Format

The SMART-24 Series instruments generate a log file that records various log and status messages generated by the unit. Some of these are configurable through software to enable or disable their generation. A new log file is started once per day at midnight. The following shows a short segment of a typical log file from power up.

Sample LOG File Segment

```
2004-12-15 22:30:06.240 [STARTUP_TASK    ] SMART-24 Startup, Version 1.17, S/N 0105
2004-12-15 22:30:06.240 [STARTUP_TASK    ] DSP  Board Found: 990-60566-0101, Rev A, SN 0103, Date 2004-03-09, FW 1.09
2004-12-15 22:30:06.240 [STARTUP_TASK    ] PWR  Board Found: 990-60567-0101, Rev -, SN 0105, Date 2004-02-20, FW 1.01
2004-12-15 22:30:06.250 [STARTUP_TASK    ] ADC1 Board Found: 990-60568-0101, Rev -, SN 0105, Date 2004-02-25, FW 1.03
2004-12-15 22:30:06.270 [STARTUP_TASK    ] ADC2 Board Found: 990-60568-0101, Rev -, SN 0103, Date 2004-03-06, FW 1.03
2004-12-15 22:30:06.270 [STARTUP_TASK    ] ETH1 Board Found: 990-60573-0101, Rev -, SN 0104, Date 2004-02-23, FW 1.01
2004-12-15 22:30:06.270 [STARTUP_TASK    ] ETH1 MAC Address: 00-50-C2-31-F0-04
2004-12-15 22:30:06.270 [STARTUP_TASK    ] I/O2 Board Not Installed
2004-12-15 22:30:06.270 [STARTUP_TASK    ] PCM  Board Not Installed
2004-12-15 22:30:06.270 [STARTUP_TASK    ] PCM  Status A = 0x001F0141, Status B = 0x001F0141
2004-12-15 22:30:06.270 [STARTUP_TASK    ] ADC1 Board 5V LSB Values: Ch1: 0.402838 uV Ch2: 0.403196 uV Ch3: 0.402783 uV
2004-12-15 22:30:06.270 [STARTUP_TASK    ] ADC2 Board 5V LSB Values: Ch1: 0.407596 uV Ch2: 0.407633 uV Ch3: 0.407437 uV
2004-12-15 22:30:06.270 [STARTUP_TASK    ] RTFS: Drive A = Device 0
2004-12-15 22:30:06.270 [STARTUP_TASK    ] RTFS: Drive B = Device 1
2004-12-15 22:30:06.270 [STARTUP_TASK    ] RTFS: Drive C = Device 2
2004-12-15 22:30:06.270 [STARTUP_TASK    ] RTFS: Drive D = Device 3
2004-12-15 22:30:06.280 [STARTUP_TASK    ] RTFS: Formatting RAMDRIVE A . . .
2004-12-15 22:30:07.540 [STARTUP_TASK    ] RTFS: RAMDRIVE Format OK: 67004416 Bytes Free
2004-12-15 22:30:07.570 [STARTUP_TASK    ] Starting TCP/IP Stack
2004-12-15 22:30:09.080 [IP_STACK_STATUS ] Network Added: If-1:192.168.100.34
2004-12-15 22:30:09.090 [IP_STACK_STATUS ] Service Status: Telnet   : Enabled  :          : 000
2004-12-15 22:30:09.090 [IP_STACK_STATUS ] Service Status: HTTP     : Enabled  :          : 000
2004-12-15 22:30:09.090 [SER_DB_CTRL_TASK] Task Started & Ready
2004-12-15 22:30:09.090 [SER_DB_CTRL_TASK] Serial Port in Character Mode
2004-12-15 22:30:09.090 [SER_1_CTRL_TASK ] Task Started & Ready
2004-12-15 22:30:09.090 [SER_2_CTRL_TASK ] Task Started & Ready
2004-12-15 22:30:09.100 [FTP_SERVER_TASK ] Task Started & Ready
2004-12-15 22:30:09.100 [FTP_SERVER_TASK ] Starting FTP Server
2004-12-15 22:30:09.100 [FTP_SERVER_TASK ] FTP Server Listening For Connections
2004-12-15 22:30:09.100 [ADC_CTRL_TASK   ] Task Started & Ready
2004-12-15 22:30:09.100 [ADC_CTRL_TASK   ] Raw Data Buffer Initialized, 44 Minutes
2004-12-15 22:30:10.010 [DISPLAY_TASK    ] Task Started & Ready
2004-12-15 22:30:10.010 [DISK_SUPERV_TASK] Task Started & Ready
2004-12-15 22:30:10.010 [USB_HUB_TASK    ] Task Started & Ready
2004-12-15 22:30:10.010 [DISK_SUPERV_TASK] Created USB Hub task
2004-12-15 22:30:10.200 [DISK_SUPERV_TASK] USB Host Power ON
2004-12-15 22:30:10.250 [ADC_CTRL_TASK   ] Starting ADC Board 1
2004-12-15 22:30:10.290 [ADC_CTRL_TASK   ] Starting ADC Board 2
2004-12-15 22:30:10.290 [CD_DISPATCH_TASK] Task Started & Ready
2004-12-15 22:30:10.290 [CONT_REC_TASK   ] Task Started & Ready
2004-12-15 22:30:10.290 [DETECTOR_TASK   ] Task Started & Ready
2004-12-15 22:30:10.290 [EVENT_REC_TASK  ] Task Started & Ready
2004-12-15 22:30:10.300 [CD_D_SRVR_1_TASK] Task Started & Ready
2004-12-15 22:30:10.300 [CD_CMD_SRVR_TASK] Task Started & Ready
2004-12-15 22:30:10.300 [CD_CMD_SRVR_TASK] Opening Command Listen Port - 8000
2004-12-15 22:30:10.310 [DECIMATOR_TASK  ] Task Started & Ready
2004-12-15 22:30:10.310 [CD_CMD_SRVR_TASK] Waiting For Command Connections
```

```
2004-12-15 22:30:10.310 [SOH_TASK        ] Task Started & Ready
2004-12-15 22:30:10.310 [DATA_MOVE_TASK  ] Task Started & Ready
2004-12-15 22:30:10.470 [CAL_REC_TASK    ] Task Started & Ready
2004-12-15 22:30:11.110 [SOH_TASK        ] GPS SOH> Time - 2004-12-15 22:30:11
2004-12-15 22:30:11.110 [SOH_TASK        ] GPS SOH> PWR OFF : UNLOCKED : SV 0 : 1PPS OFF
2004-12-15 22:30:11.110 [SOH_TASK        ] GPS SOH> LAT +0.000000 : LON +0.000000 : ALT +0.000000
2004-12-15 22:30:11.110 [SOH_TASK        ] CLK SOH> Time - 2004-12-15 22:30:11
2004-12-15 22:30:11.110 [SOH_TASK        ] CLK SOH> UNLOCKED : EXT 1PPS NO : DAC 0 : TEMP: +0.000 C
2004-12-15 22:30:11.110 [SOH_TASK        ] CLK SOH> INIT DIFF +0.000000000 Sec : CUR DIFF +0.000000000 Sec
2004-12-15 22:30:11.300 [DISK_SUPERV_TASK] USB Device Found
2004-12-15 22:30:11.400 [USB_HUB_TASK    ] USB HUB Connect Event (2)
2004-12-15 22:30:11.490 [USB_HUB_TASK    ] USB Device Connected
2004-12-15 22:30:11.610 [USB_HUB_TASK    ] USB Device Indentified: Geotech USB Drive
2004-12-15 22:30:11.630 [USB_HUB_TASK    ] USB Device Configured
2004-12-15 22:30:11.660 [DISK_SUPERV_TASK] Drive B Startup Status: -4 [drive not found]
2004-12-15 22:30:11.660 [DISK_SUPERV_TASK] Drive C Startup Status: -4 [drive not found]
2004-12-15 22:30:14.890 [DISK_SUPERV_TASK] RTFS: DRIVE D Format OK: 30185160704 Bytes Free
2004-12-15 22:30:16.060 [SER_1_CTRL_TASK ] Serial Port in PPP Server Mode
2004-12-15 22:30:16.060 [SER_2_CTRL_TASK ] Serial Port in Character Mode
2004-12-15 22:30:16.090 [LOG_MSG_TASK    ] Log File Openned: A:\log\20041215_000000_L_S0105.log
2004-12-15 22:31:00.030 [ADC_CTRL_TASK   ] ADC 2 Initial Time Sync at 2004-12-15 22:31:00
2004-12-15 22:31:00.030 [ADC_CTRL_TASK   ] ADC 1 Initial Time Sync at 2004-12-15 22:31:00
2004-12-15 22:31:00.110 [CD_D_SRVR_1_TASK] Connection Request to 192.168.100.148 on Port 9000
2004-12-15 22:31:00.120 [CD_D_SRVR_1_TASK] Connect ERROR #61 (ECONNREFUSED)
2004-12-15 22:32:01.620 [CONT_REC_TASK   ] Continuous File Openned: A:\data\cont\20041215_223100_C_S0105.cd11
2004-12-15 22:32:01.900 [CONT_REC_TASK   ] Continuous File Closed: A:\data\cont\20041215_223100_C_S0105.cd11, File Size: 1440896
2004-12-15 22:32:01.940 [CONT_REC_TASK   ] Continuous Header File Written: A:\headers\cont\20041215_223100_C_S0105.txt, File Size: 1202
2004-12-15 22:32:15.040 [DISK_SUPERV_TASK] Powering Down USB Drive D
2004-12-15 22:32:15.200 [DISK_SUPERV_TASK] USB Host Power OFF
2004-12-15 22:32:15.300 [USB_HUB_TASK    ] USB HUB Connect Event (1)
2004-12-15 22:32:15.400 [USB_HUB_TASK    ] USB Device Power Off Disconnect
```

4.7.13 Fortezza PCMCIA Card

The SMART-24 Series instruments support the use of a Fortezza Crypto PCMCIA Card to provide data signing and authentication in the CD 1.1 data stream and file format. Any Fortezza compliant card may be used in the PCMCIA slots of a SMART-24 subject to the following notes:

1) New Fortezza Cards must be initialized prior to being inserted into a SMART-24 digitizer for the first time. This initialization sets up the proper user ID and password to allow the SMART-24 to work with the Fortezza Cars correctly. Please consult with Geotech on how to perform this initialization procedure.

2) Upon being used the first time with a SMART-24 digitizer, the Fortezza Card will be "formatted" for use and initial key pairs will be generated using the internal hardcoded PQG values embedded in the firmware.

3) The following sequence of CSP commands would be needed to generate new keys using the internal hardcoded PQG values, retrieve the newly created public key and start its use immediately:

AGK 0,1000<ENTER>	Generate a new pending key (key id = 1000).
ARK 1<ENTER>	Return the new pending public key (signed by the current key).
ASK 1<ENTER>	Start it immediately.

4) The following sequence of CSP commands would be needed to generate new keys using the current key PQG values, retrieve the newly created public key and schedule its use at a future time:

AGK 1,1001<ENTER>	Generate a new pending key (key id = 1001).
ARK 1<ENTER>	Return the new pending public key (signed by the current key).
ASK 2,12:00:00,01/01/2006<ENTER>	Scheduled to start at 12 noon on Jan. 1, 2006.

5) The following sequence of CSP commands would be needed to generate new keys using user entered PQG values, retrieve the newly created public key and schedule its use at a future time:

AUP 2,1,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUP 2,2,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>
AUP 2,3,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUP 2,4,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>

AUP 2,5,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUP 2,6,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>
AUP 2,7,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUP 2,8,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>

AUQ 2,1,23,F4,AB,00,76,5C,45,99,EE,8A<ENTER>
AUQ 2,2,EE,8A,AB,00,76,5C,45,99,23,F4<ENTER>

AUG 2,1,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUG 2,2,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>
AUG 2,3,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUG 2,4,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>
AUG 2,5,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUG 2,6,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>
AUG 2,7,23,F4,AB,00,76,5C,45,99,EE,8A,AB,00,76,5C,45,99<ENTER>
AUG 2,8,EE,8A,AB,00,76,5C,45,99,23,F4,AB,00,76,5C,45,99<ENTER>

AGK 2,1002<ENTER>	Generate a new pending key (key id = 1002).
ARK 1<ENTER>	Return the new pending public key (signed by the current key).
ASK 2,12:00:00,01/01/2006<ENTER>	Scheduled to start at 12 noon on Jan. 1, 2006.

4.8 APPLICATION FIRMWARE UPDATE

The SMART-24 Series instruments provide two methods of updating the unit application firmware code as described in the following two sections.

