Ocean Systems Test and Evaluation Program

Air Gap Field Installation Guide

A Manual for Field Installation and Maintenance Procedures for Deployment of Air Gap Measurement Systems Using the Sutron Xpert 9210B DCP with the Miros Microwave Sensor and the Laser Technology, Inc. Universal Laser Sensor

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U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

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Foreword

CO-OPS has accepted the responsibility for implementing the measurement of air gap, the distance between the water's surface and the lowest point (low steel) of a bridge. This measurement determines the vessel's clearance or air gap as it passes under a bridge, providing important information for marine pilots. Air gap sensors are becoming an integral part of the Physical Oceanographic Real-Time System (PORTS®), an expanding suite of instruments that measure and disseminate observations of environmental and meteorological parameters.

In May 2008 CO-OPS approved the use of a Laser Technology, Incorporated (LTI) Universal Laser Sensor (ULS) as a quality control device for the air gap system. This supplement describes the improvements to the system, including the laser sensor, updated data collection platform (DCP) and software, a Geostationary Operational Environmental Satellite (GOES) transmitter, 12-volt power supply for the Miros microwave sensor, and the elimination of the PORTS® Interface Board. A "Hydro type" system is now being used, which creates a cleaner looking installation.

In January 2009, the requirement for trigonometric leveling of the system was removed if a laser sensor is installed as part of the system.

This manual covers air gap systems installed after June 2008.

This Field Installation Guide assumes that the details of funding air gap measurement stations have been included in an overall Memorandum of Agreement (MOA) between NOS/CO-OPS and the PORTS® local partner, or that a new MOA has been developed and enacted. It also assumes that the exact location of the air gap measurement system has been determined and that all necessary permissions have been obtained. It is written for use by CO-OPS personnel and/or CO-OPS PORTS® operations and maintenance contractors who are experienced in the installation of air gap systems.

Introduction

The National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) manages several programs to monitor the Nation's coastal waters. The Physical Oceanographic Real-Time System (PORTS®) is one of NOS's vanguard improvements in providing environmental information to the maritime community. PORTS® provides real-time tide, current, and meteorological information to improve navigational decision-making, maximize a port's safety and economic performance, and prevent loss of life from maritime accidents.

As vessel sizes and the number of bridges increase, "ship-hit-bridge" stories are becoming more common. Less widespread are reports of ships that could not enter or exit a harbor due to air gap (bridge clearance) limitations. However, the economic gains to be realized by enhanced commerce and the avoidance of collisions are considerable, and a clear requirement for air gap information has been voiced.

Measuring the air gap between the water surface and the low steel of a bridge and making that measurement available to mariners are essential to help prevent damaging bridge strikes. A real-time determination of available clearance for bridges that experience significant seagoing vessel traffic of different sizes is critical for port authorities who are responsible for maritime safety in their area of operations. There are numerous documented cases of accidents where passing ships struck bridges, causing loss of life, damage estimated in the millions of dollars, and harmful ecological effects.

With ships taking advantage of every available inch of channel depth, plus the added difficulty of ship squat calculations, determining the available clearance of a ship under a bridge is complex. Bridge clearance information that includes water-level measurement helps mariners quickly determine the ship's margin of safety and contributes greatly to the prevention of maritime accidents.

As part of an expanding suite of instruments needed for PORTS®, CO-OPS has accepted the responsibility for implementing the installation of air gap sensors. The Port Authority of New York and New Jersey, the U.S. Coast Guard, and the Maryland Port Administration requested and funded the development and installation of the first air gap sensors.

Microwave sensor technology for measuring air gap was selected from among several options because it has the advantage of a relatively large footprint on the water surface, providing a spatial integration in contrast to a laser's single point, as well as being immune to fog and rain. Two commercial microwave altimeters were considered. The first, produced by Saab Marine Electronics in Sweden, was primarily used on offshore drilling rigs to observe waves and under-rig clearance; the second was produced by Miros in Norway. Functionally, the two sensors performed well, but the Ocean Systems Test and Evaluation Program (OSTEP) selected the Miros air gap sensor because it costs less;

has a larger range; is more precise, smaller, and lighter; draws less power, and has a wider environmental tolerance than the Saab unit.