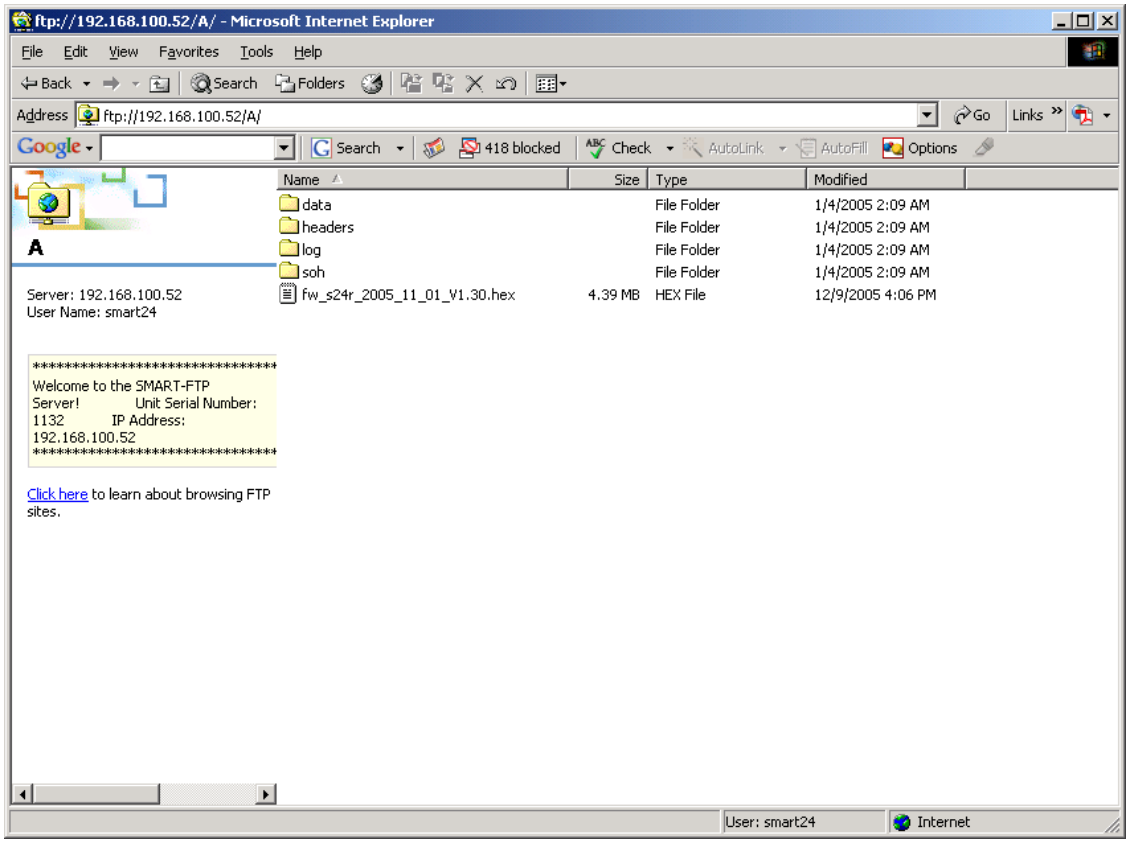
4.8.1 Bootloader Update Mode

This method requires a direct serial connection from the SMART-24 Series instrument (I/O1 or I/O2 serial port) to be updated and a PC. The user can then force the unit to boot into the Bootloader command menu mode (as described in section 4.6.1) and then upload and program the FLASH with new firmware (as described in section 4.6.2).

4.8.2 Application TCP/IP Update Mode

When the application firmware is running, the user can update the application firmware FLASH over a TCP/IP connection either locally or remotely. The following procedure should be used to update the application firmware.

1. Use FTP to login with the system user name and password, then upload the new application firmware HEX file (supplied by Geotech) to the unit's internal drive A (RAMDISK). The HEX file **MUST** be placed in the root directory of drive A as shown in the following screen capture (using Internet Explorer). The FTP session can be closed after the file is uploaded if desired.



2. Start a Telnet session to the unit and login with its system user name and password.

3. At the '>' prompt enter the 'update' command. The update utility displays the current status of the FLASH application firmware banks. It then looks for valid HEX files and displays any found.

4. Select the desired HEX file by entering the number displayed next to the file name. The utility then checks the select file to make sure it is a good SMART-24 application firmware HEX file and displays its information. It also looks to see if this is a duplicate version to one that is already stored in the FLASH (a message will be displayed if a duplicate is found).

5. The user is then asked one of two questions depending on whether a duplicate version is found:

   'Do you wish to overwrite FLASH Bank X with this duplicate file (YES/NO)?'

   or

   'Do you wish to proceed with this HEX file version (YES/NO)?'

   Answer 'yes' to continue. Any other response will abort the update.

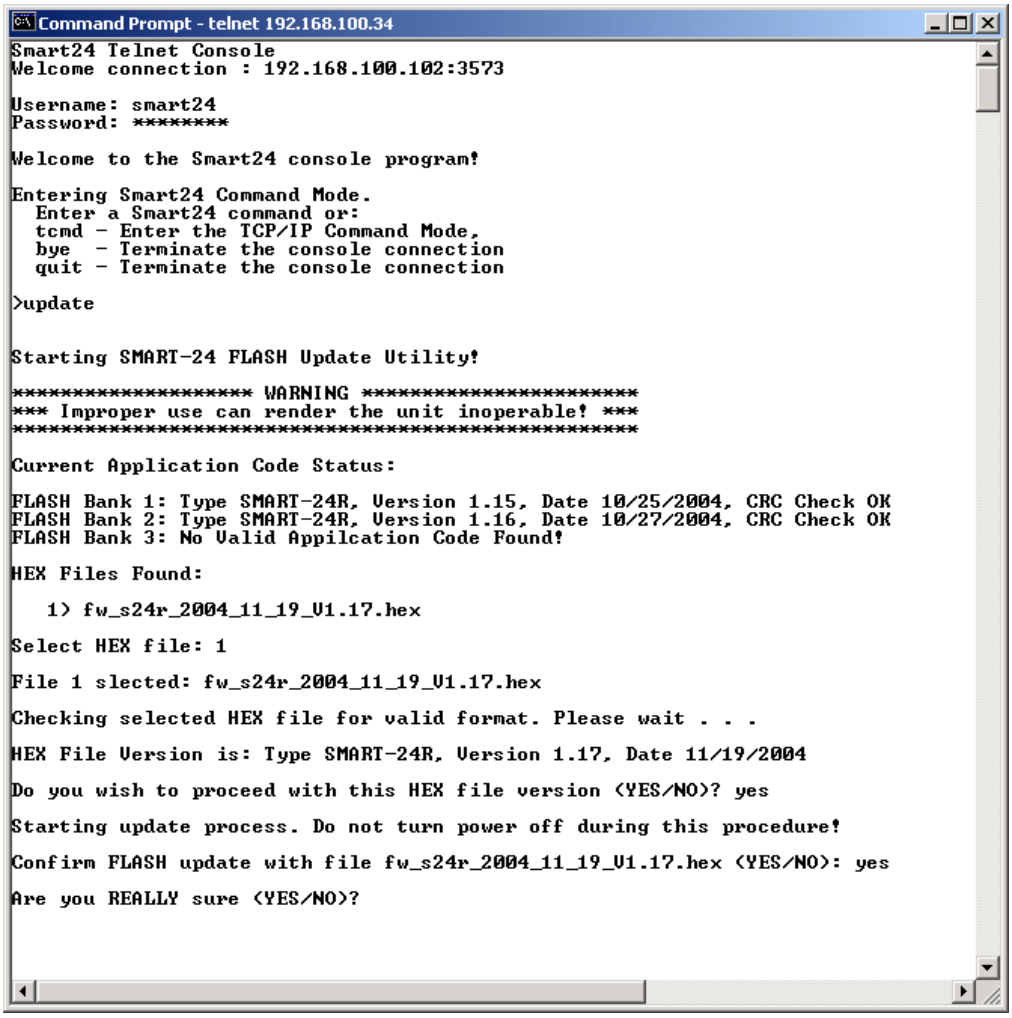
6. The user will then be asked two more times to confirm the update to ensure that the user really wants to do the update. Answer 'yes' to both questions to start the update. Again, any other response will abort the update.

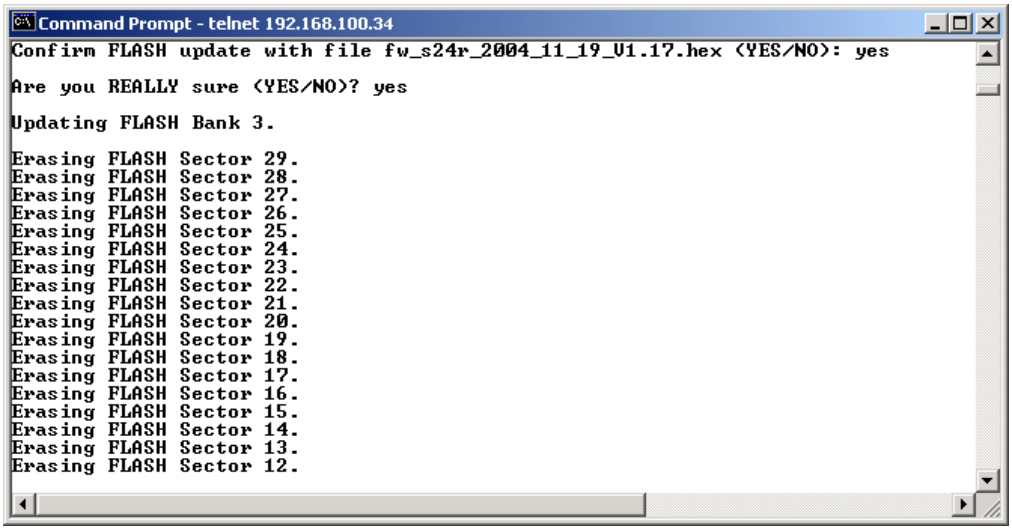
WARNING: Do not power off the unit during this procedure!

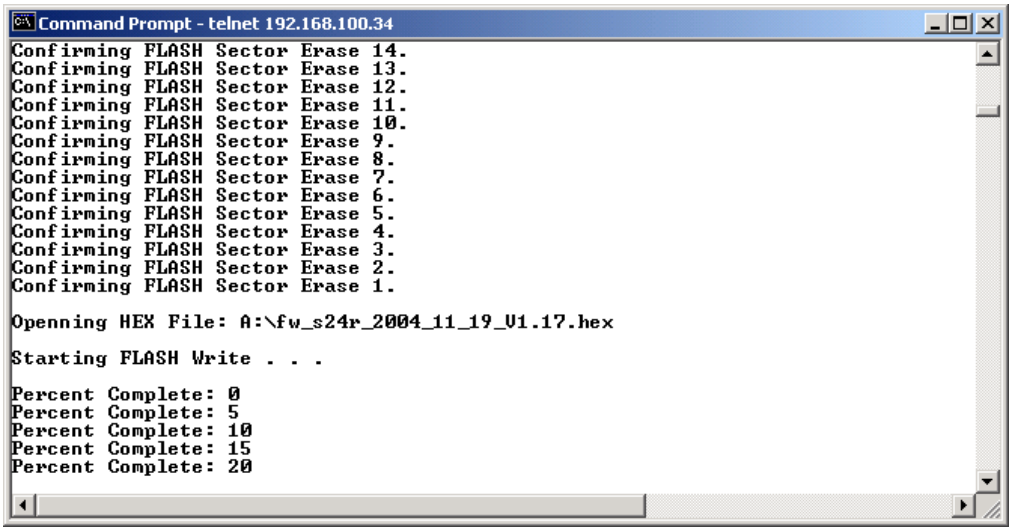
From this point on, the update process is automatic. The update utility performs the following actions:

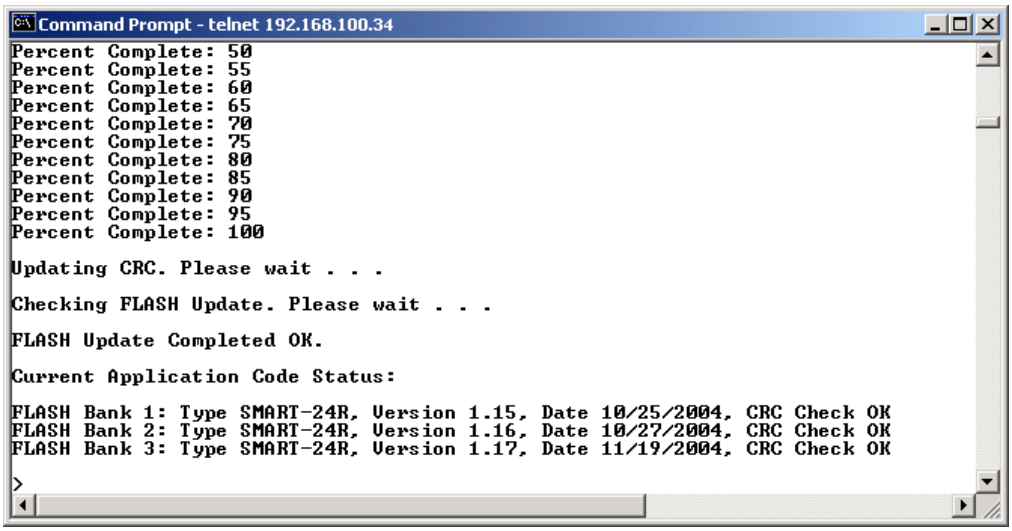
- Erases the selected FLASH bank.
- Checks that the FLASH bank was properly erased.
- Opens the HEX file and starts the write process. The percent complete is displayed.
- Calculates and stores the CRC check value.
- Verifies the stored code in the FLASH bank.
- Displays the new FLASH bank status and then exits the utility.