CO-OPS has successfully installed nine operational systems, two of which are on bridges that span the western and eastern ends of the Chesapeake & Delaware Canal (fig. 1). Other systems include the Bayonne Bridge (New Jersey), the Chesapeake Bay Bridge (Annapolis), and the Gerald Desmond Bridge (Los Angeles). The most recent installations are on the Verrazano-Narrows Bridge (New York City), the Huey Long Bridge and Crescent City Connector (New Orleans), and the I-210 Bridge (Lake Charles, Louisiana). These installations include the Laser Technology, Incorporated (LTI) Universal Laser Sensor (ULS) and the latest Sutron Xpert 9210B data collection platform (DCP). Mounting diagrams for these systems can be found in appendix A.

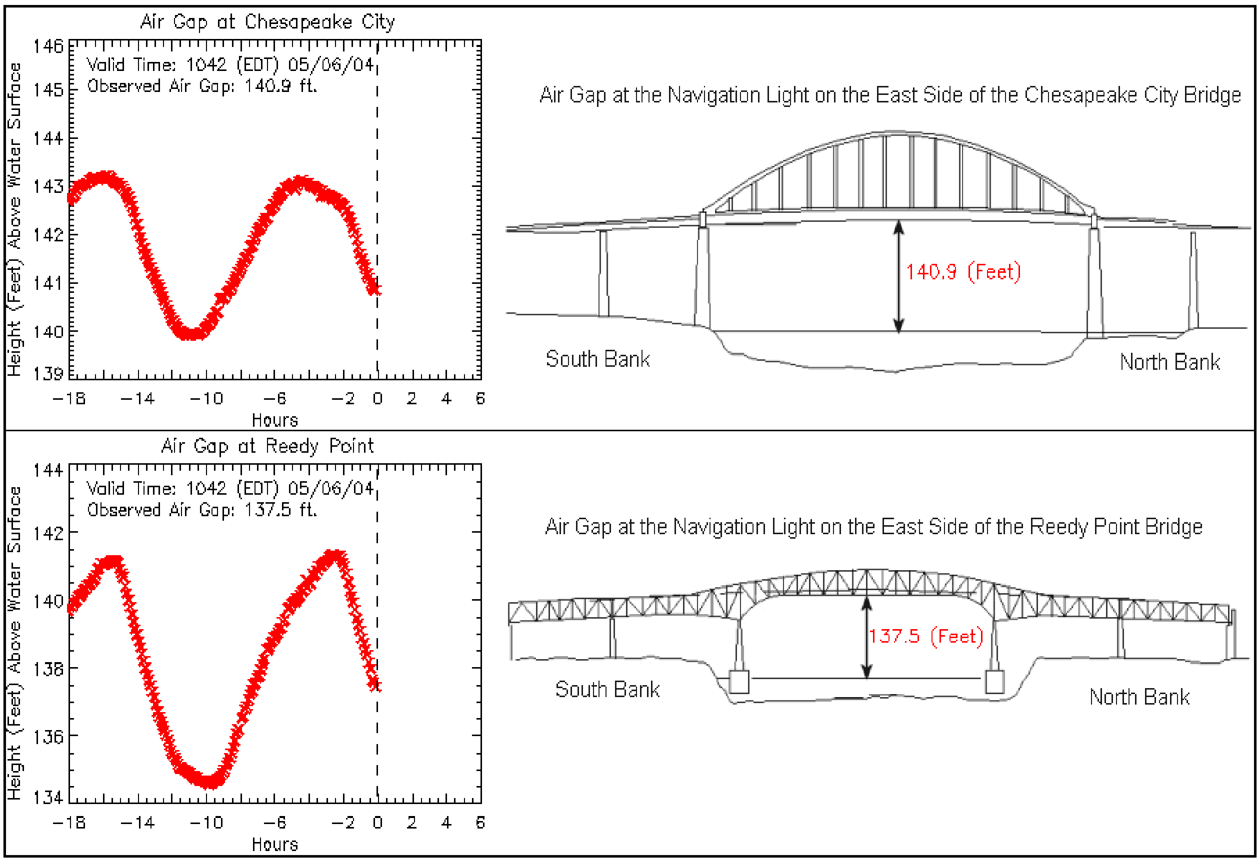

Figure 1

1.0 Purpose of this Document

This Field Installation Guide is for personnel who install and maintain air gap systems and includes the information needed for field personnel to stage equipment and successfully deploy, repair, and perform preventative maintenance on PORTS® air gap measurement systems. Although system standardization is a goal, the uniqueness of each bridge will require minor differences between each installation. This is a living document that contains the many lessons learned from each deployment. New lessons learned from operational experience and each subsequent deployment will be added as appropriate.

In May 2008 CO-OPS approved the use of an LTI laser sensor as a quality control device for the air gap system. This supplement describes the improvements to the system that include the laser sensor, updated DCP and software, a GOES transmitter, 12-volt power supply for the Miros sensor, and the elimination of the PORTS® Interface Board. A "Hydro type" system is now being used, which results in a cleaner looking installation.

2.0 System Overview

The air gap system consists of an air gap sensor, a data collection platform (DCP), and data communications hardware to transmit data to the CO-OPS server in Silver Spring, Maryland.

Miros Microwave Range Finder

The Miros Microwave Range Finder (fig. 2) operates according to the FMCW (frequency modulated continuous wave) principle. FMCW sensors emit a microwave FM chirp signal and receive an echo from the water surface. The signal propagation delay given by the distance from the antenna to the water surface causes a beat signal in the receiver. This beat frequency is converted to an accurate distance via advanced signal processing, thus, the range is proportional to changes in frequency. The digital signal processing is performed by a Motorola HC16 microprocessor. The special purpose range finder firmware performs data acquisition, range filtering and signal decimation, spectral analysis, range tracking, and data presentation. Table 1 provides the Miros sensor specifications. More technical information on the Miros Microwave Range Finder can be found in the Miros User Manual, which is available at the Chesapeake Instrument Laboratory (CIL).

The original Miros sensors required a 24-volt direct current (Vdc) power source. All new sensors are equipped with a 12-V power supply board that eliminates the need for the PORTS® Interface Board. Older sensors will be upgraded to the new board when each sensor is serviced. All upgrades must be performed at the CIL, and the sensor must be checked at the calibration facility.

Figure 2

Table 1

ATTRIBUTE	DESCRIPTION
Range	SM-094/50 3 to 50 m SM-094/85 3 to 85 m Minimum range: 1 m for all models
Accuracy	±1 cm (nominal, against fixed target) ±1 mm (averaged measurements, against /fixed target)
Measurement Principle	CWFM
Frequency of Operation	9.4 - 9.8 GHz
Modulation	Triangular
Output Power	-6 dBm (1/4 mW) (nominal)
Antenna	Type: Printed circuit patch antenna Beam-width: 5 degrees (one way half power) Gain: > 24 dB Antenna (reduced effective aperture, the antenna is designed to have symmetrical patterns in E and H-plane)
Voltage	+12 Vdc +30/-10%
Current	0.2 A
Environmental	Temperature: -30 °C to + 50 °C Humidity: 10 - 100%, condensing
Housing Material	Aluminum EN AW 5052 (57S) Finish: Enameled Color: Grey RAL 7035
Ingress Protection	Designed to meet IEC IP66
Dimensions and Weight	Max dim. (H × W × D): 70 × 510 × 420 mm Weight: 7 kg

Laser Technology, Incorporated Universal Laser Sensor

The Laser Technology, Incorporated (LTI) universal laser sensor or ULS (fig. 3) is a pulsed range finder that sends a single pulse of light, typically 8 milliseconds (ms) in duration, to a target and measures the time it takes for the pulse to return to the unit. Given that the speed of light is relatively constant, the distance to the target can be calculated. Because the duration of the pulse is in picoseconds, one pulse does not provide an accurate measurement. Therefore, the range finder uses a series of pulses and averages them, yielding a more accurate measurement. Table 2 provides the LTI sensor specifications. A complete LTI ULS User Manual is available at the CIL.

Figure 3

Table 2

ATTRIBUTE	DESCRIPTION
Pulsed Laser	905 nm (infrared) High Power 400 nJ per pulse Medium Power 200 nJ per pulse Low Power 100 nJ per pulse Average Power Proportional to PRF (pulse firing rate) Eye Safety FDA CFR 21 Class I - 7 mm
Accuracy **Resolution**	± 4 cm typical Non- Cooperative Target ± 2 cm typical Cooperative Target 0.01 ft (1 mm)
Internal Laser Pointer	Wavelength 650 nm (red) Eye safety FDA CFR 21 Class I 1 meter Switch Software controlled Output power 1 mW (average)
Communications	Configuration Port RS232 1200 - 230400 baud Universal Port RS232 1200 - 230400 baud RS485 1200 - 230400 baud 4 – 20 mA
Physical	Dimensions 5.3 in (L) × 4.75 in (W) × 2.5 in (H) 13.5cm (L) × 12cm (W) × 6.3cm (H) Weight 1.75 lbs (0.8 kg) Enclosure Anodized Aluminum Weather IP 54 Temperature -22 °F to +140 °F -30 °C to + 60 °C