The following four screen captures illustrate the Telnet update session.









When the update is complete, the unit must be restarted or reset for the new application firmware to be loaded and executed. The 'RBT' command from the Telnet session can be used to do this remotely.

The HEX file should be removed from the internal drive A after it is no longer needed to free up disk space. This can be done via a FTP session to delete it. Note that if power is removed from the unit, the content of drive A will be lost and the HEX file will no longer be there. Also note that the content of drive A is not lost when just a hardware or software reset occurs (power is not removed).

Section 5

5. MAINTENANCE

After initial installation and configuration, the SMART-24 Series instruments do not require any routine or scheduled maintenance. From time to time the internal sensors of the SMART-24A® may need to be mechanically adjusted to remove any offset due to aging effects. See section 3.4.2.3 for details of this adjustment procedure.

Should an application firmware update be required, follow the corresponding procedures given in section 4.8 or by the factory for uploading new code to the unit.

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Section 6

6. BOREHOLE DATA DIGITIZER MODEL SMART-24B

6.1 INTRODUCTION

The SMART-24B (Borehole) is the newest member of the SMART-24 product line. Based on the SMART-24 architecture the borehole product brings all the features of the SMART-24D to borehole applications.

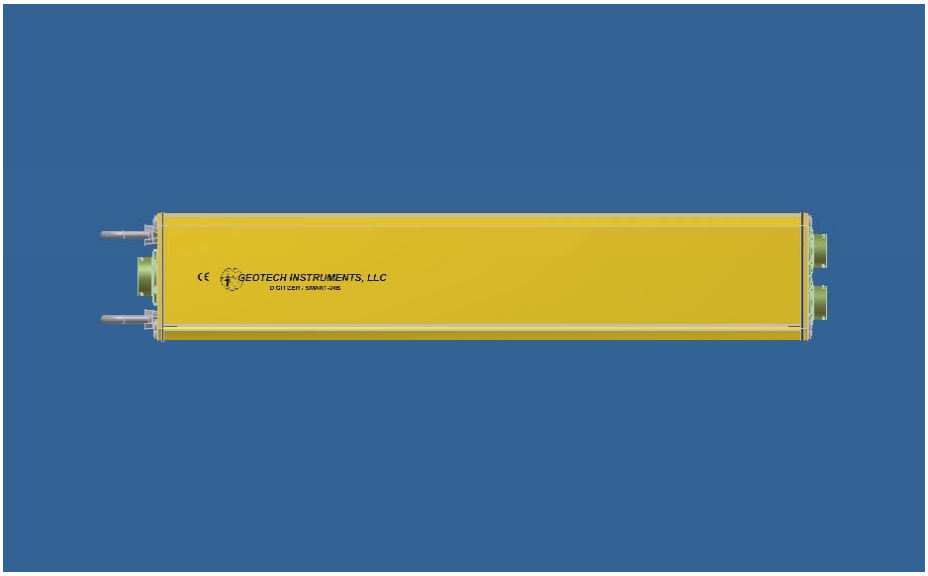

Figure 6-1. SMART-24B Instrument

6.1.1 Packaging

The SMART-24B instrument is housed in an extruded aluminum casing suitable for insertion in a 4" borehole (minimum). The enclosure provides protection from environmental factors such as wind, rain and dirt. However, it is not intended to provide submersion protection and should not be installed in a location that is susceptible to flooding conditions. Standard, sealed circular style connectors are provided for external user connection to the unit.

Internally, the SMART-24 Series instruments are composed of the following boards:

1. Power I/O Board (P/N 990-60631-0101)

2. DSP Board (P/N 990-60632-0101)

3. Three channel ADC Board (P/N 990-60568-010X, one standard, second board optional)

4. PCMCIA Interface Board (P/N 990-610162-0101, optional)

5. Digital I/O Board (P/N 990-60633-0101) – passive board provides connectivity only
6. Analog I/O Board (P/N 990-60634-0101) – passive board provides connectivity only

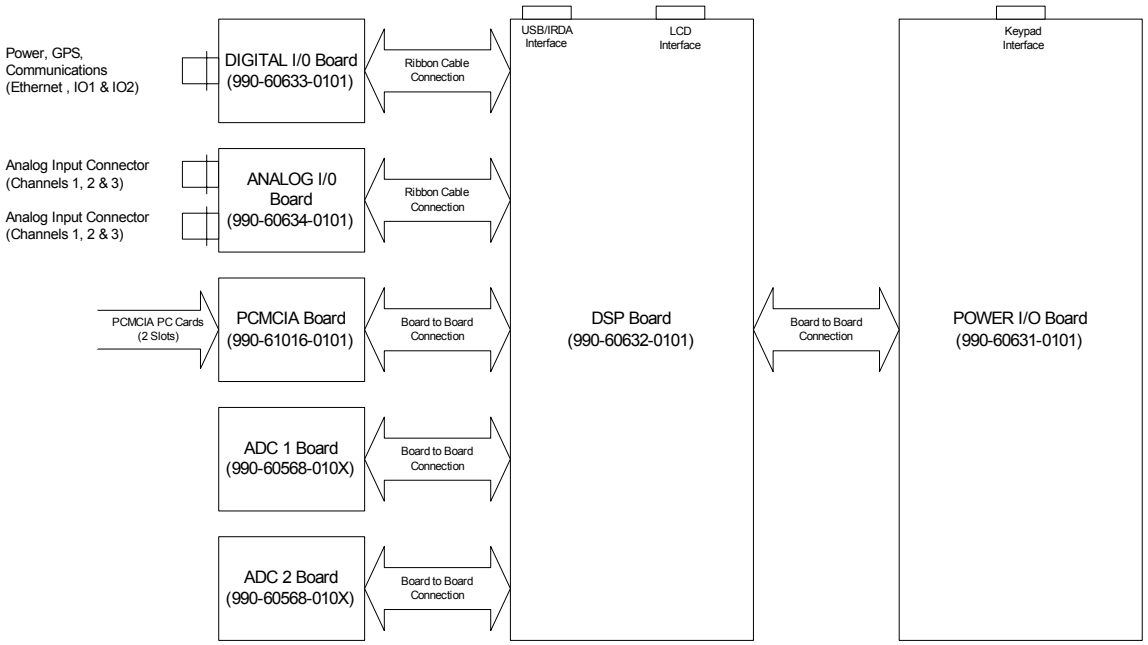

Figure 6-2. SMART-24 Series Block Diagram

6.1.2 Controls, Indicators and Connectors

The SMART-24 touch pad and LCD Display have been eliminated from the SMART-24B product housing, however the interfaces exist internally for manufacturing and test purposes.

Controls

The USER control is still available externally but has been moved to a new location. The USER button is now implemented with a ruggedized (IP67), push-button switch located in the Digital Harness.

Connectors

a) Analog Input/Output - Two analog input connectors are provided on the SMART-24 Series instruments, for ADC channels 1-3 and 4-6, respectively. See Figure 6-3.

b) Digital Input/Output– This connector consolidates the POWER, GPS, I/O1 and I/O2 connectors on the standard SMART-24 product line. See Figure 6-4.

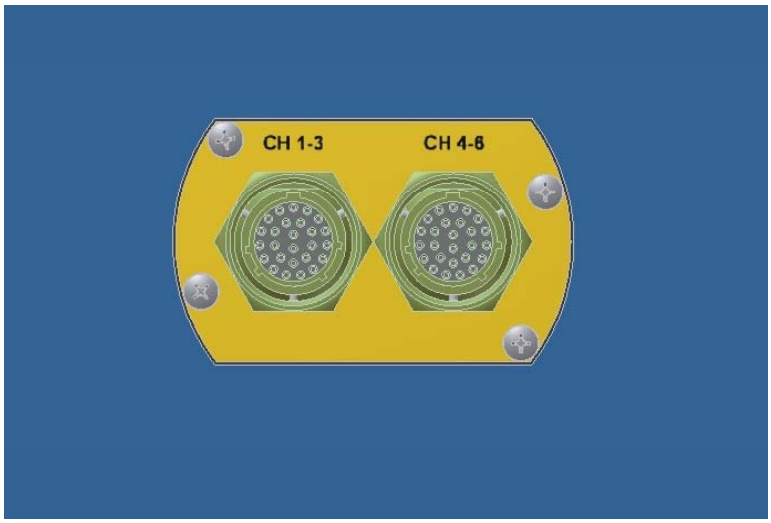

Figure 6-3 - Analog Input/Output Connectors

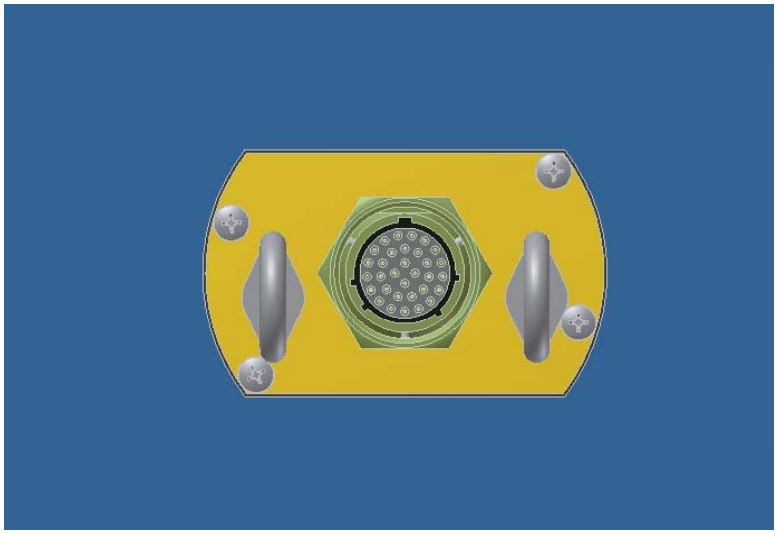

Figure 6-4 - Digital Input/Output Connector

1.2 EXTERNAL CONNECTIONS

6.2.1 Analog Input/Output

Purpose:

These connectors (CH 1-3 and CH 4-6) are used to supply the analog sensor input voltage to the digitizers. They also provide the calibration output signals. Unregulated 12V dc switched power output is also provided to the user on this connector.

Connection:

16-26S circular connector type.

Signals:

See Table 6-1.

Table 6-1. Analog Connector pin assignments and descriptions.

PIN	NAME	FUNCTION
R	CH1_SIG_POS	Channel 1 (Z) positive differential input (±10V)
P	CH1_SIG_NEG	Channel 1 (Z) negative differential input (±10V)
S	CH1_SIG_SHLD	Channel 1 (Z) shield (AGND)
N	CH1_CAL_POS	Channel 1 (Z) positive differential calibration output
M	CH1_CAL_NEG	Channel 1 (Z) negative differential calibration output
a	CH1_CAL_SHLD	Channel 1 (Z) shield (AGND)
L	CH1_MASSP	Channel 1 (Z) single ended mass position input (±10V) referenced to power ground
Z	CH1_AUTOZ/	Channel 1 (Z) auto zero digital control output (open collector) referenced to power ground
K	CH2_SIG_POS	Channel 2 (N) positive differential input (±10V)
J	CH2_SIG_NEG	Channel 2 (N) negative differential input (±10V)
Y	CH2_SIG_SHLD	Channel 1 (Z) shield (AGND)
H	CH2_CAL_POS Or CAL_CTRL_USER/	Channel 2 (N) positive differential calibration output Or Calibration digital control output (user defined, open collector)
W	CH2_CAL_NEG	Channel 2 (N) negative differential calibration output

	Or CAL_CTRL_1/	Or Calibration digital control output 1 (Z) (open collector)
G	CH2_MASSP	Channel 2 (N) single ended mass position input (±10V) referenced to power ground
F	CH2_AUTOZ/	Channel 2 (N) auto zero digital control output (open collector) referenced to power ground
V	CH3_SIG_POS	Channel 3 (E) positive differential input (±10V)
E	CH3_SIG_NEG	Channel 3 (E) negative differential input (±10V)
U	CH3_SIG_SHLD	Channel 1 (Z) shield (AGND)
D	CH3_CAL_POS Or CAL_CTRL_2/	Channel 3 (E) positive differential calibration output Or Calibration digital control output 2 (N) (open collector)
C	CH3_CAL_NEG Or CAL_CTRL_3/	Channel 3 (E) negative differential calibration output Or Calibration digital control output 3 (E) (open collector)
B	CH3_MASSP	Channel 3 (E) single ended mass position input (±10V) referenced to power ground
T	CH3_AUTOZ/	Channel 3 (E) auto zero digital control output (open collector) referenced to power ground
b	PWR	Power output (+12Vdc nominal)
A	PWR_GND	Power ground return
X	SER_1_POS	SMART seismometer serial 1 communications positive differential signal (function TBD)
c	SER_1_NEG	SMART seismometer serial 1 communications negative differential signal (function TBD)

6.2.2 Digital Input/Output

Purpose:

The Digital I/O connector provides the connections for POWER, GPS, serial I/O1, serial I/O2, ETHERNET plus some miscellaneous connections.