Data Collection Platform

The Data Collection Platform (DCP) used with the Miros microwave sensor is manufactured by Sutron Corporation and is part of the Xpert family of DCPs. The Sutron Xpert model 9210B DCP (fig.4) is based on a 32-bit microprocessor using the Microsoft Windows CE operating system. The unit has integrated Analog and Digital I/O modules, four RS232 serial ports, an SDI-12 port and an I2C port for additional I/O modules (fig. 5). The system also includes a CD data card slot and Ethernet port. The unit is packaged in an 11 inch (in) × 6 in × 3 in aluminum case. Table 3 outlines the Sutron DCP system specifications. Appendix C provides more information about the DCP. A full Sutron Xpert 9210B manual is available at the CIL.

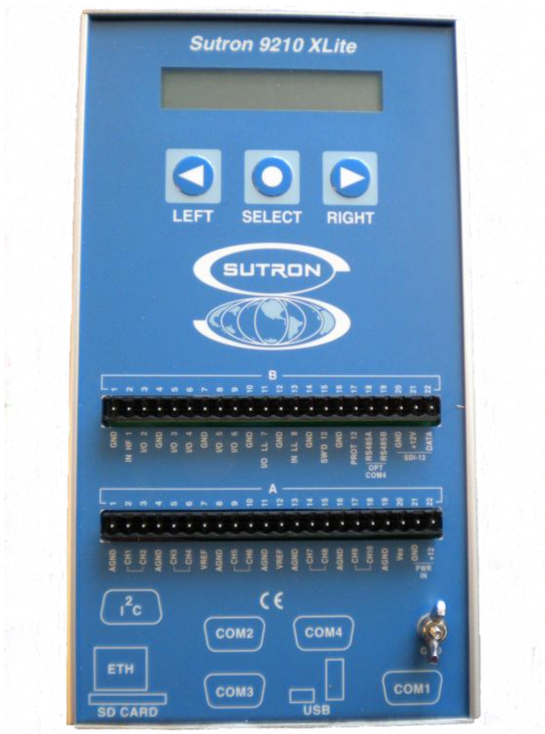

Figure 4

Figure 5

Table 3

SUTRON DCP SPECIFICATIONS
32 bit microprocessor running Microsoft Windows CE operating system
8 channel digital I/Os (6 bi-directional)
10 channel 16 bit A/D inputs (0-5Vdc full scale)
Software control of switched 12Vdc power on the I/O modules
32MB flash disk
32 MB RAM
4 RS232 ports that can be used for sensor inputs or outside communications such as LOS radio, GOES satellite, telephone or IP modems.
CD card slot for additional storage, up to 2 GB
Ethernet port
Input power 10-16 Vdc (40 mA, 230 mA with Display on)

Data Transmission

A Sutron Satlink GOES transmitter has been added to the system to provide GPS timing and transmission of the data every six minutes. The upgrade also includes GOES and GPS antennas that must be mounted with a clear view to the south. The transmitter is programmed through the 9210B DCP.

Data are transmitted one of two ways: either via the PORTS® data acquisition system (DAS) or GOES. Each way follows the same path as other CO-OPS data types. Figure 6 illustrates both paths for transmitting air gap sensor data.

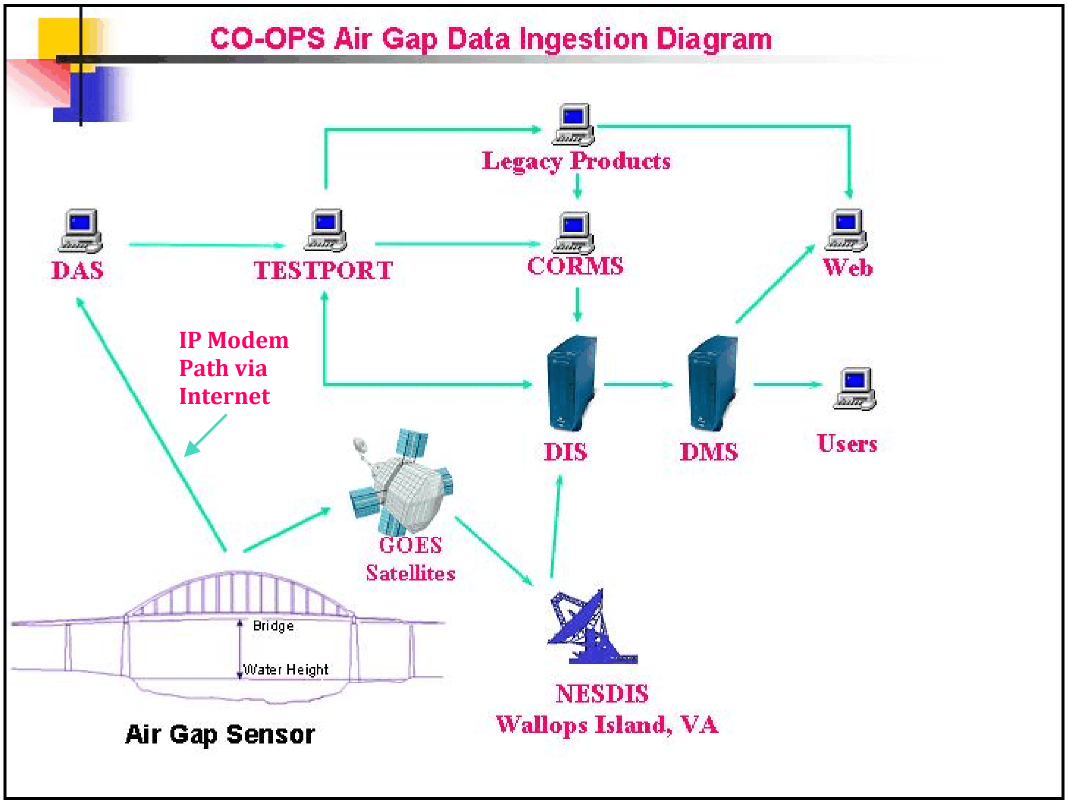

Figure 6

3.0 Field Deployment and Maintenance Instructions

Because each air gap sensor installation is unique, this document is an installation and maintenance guide, not a step-by-step instruction. No two bridges are exactly the same; therefore each sensor mounting will be slightly different. It assumes that only personnel who are experienced with air gap systems will be installing them.

An extensive site reconnaissance is conducted prior to each sensor installation. Personnel should review the CO-OPS Bridge Clearance Site Reconnaissance Procedures, as well as the resulting documentation from the reconnaissance for the particular installation being performed. The CO-OPS Bridge Clearance Site Reconnaissance Procedures, which also contains the documentation forms, can be found in appendix B.

3.1 INITIAL INSTALLATION

3.1.1 Notify Local Contact

The CO-OPS PORTS® Site Representative or the PORTS® Implementation Manager will supply the field crew with a Points of Contact (POC) list for each air gap station. The Field Crew Chief must notify the appropriate local contact and agree on an installation date. Systems located on busy bridges may require a bridge or lane closure, which may need a 2- to 3-week advance notice. Bridge or lane closures are expensive and disruptive; therefore, it is important that all equipment is fully checked and functional before closures are scheduled. The Crew Chief should also check for any already-planned closures or work, installing the system at that time if possible. The same holds true for routine maintenance; check for a scheduled closure and arrange for maintenance to occur at the same time.

3.1.2 Safety Precautions

Personnel must comply with all CO-OPS Field Facility Safety Rules (draft 4/7/04) and NOAA Safety Rules (draft 4/1/03). NOAA and CO-OPS Safety Procedures require that hard hats, safety reflective vests, safety shoes, and climbing gear be worn by all persons at all times while on bridges. Hard copies of this safety information can be found in the CO-OPS Chesapeake facility library or on the CO-OPS common drive at: \\Co-ops-s-ssmc1\common\CO-OPS_Com\Field_Safety_Manual and on the Chesapeake common drive (H) in a folder called Field_Safety_Manual.

3.1.3 System Mounting

Since no single mounting system works on all bridges, this Field Installation Guide uses the Reedy Point Bridge test site as a guide. Other mounts can be found in appendix A, and additional mounts will be added as they are designed and installed.