The POWER connections support the input of external DC power. The GPS connections support serial I/O and 1PPS connection to an external GPS receiver. Serial I/O1 and Serial I/O2 connections provide miscellaneous I/O such as Serial RS232/RS422 and the ETHERNET connections provide for a 10/100Base-T Ethernet port.

The USER touch pad button is provided via the Digital I/O connector. A ruggedized, push-button switch is provided on the Digital I/O Harness to access this feature.

An internal switch is used to denote authentication seal broken and the digitizing equipment open bits of the channel security byte contained in the channel status field of the CD1.1 Data Format Frame. This field is described in section 4.7.7.

Also included in the channel security byte are bits reflecting the Vault Door Open and Equipment Housing Open external digital inputs as referenced in Table 6-2.

Connection:

16-26S circular connector type.

Signals:

See Table 6-2.

Table 6-2. Digital Input/Output Connector pin assignment

PIN	NAME	FUNCTION
M	PWR	External power input, +10Vdc to +15Vdc, fused
L	PWR_GND	Power ground.
W	GPS_TX+	GPS RS422 TX Data +
D	GPS_TX-	GPS RS422 TX Data -
X	GPS_RX+	GPS RS422 RX Data +
E	GPS_RX-	GPS RS422 RX Data -
G	GPS_1PPS+	GPS RS422 1PPS +
F	GPS_1PPS-	GPS RS422 1PPS -
H	GPS_12V_PWR	GPS Power
Y	GND	GPS Ground (DGND)
S	IO_1_RX (RX+)	RS232 RX (RS422 RX+)
R	IO_1_TX (RX-)	RS232 TX (RS422 RX-)
T	IO_1_RTS (TX+)	RS232 RTS (RS422 TX+)(DIGITAL O.C. OUT1/)
e	IO_1_CTS (TX-)	RS232 CTS (RS422 TX-)(DIGITAL IN2/)
d	GND	RS232 Signal Ground (DGND)
B	IO_2_RX (RX+)	RS232 RX (RS422 RX+)
A	IO_2_TX (RX-)	RS232 TX (RS422 RX-)
C	IO_2_RTS (TX+)	RS232 RTS (RS422 TX+)(DIGITAL O.C. OUT1/)
V	IO_2_CTS (TX-)	RS232 CTS (RS422 TX-)(DIGITAL IN2/)(EQUIPMENT HOUSING OPEN)
g	IO_2_DIN3/	Digital input (active low) (VAULT DOOR OPEN)
U	GND	RS232 Signal Ground (DGND)
Z	TD+	Ethernet 10Base-T/100Base-TX TX Data +
J	TD-	Ethernet 10Base-T/100Base-TX TX Data -
a	RD+	Ethernet 10Base-T/100Base-TX RX Data +
K	RD-	Ethernet 10Base-T/100Base-TX RX Data -

c	IO_1_ANALOG_IN	Spare Analog Input (+/-10V)
b	IO_1- _ANALOG_RET	Spare Analog Input Return
p	IO_2_ANALOG_IN	Spare Analog Input (+/-10V)
n	IO_2- _ANALOG_RET	Spare Analog Input Return
f	USER_SWITCH/	Mode switch (active low)
j	GND	Ground (DGND)
h	GND	Ground (DGND)

6.3 PHYSICAL

6.3.1 Construction

Extruded aluminum case, aluminum end caps with standard, sealed circular style connectors

6.3.2 Size

3.82 in (97 mm) wide x 21.4 in (544 mm) long x 2.34 in (59 mm) high.

6.3.3 Weight

4.0 lbs (1.8 kg)

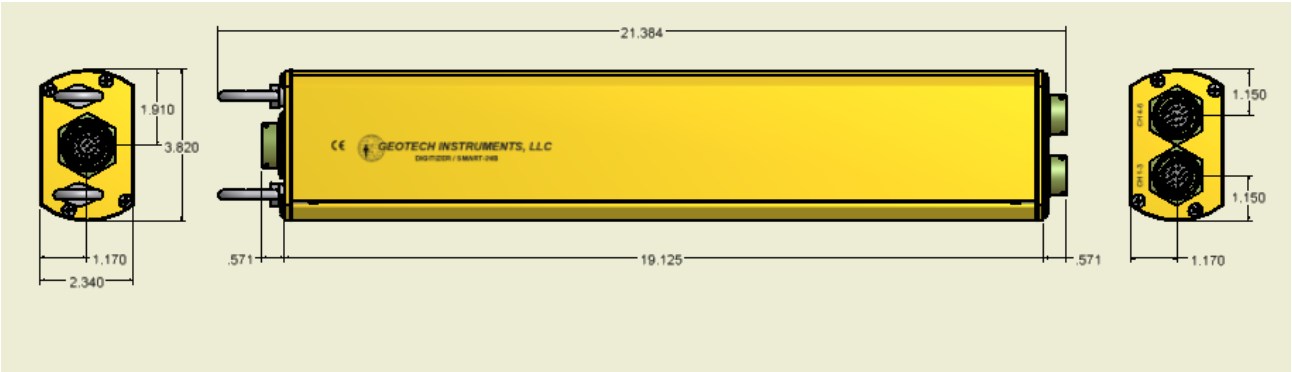

Figure 6-5. SMART24B Physical Dimensions

Appendix A

APPENDIX A. SMART-24 SERIES CABLE DIAGRAMS

This appendix provides schematics and diagrams of the standard SMART-24 Series instrument cables commonly used with the unit. These are as follows:

- Figure A-1. SMART-24 Power Cable
  Geotech P/N 990-60626-0101, Rev. B

- Figure A-2. SMART-24 I/O Cable, Serial to 9 Pin PC Plus Ethernet
  Geotech P/N 990-60649-0101, Rev. -

- Figure A-3. SMART-24 I/O Cable, Serial to 9 Pin PC
  Geotech P/N 990-60649-0102, Rev. -

- Figure A-4. SMART-24 I/O Cable, Ethernet Only
  Geotech P/N 990-60649-0103, Rev. -

- Figure A-5. SMART-24 I/O Cable, Serial to 9 Pin Modem Plus Ethernet
  Geotech P/N 990-60687-0101, Rev. -

- Figure A-6. SMART-24 I/O Cable, Serial to 25 Pin Modem Plus Ethernet
  Geotech P/N 990-60687-0102, Rev. -

- Figure A-7. SMART-24 to KS-2000 Cable
  Geotech P/N 990-60648-0101, Rev. A

- Figure A-8. SMART-24 to PA-23 Cable
  Geotech P/N 990-60639-0101, Rev. B

- Figure A-9. SMART-24 to S-13J Cable
  Geotech P/N 990-60677-0101, Rev. A

- Figure A-10. SMART-24 to GPS-3 Cable
  Geotech P/N 990-60628-0101, Rev. A

- Figure A-11. SMART-24 to S-13 Cable
  Geotech P/N 990-60955-0101, Rev. A

- Figure A-12. SMART-24B Digital I/O Cable,
  Geotech P/N 990-61058-0101, Rev. A

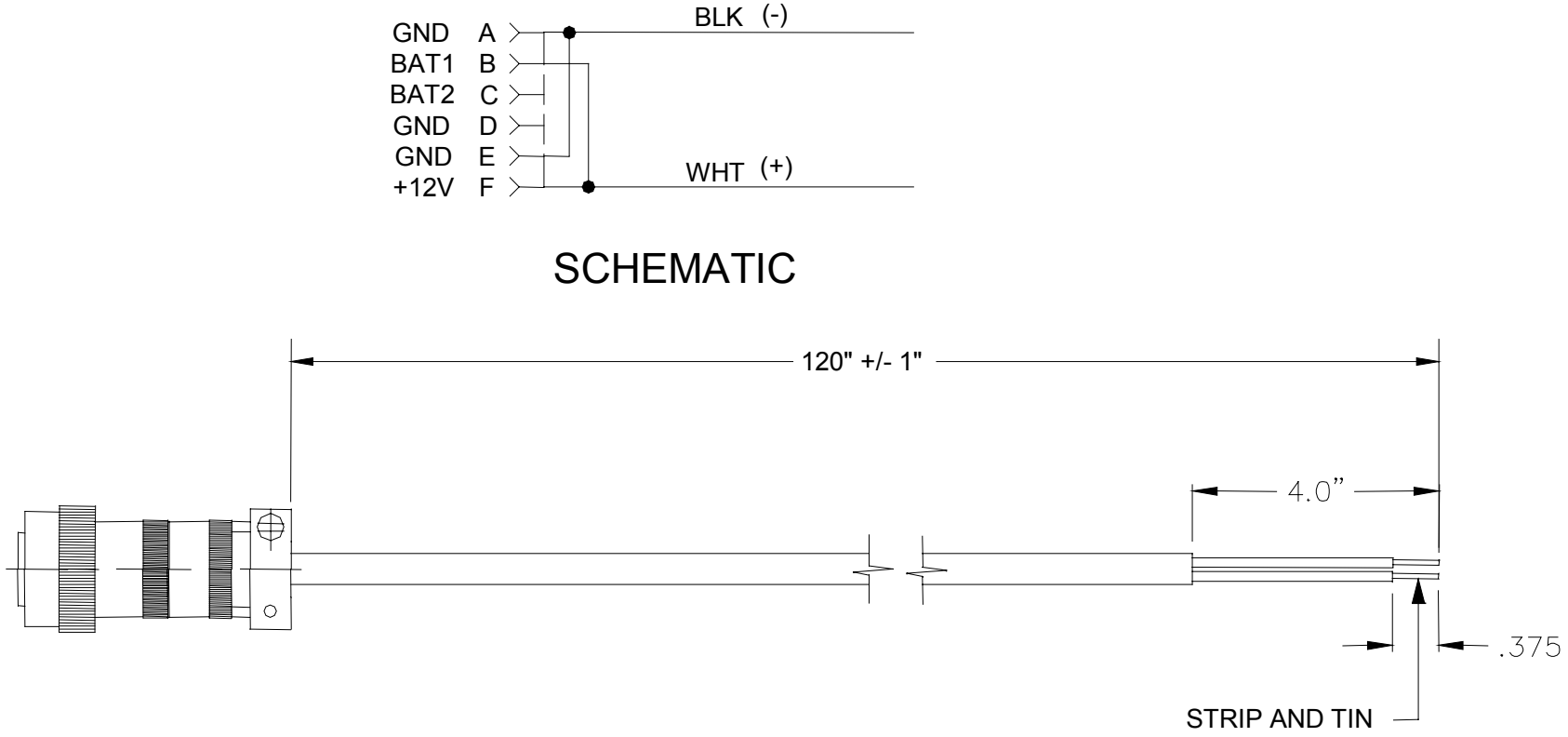

Figure A-1. SMART-24 Power Cable
Geotech Instruments Part Number 990-60626-0101, Rev. B

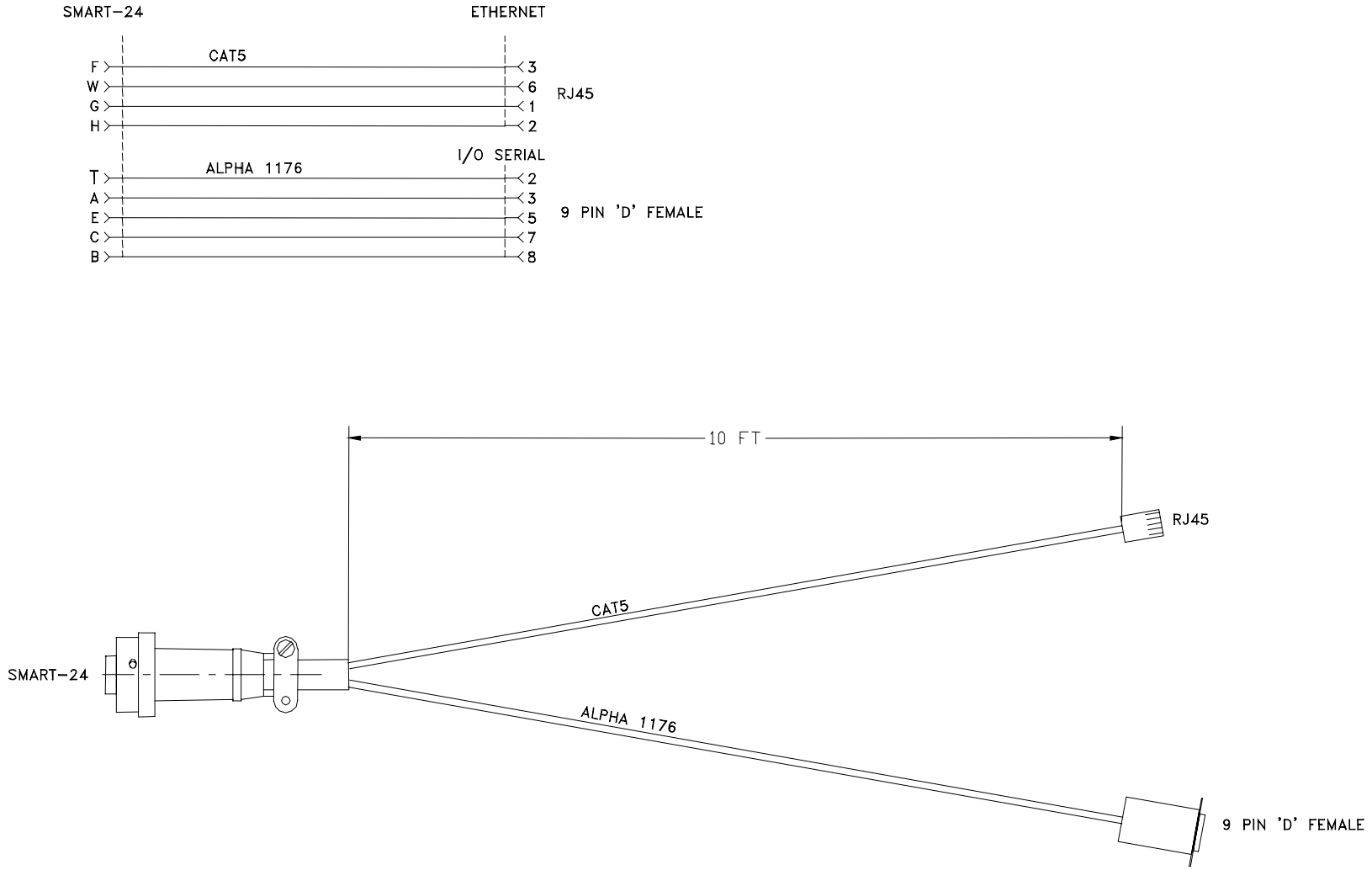

Figure A-2. SMART-24 I/O Cable, Serial to 9 Pin PC Plus Ethernet
Geotech Instruments Part Number 990-60649-0101, Rev. -