The sensor at the Reedy Point test site is mounted on the south side of the man-cage, which is located on the east side of the Route 9 Bridge in Delaware City, Delaware (fig. 7

and fig. 8 show top view and front view, respectively). This is the same location of the Reedy Point operational air gap system, which is mounted on the north end of the man-cage. The test sensor is mounted to a stainless steel frame, which is mounted to the man-cage using stainless steel U-bolts. Because the sensor case is aluminum, it must be isolated from the frame to prevent corrosion. Figure 9 shows the correct location of the plastic isolation washers. **DO NOT** install the sensor without these washers. The laser sensor is mounted in a Pelco waterproof camera case, which is vertically mounted next to the Miros microwave sensor. The Pelco case is mounted to a stainless steel channel, which is mounted to the man-cage by using U-bolts and stand-off blocks. The DCP, batteries, and related equipment are located in a NEMA4 enclosure to the right of the sensors and are secured using a Unistut mounting system.

Figure 7

Figure 8

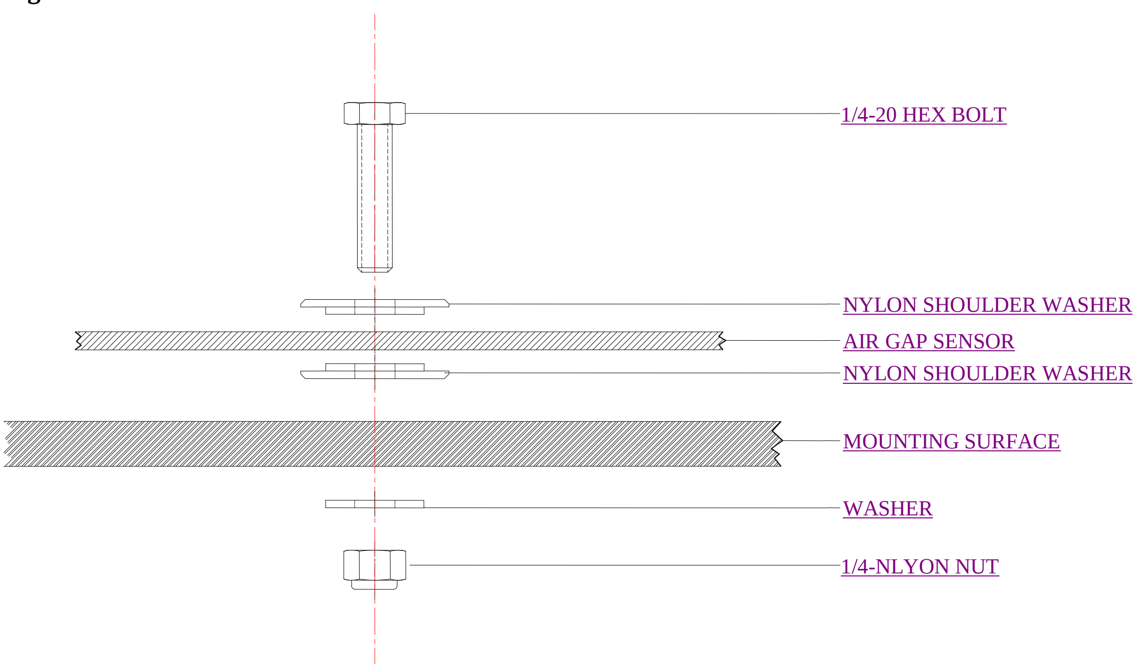

Figure 9

3.2 POWER CONNECTIONS

Three 12V 40A batteries, which are charged using three 110-Vac chargers, provide system power. During installation, 110-Vac service must be available near the location of the electronics enclosure. Receptacles (or a power strip) are mounted inside the enclosure. The batteries are connected to the fuse panels using the pre-wired power cables, as shown in the air gap power wiring diagram (fig. 10). A larger diagram can be found in appendix F.

Sensor Connections

All sensor and DCP connections are made via the main terminal strip, which is located on the communications mounting plate (fig. 11). The strip provides connections for power and data for all sensors. See fig.10 for connection information.

Communications Connections

There are three antenna connections, and they are located on the lower right side of the electronics box. The connectors for GOES, GPS, and wireless IP modem are marked for each antenna. Figure12 shows the location of the connectors.