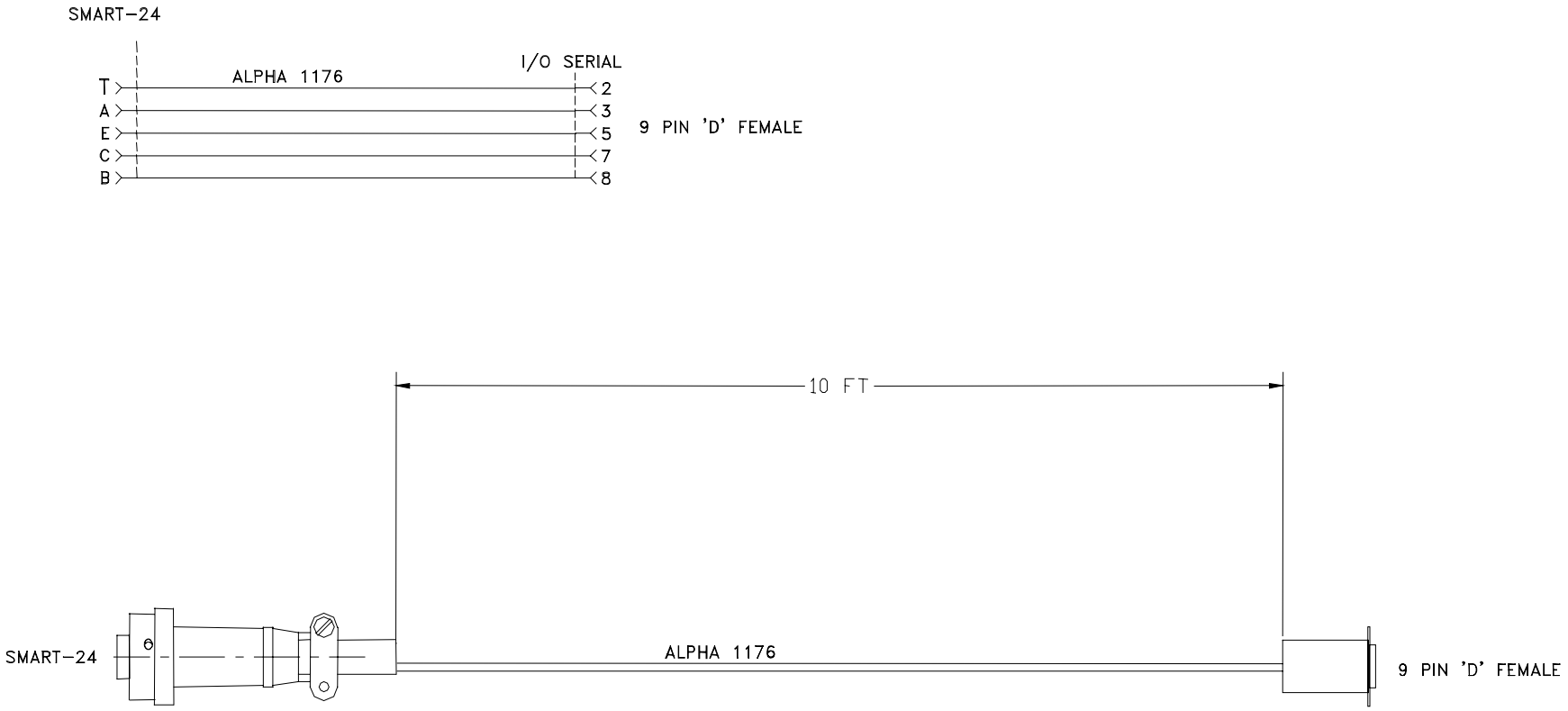

Figure A-3. SMART-24 I/O Cable, Serial to 9 Pin PC
Geotech Instruments Part Number 990-60649-0102, Rev. -

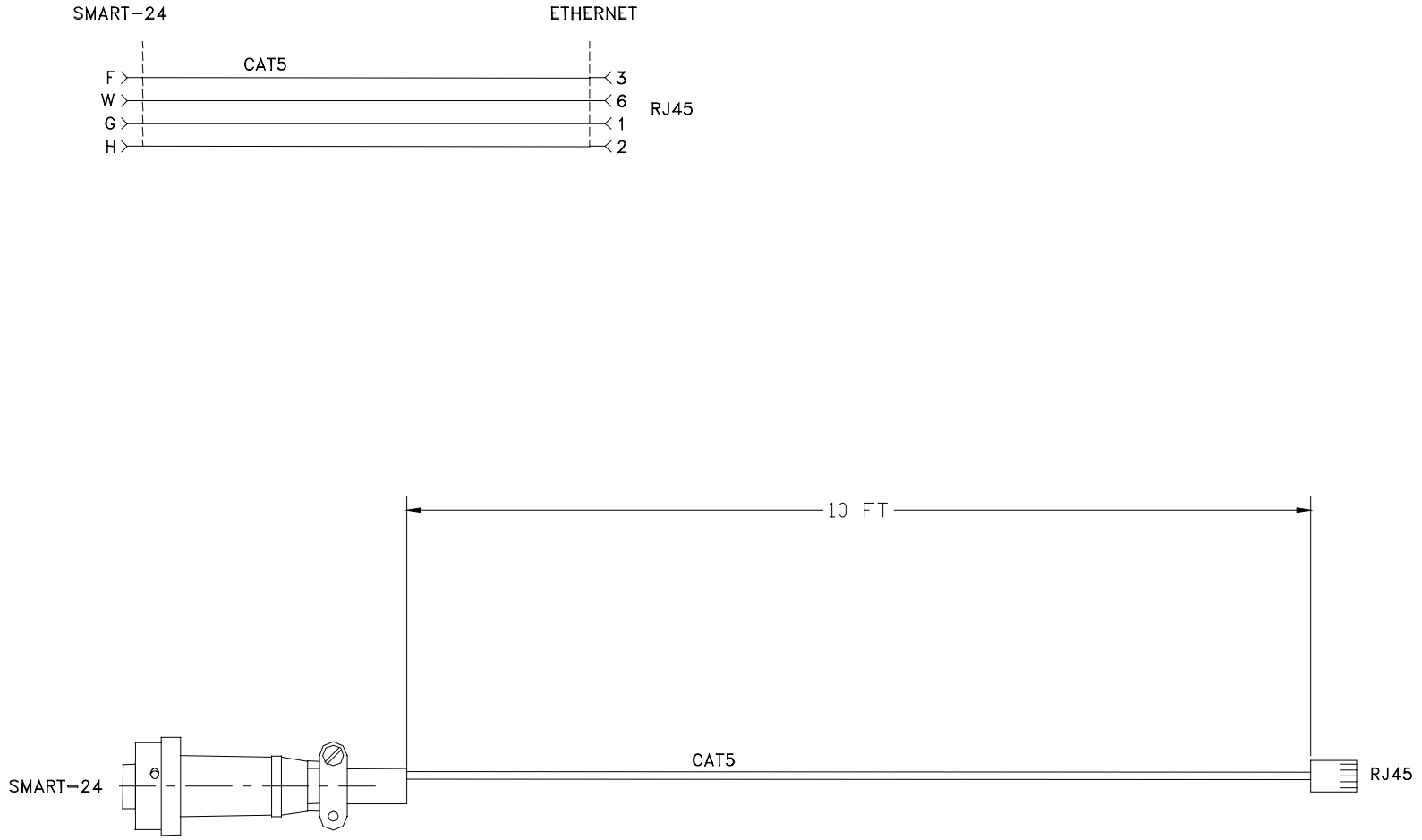

Figure A-4. SMART-24 I/O Cable, Ethernet Only
Geotech Instruments Part Number 990-60649-0103, Rev. -

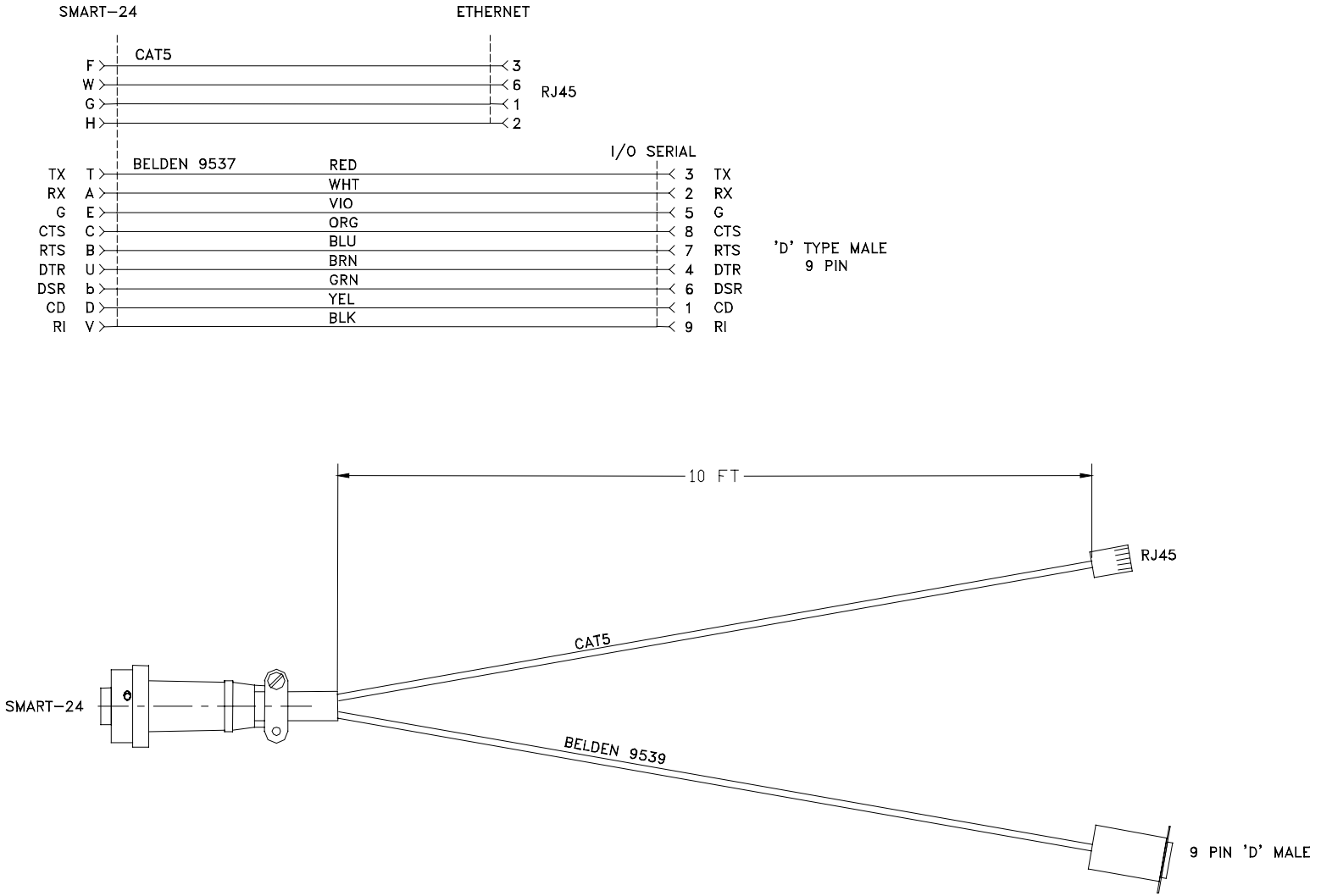

Figure A-5. SMART-24 I/O Cable, Serial to 9 Pin Modem Plus Ethernet
Geotech Instruments Part Number 990-60687-0101, Rev. -

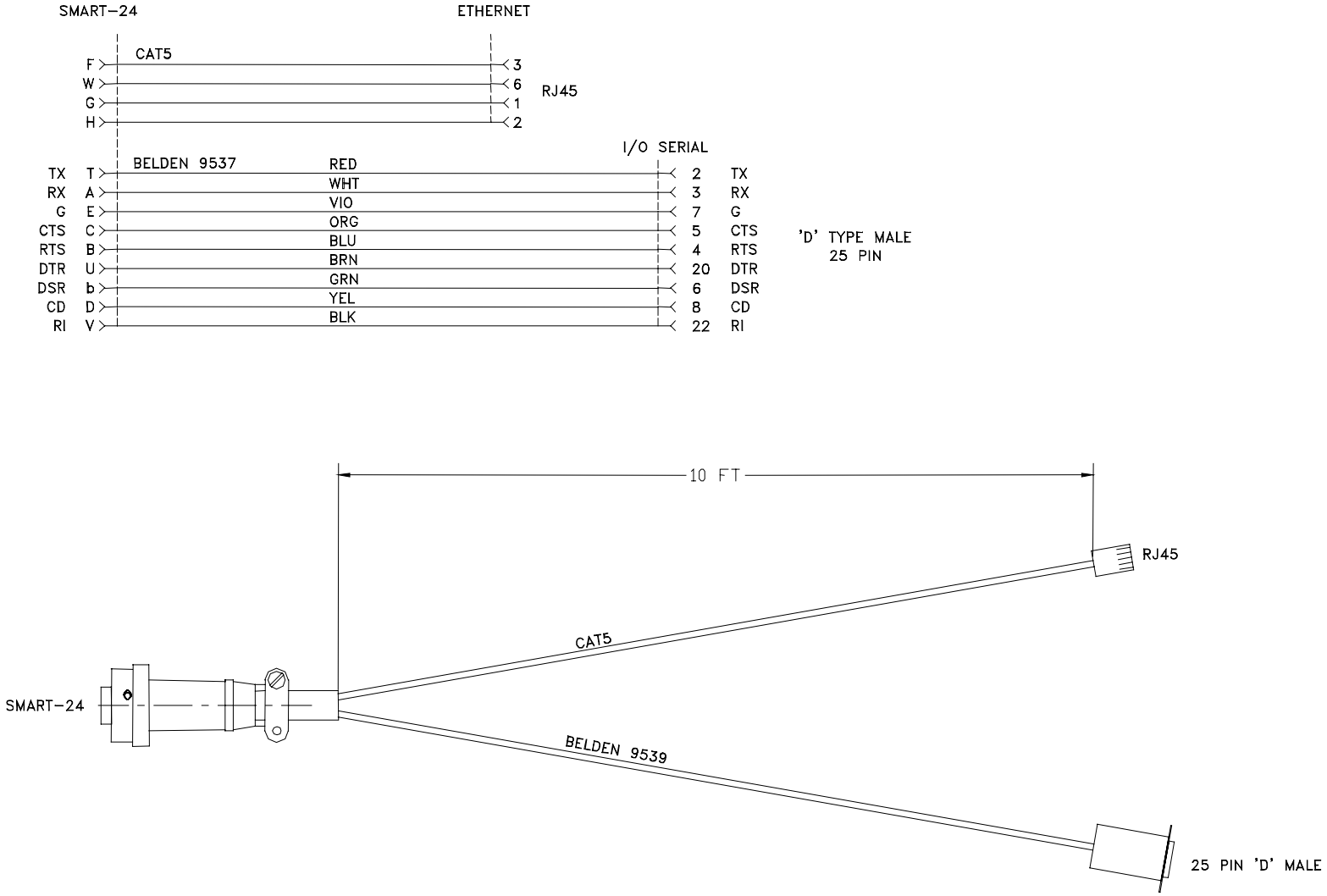

Figure A-6. SMART-24 I/O Cable, Serial to 25 Pin Modem Plus Ethernet
Geotech Instruments Part Number 990-60687-0102, Rev. -

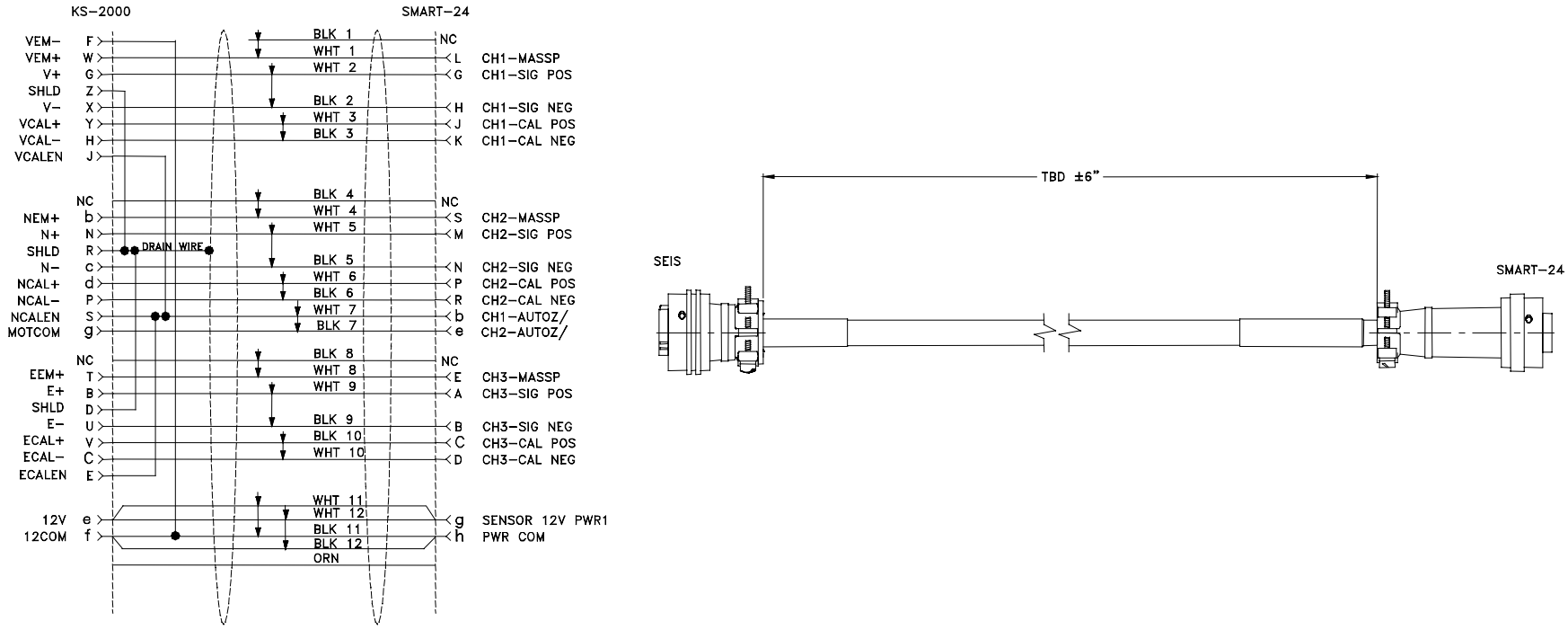

Figure A-7. SMART-24 to KS-2000 Cable
Geotech Instruments Part Number 990-60648-0101, Rev. A

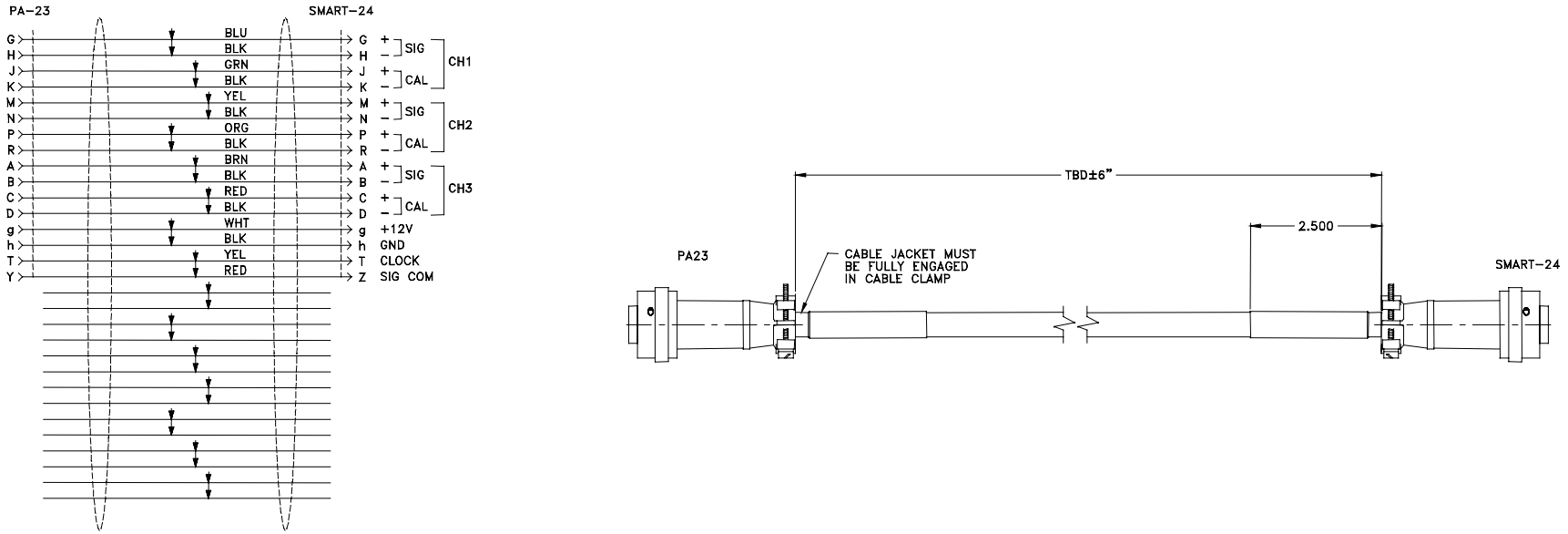

Figure A-8. SMART-24 to PA-23 Cable
Geotech Instruments Part Number 990-60639-0101, Rev. B

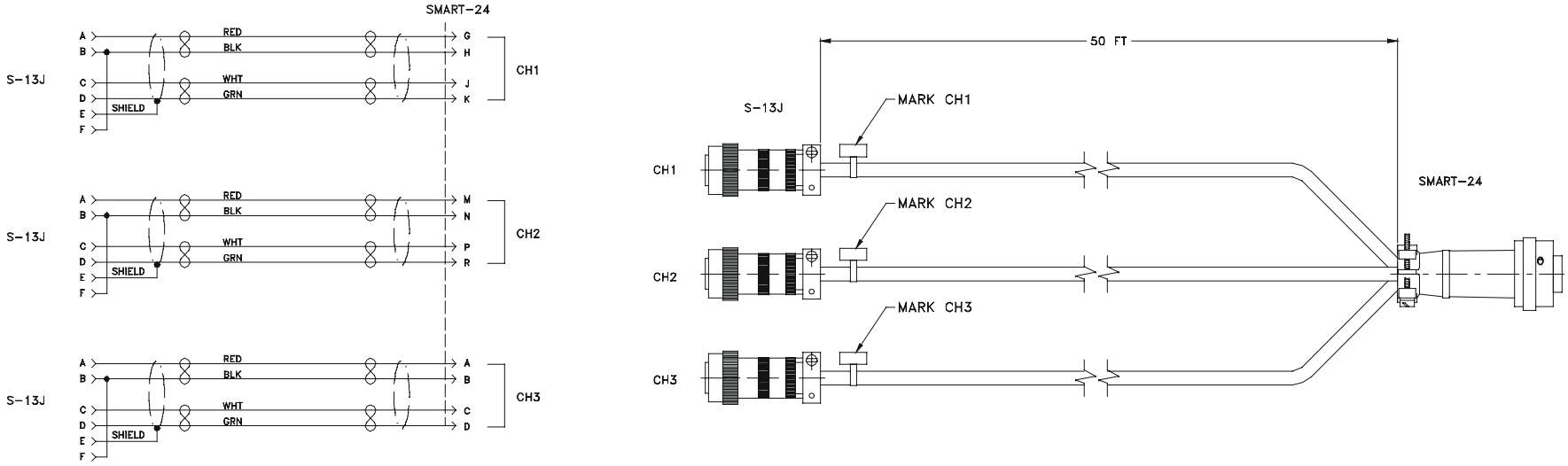

Figure A-9. SMART-24 to S-13J Cable
Geotech Instruments Part Number 990-60677-0101, Rev. A

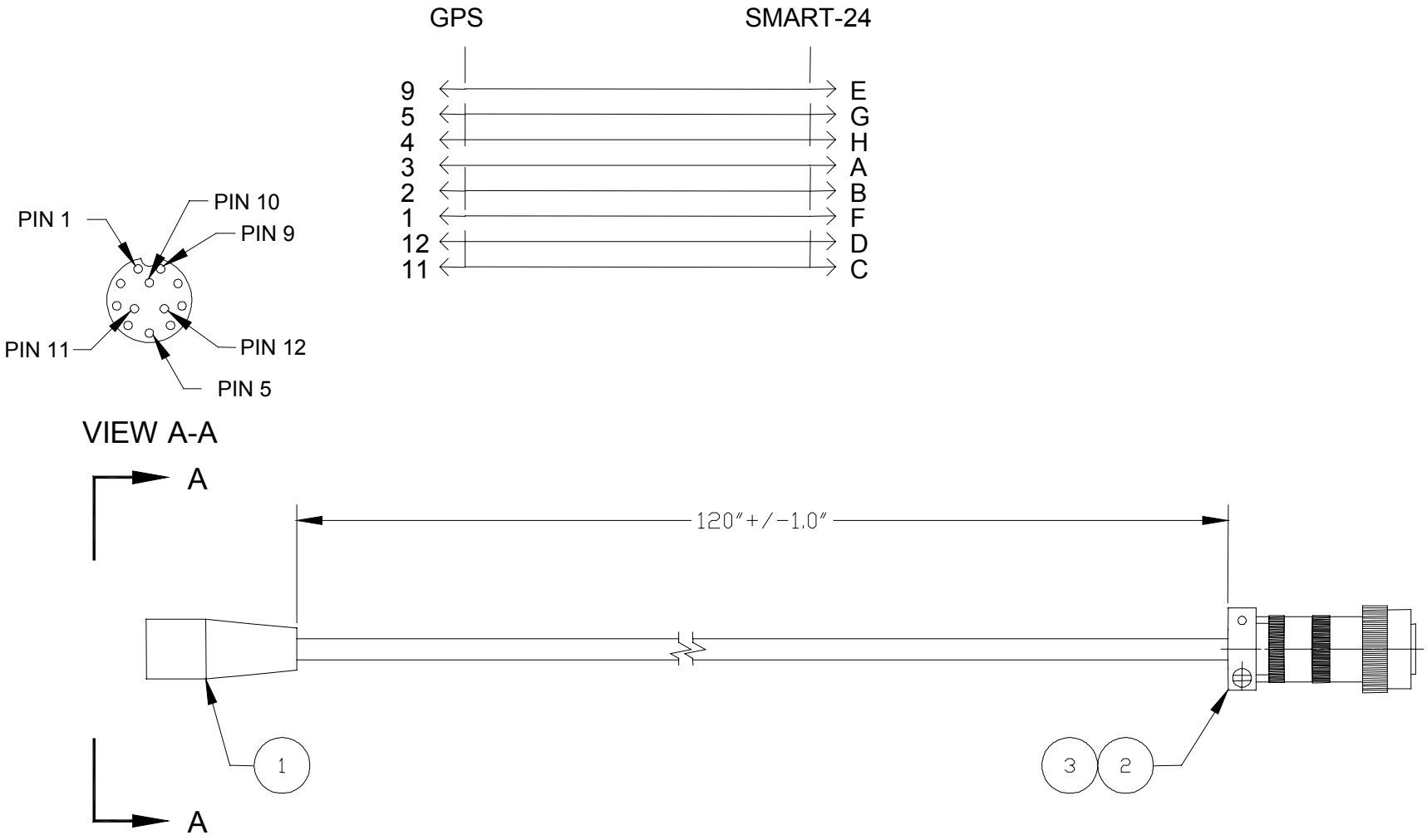

Figure A-10. SMART-24 to GPS-3 Cable
Geotech Instruments Part Number 990-60628-0101, Rev. C

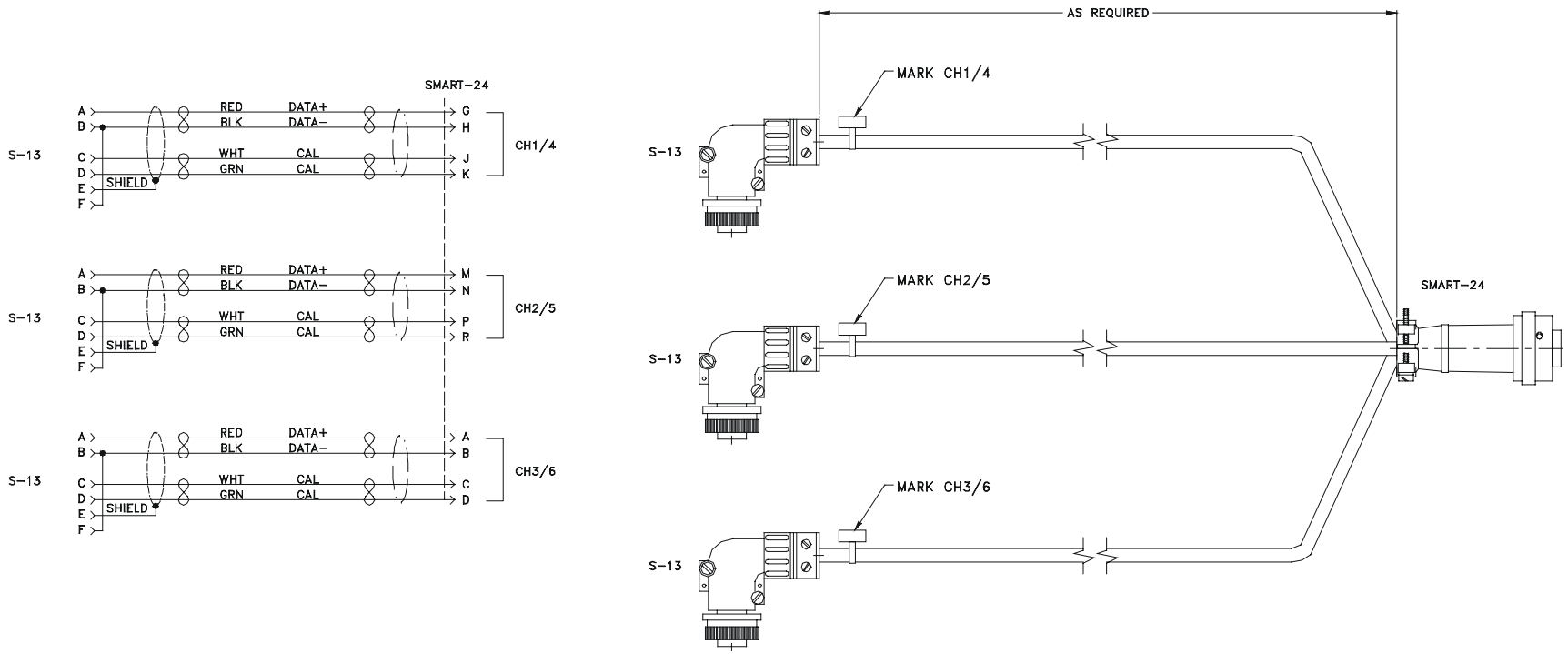

Figure A-11. SMART-24 to S-13 Cable
Geotech Instruments Part Number 990-60955-0101, Rev. A

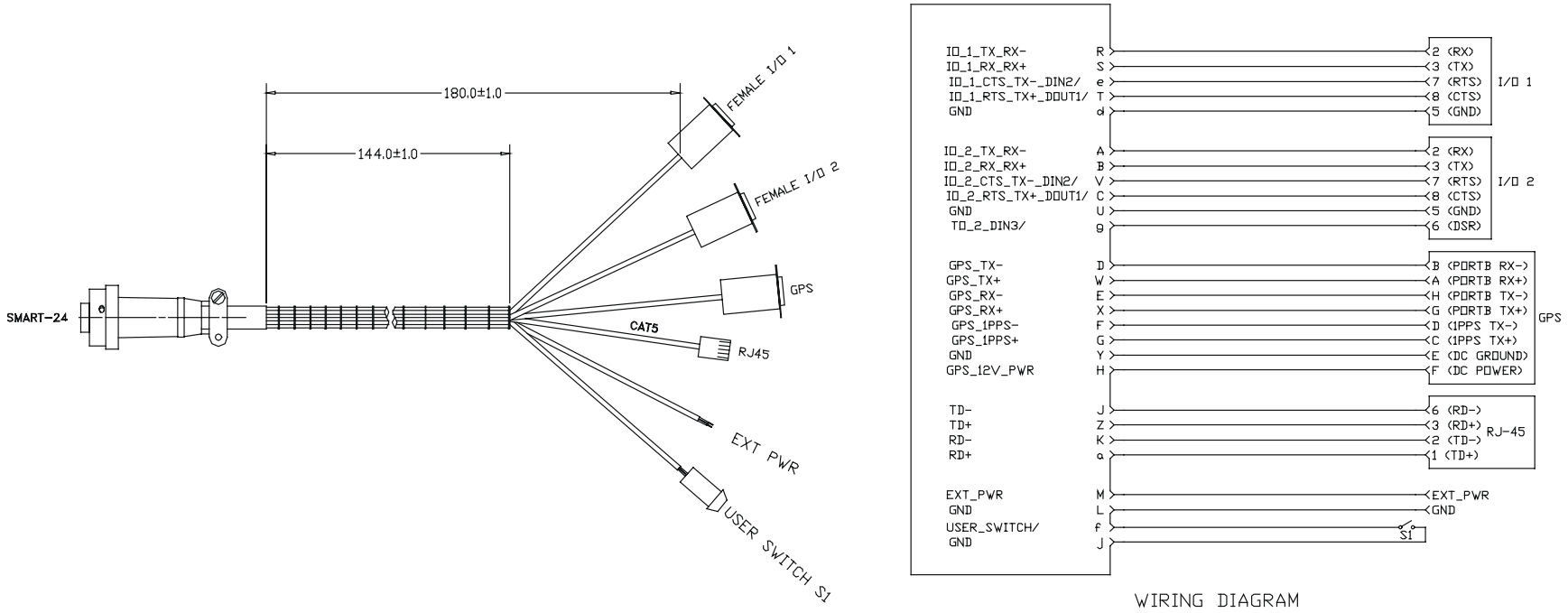

Figure A-12. SMART-24B Digital I/O Cable,
Geotech P/N 990-61058-0101, Rev. A

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Appendix B

APPENDIX B. SMART-24 SERIES FIRMWARE UPDATES

The following Appendix provides summary information on the SMART-24 series firmware updates that have been released since firmware version 1.17.

SMART-24 Version 1.18 Update

PBA - February 11, 2005

Summary of SMART-24 Application Software Version 1.18 Update

1. The SMART-24 code is now compiled (from a common source) into 24D, 24R and 24A specific versions.

   - The 24D version disables the following: disk drives B, C & D (RAMDRIVE A is still active), continuous recording, event trigger detection, event recording. Calibration, LOG and SOH files can still be recorded to drive A subject to its limited space. The 24D in intended for real time telemetry only (similar to the DR-24).

   - The 24R version has full functionality of all functions (file recording & real time telemetry).

   - The 24A version currently is different from the 24R only in its factory defaults. In the future it will differ also in 24A specific functions. It currently defaults to the following:

     a. 200sps primary sample rate.
     b. USGS RTD 16-bit output on serial port 2 at 50sps and 4800 baud.
     c. Event triggers and recording are enabled at 1% full-scale trigger level for channels 1, 2 & 3 only. Trigger filter is set to a 0.1 to 12Hz bandpass.
     d. All CD real time profiles are disabled so the unit is not continually trying to connect to a database server.

2. Improved GPS lock time.

3. Better protection against false RTC writes that could corrupt the unit's time on power down (this is in conjunction with new board MCU firmware on all boards).

4. Anonymous FTP access is now disabled by default but can be enabled using the new ANO command.

5. Modified compression so that if the compressed data turns out to be larger than the original data (because of padding, etc.), compression is disabled on the fly while this condition exists.

6. Added the ability to select minimum phase FIR filters instead of the standard linear phase FIR filters in the Crystal ADC. (Has not been tested yet!) The SFT

command was added to select the FIR filter type.

7. ADC Sync delay code has been added to correct for timing skew in the ADC data, but this is not functional until the Xilinx programmable logic has been modified. Added the SSD command to enable/disable this correction when available.

8. Added the USGS RTD serial data output (16-bit) format. This data stream can be enabled to come out either the I/O 1 or I/O 2 serial ports. Added the URT command to setup the format and sample rate of the RTD output.

9. Fixed bug that could cause the event detector filters to be improperly initialized. This effect was random depending on the power up state of the memory and caused by the fact that the TI complier does not set un-initialized variables to zero at startup as most compliers do. This could have cause a continuous trigger condition in level mode and no triggers in STA/LTA mode.

10. Fixed problem where the 'C', 'E' and 'B' display icons might not appear even though data files where being recorded correctly.

SMART-24 Version 1.19 Update

PBA - March 16, 2005

Summary of SMART-24 Application Software Version 1.19 Update

1. Added code to read the two Programmable Logic version values (DSP chip and CLK chip). These values are sent to the DSP MCU for it to decide whether it should write to the ADC synchronization correction registers or not (requires DSP MCU Firmware version 1.11 or higher to use the correction registers, but can still be used older DSP MCU firmware). These values are now also displayed by the HWS command as follows:

```
PLD_DSP_CHIP_VER: 14
PLD_CLK_CHIP_VER: 14
```

2. Added watchdog timer code. The watchdog timer can now be used as long as the application code is version 1.19 or higher AND the DSP Bootloader firmware is version 1.08 or higher. Installing jumper W36 on the Power I/O Board (990-60567-0101, the bottom board in the stack) will enable the hardware watchdog timer function. The unit will continually reset its self if this jumper is installed and the improper software versions are used.

3. The number of CD data and SOH frames that are saved and then retransmitted in case of a connection drop is now programmable by command rather than being hardcoded to 5. The new CDS (for data frames) and CSS (for SOH frames) commands were added for this purpose (see below for details). The user can set a range from 1 to 600 frames on both. This is only enabled on CD Profile 1 for now.

4. The parameter "Connection Request Timeout" is now used as the global socket timeout value for the CD Data Server (CD Profile 1 only for now). This means that the data server sockets will timeout X minutes (2 minutes default) when waiting to send data or receive data on a stalled connection. This value is set using the CRT command.

SMART-24 Version 1.20 Update

PBA - April 4, 2005

Summary of SMART-24 Application Software Version 1.20 Update

1. Fixed bug that prevented CD Profiles 2, 3 & 4 from transmitting data correctly.
2. Modified time tag correction for the minimum phase FIR filters.

SMART-24 Version 1.21 Update

PBA - April 29, 2005

NOTE: All of the new features of the SMART-24 Version 1.21 software rely on an updated version of the DSP MCU firmware, version 1.12. If this version is not installed on the unit the user will see no operational difference from that of version 1.20. This new version will work OK with older firmware, but without the added features.

Summary of DSP MCU Firmware Version 1.12 Update

1. Optimized the GPS control function to allow for easier and quicker locking of the GPS receiver in obscured conditions. Added an internal SPI bus command to allow the application code to modify various GPS operating parameters if needed. The new default settings should work in most cases.

2. Modified the GPS Status LCD screen to add a signal quality numeric value that shows the current overall quality of the combined satellite acquisition lock (see below for details). This value ranges from 0 to 100%. Generally a number higher than 86% is required to lock the GPS receiver.

3. Added a GPS Satellite Signal Strength Status LCD screen (see below for details). Also added an internal SPI bus command to allow the application code to retrieve the signal level values.

4. Added 8 more application controllable LCD screens (for a total of 16) that can be used by the application code to display information.

5. LCD screen time out is now 15 minutes before the LCD will automatically return to the main home screen.

6. Added channel signal data display capability to display the primary data channels on the LCD display under the control of the application software. Added internal SPI bus commands to pass control and data information from the application software to the DSP MCU.

7. Removed some of the test & debug functions from the debug serial port (GPS status display, etc.) to make room for the new code. This does not affect the user in any way since he has no access to these functions.

Summary of SMART-24 Application Software Version 1.21 Update

1. Added the GPC command to allow the user to set various GPS operating parameters.

2. Added the GPT command to allow the user to retrieve and view the current GPS satellite tracking signal levels from the GPS receiver.

3. Added functions to calculate running signal data statistics such as maximum count value, minimum count value, average (mean or offset) count value and average (mean or offset) voltage value. Added the GCS command to allow the user to retrieve and view the current data channel statistics.

4. Added the DDC command to allow the user to control the display of some new LCD screen displays (see below for details).

5. LCD screen changes:

    a. Station Information Screen: This screen now shows the NET and STA names and the primary channel names and location codes. The CP Profile information has been moved to a new set of screens.

    b. CD Profile Information Screens: These screens (one for each enabled CD Profile) show the connection request IP address, connection request port, command port, data frame size, SOH send rate, compression on/off and authentication on/off for each CD Profile.

    c. Data Channel Statistics Screens: These screens (one for channels 1, 2 & 3, and another for channels 4, 5 & 6) show the current average (mean or offset) count value and average (mean or offset) voltage value for each primary channel.

    d. Data Display Screens: These screens (one for channels 1, 2 & 3, and another for channels 4, 5 & 6) show the current channel waveforms for each channel in 10-second windows.

    e. GPS Status Screen: This screen adds a GPS signal quality measure in the upper right-hand corner. This value ranges from 0 to 100%.

    f. GPS Satellite Signal Level Screen: This screen shows the current GPS satellite signal levels for each satellite currently being tracked.

SMART-24 Version 1.22 Update

PBA - May 3, 2005

Summary of SMART-24 Application Software Version 1.22 Update

1. Maintenance update fixing a few minor bugs and improving inter-processor communication. No user operational or interface changes were made in this version.

SMART-24 Version 1.23 Update

PBA - May 10, 2005

Summary of SMART-24 Application Software Version 1.23 Update

1. Fixed AZR command query response (returned AZI instead of AZR).

2. The offset calibration command OSC was implemented but stubbed off so that it did not really do anything. It now performs the calibration correctly.

3. Beefed up the debug log messages and added more debug log levels.

4. Added the backfill enable/disable command CBF to enable or disable the LIFO backfill on the CD 1.1 data streams.

5. Improved the PPP connection reliability.

6. Improved DSP to MCU inter-processor SPI bus communications reliability.

7. Added WEB page access to display various status information pages.

SMART-24 Version 1.24 Update

PBA – July 11, 2005

Summary of SMART-24 Application Software Version 1.24 Update

1. Maintenance update fixing a few minor bugs and improving inter-processor communication. No user operational or interface changes were made in this version.

    - Fixed a problem where the LSB values from the ADC cards could be reported as 0 rather than the real value.

    - Fixed a scheduled calibration problem where the first calibration (repetition 1) of a scheduled sequence would not be executed properly. All other repetitions (2 and above) would be executed on schedule correctly.

SMART-24 Version 1.25 Update

PBA – August 11, 2005

Summary of SMART-24 Application Software Version 1.25 Update

1. This update adds four new Telnet commands available for the SMART-24A version only. These commands, accessed via the Telnet interface only, were added to aid in the testing and installation of the SMART-24A with internal accelerometers. The commands added are:

    - LEVEL – The LEVEL command allows the user to display the current sensor level inputs (averaged over two seconds) to aid in the testing and leveling of the unit during installation. It can also be used when adjusting the mechanical mass center of the sensors during maintenance.

    - TILT – The TILT command is used during factory tilt testing and calibration. The calibration results are stored in FLASH memory for later retrieval. A user considering using this command would need to replicate Geotech's tilt table setup and procedures to produce successful results. Please contact Geotech for advice in using this command.

    - CAL – The CAL command is used during factory testing and calibration of the sensor calibration signal inputs. The calibration results are stored in FLASH memory for later retrieval.

    - REPORT – The REPORT command is used to retrieve the results of the last successful TILT and CAL commands from FLASH memory.

SMART-24 Version 1.31 Update

PBA – February 1, 2006

Summary of DSP MCU Firmware Version 1.18 Update

1. Updated the time synchronization PLL logic to improve performance over all operating conditions. Added a factory programmable VCO adjust voltage span calibration variable to optimize performance and time to lock.

2. Fixed the potential LCD lockup problem when a time skip (such as a GPS leap second) occurs.

3. Added MCU/DSP SPI bus commands to report Time Sync status and VCO adjust span back to the DSP.

Summary of SMART-24 Application Software Version 1.31 Update

1. Added support for the Fortezza Crypto PCMCIA Card and authentication of the CD-1.1 real time data streams.

2. Added the following commands to support the Fortezza card and key management (discussed in more detail in the following sections):

    a. AGK – Generate new DSA key pair.

    b. ARK – Return DSA key pair.

    c. ASK – Start/Abort DSA key pair.

    d. AUG – Set user DSA G parameter values.

    e. AUP – Set user DSA P parameter values.

    f. AUQ – Set user DSA Q parameter values.

    g. FZS – Get Fortezza card status.

    h. PCS – Get PCMCIA card status.

3. Removed patch that allowed the Little Indian IP address bug in the connection response frame from the data server to be read correctly. The connection request frame from the digitizer now sets the sequence number in the frame header to a non-zero value indicating that this digitizer has new firmware in it that expects a correctly formatted IP address in the connection response frame.

4. Added new Web pages for PC Card and Fortezza card status information.

5. Fixed bug in the calibration signal generation logic that caused sine wave frequencies of less than 1Hz to be incorrectly generated.

6. Added/modified channel status in the CD data frames (vault door open, etc.).

7. Added a LIFO backfill marker in the CD data frames using the series field in the frame header. A value of 1 in this field means that the data is backfill data.

8. Added checks to detect the possible LCD lockup condition that could occur on a time skip (such as a GPS leap second) with DSP MCU firmware versions prior to 1.17. If this condition is found, the unit will cause the watchdog timer to trip and reset the unit.

9. Added the GTS command to report time synchronization status information from the DSP MCU.

10. Added the RST HARDWARE command to allow the user to command hardware resets remotely.

11. Added the TIMESYNC utility to the Telnet server that displays the time synchronization status information in real time.

12. Modified LOG file behavior to allow for correct appending to an existing LOG file on soft (non-power on) startups.

SMART-24 Version 1.32 Update

PBA – March 23, 2006

Summary of SMART-24 Application Software Version 1.32 Update

1. Modified the operation of the Global Channel Enables. Now they are always enabled on a set factory defaults command, so that if a new ADC board is installed it will be immediately usable without using the low level commands to enable it. The low level commands (GCE/GCD) are still available should the user need to use them.

2. Added the AZW command to allow the user to set the width of the autozero command pulse. This applies to both immediate and scheduled autozero commands. The default pulse width is ~250mS, but can now be set through this command up to 1 day (86400000 mS). The resolution of the pulse width is 250mS.

3. Bumped configuration version to 2 to add SNTP parameters and room for future expansion. On update, this version will find and convert V1 configurations to V2 so that the user does not have to do a set factory default command.

4. Various modifications and improvements to make the GPS slave mode operate and display correctly.

5. Fixed DSS HASH bug that caused authentication signatures to be incorrectly generated.

SMART-24 Version 1.33 Update

PBA – May 22, 2006

Summary of SMART-24 Application Software Version 1.33 Update

1. Modified the operation of the CD 1.1 Channel Subframe, Channel Status Field to include the following status bits:

    a) Zeroed Data Bit
    b) Clipped Data Bit
    c) Digitizing Equipment Open Bit
    d) Authentication Seal Broken Bit

    Zeroed data can occur on a GPS time synchronization where the time jumps forward to catch up to real time. Clipped data comes from the ADC flag bit and means that the analog front end is over ranged. Both Digitizing Equipment Open Bit and the Authentication Seal Broken Bit are derived from Digital Input 3 that is now wired to an internal magnetic switch. These status bits are now set in the real time CD 1.1 data streams as well as in data recording files.

2. Added OSR command to set an offset value (in counts) that will be removed from an AUX or Mass Position channel.

SMART-24 Version 1.34 Update

PBA – July 18, 2006

Summary of SMART-24 Application Software Version 1.34 Update

1. Modified Log Level 21 to provide log messages containing CD Channel Status information.

2. Modified Log Levels 17/19 to dump more detailed PPP packet information.

3. Updated the Tilt and Cal tests for the SMART-24A to allow for the correct testing of 4, 2 and 1g units.

4. Added DRT command to display the IP Routing Table status without having to be in the Telnet TCMD mode.

5. Added IPP command to set the Primary IP port.

6. Added SPH command to select the PPP Connection Handshake mode between either Microsoft PPP mode or Lantronix SCS PPP mode.

SMART-24 Version 1.47 Update

December 15, 2009

Summary of SMART-24 Application Software Version 1.47 Update

1. USB updates to recover from infrequent USB drive transaction fatal errors. Expanded USB driver support for different USB drive types.

2. Added support for an extended partition on the USB drive, Drive E. LCD display, FTP and WEB page status works on the second partition (Drive E) if present. Event file and continuous file recording can be split onto different partitions on the USB drive, and work in ring buffer mode on each. Low level commands were modified to support Drive E.

3. Added the command CTM to send CD 1.1 Event Triggered Data. Primary channels are sent as event data, and secondary channels as the continuous data stream. Sending event data only, continuous data only, or both is supported.

4. Synchronized all four CD profiles to support CDS and CSS low level commands.

SMART-24 Version 1.48 Update

September 1, 2010

Summary of DSP MCU Firmware Version 1.22 Update

1. Added support for GPS local time offset.

Summary of SMART-24 Application Software Version 1.48 Update

1. Added support to send continuous data to Earhworm on profile 1, using the Earthworm export protocol. Added new commands EWE to enable/disable Earthworm mode, EWI to set Earthworm installation ID, and EWM to set Earthworm module ID.

2. Added command GOS to set GPS Local Time Offset. If this is set to a non-zero value the SMART-24 will run on local time with the specified time offset from UTC.

3. Changing the station name with CNS command will cause the SMART-24 to reboot and restart.

4. Earthworm connection will now cause the "T" to appear on the LCD display.

5. Unknown commands (not found in the command list, for example if newer SmartConfig sent new commands to older SMART-24 firmware) will now just be ignored rather cause the multi command processing to abort.

Appendix C

APPENDIX C. SMART-24 SERIES COMMAND & SETUP PROTOCOL

This appendix provides the current Interface Control Document (ICD) for the SMART-24 Series Command & Setup Protocol. This document defines the low level ASCII commands used for the setup and configuration of the SMART-24 Series instruments.

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