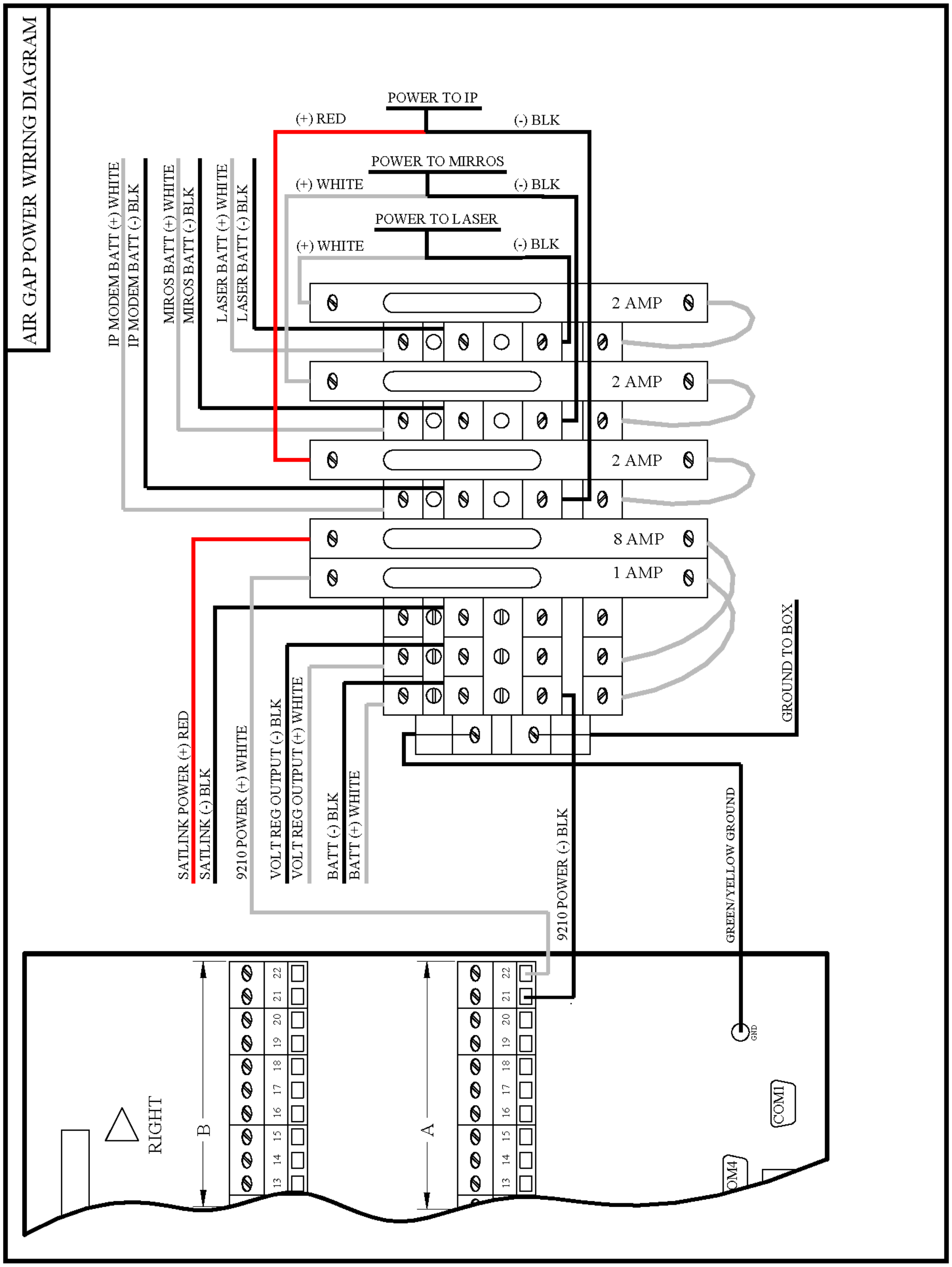
AIR GAP POWER WIRING DIAGRAM
POWER TO IP
(+) RED
(-) BLK
POWER TO MIRROS
(+) WHITE
(-) BLK
POWER TO LASER
(+) WHITE
(-) BLK
IP MODEM BATT (+) WHITE
IP MODEM BATT (-) BLK
MIROS BATT (+) WHITE
MIROS BATT (-) BLK
LASER BATT (+) WHITE
LASER BATT (-) BLK
2 AMP
2 AMP
2 AMP
8 AMP
1 AMP
GROUND TO BOX
SATLINK POWER (+) RED
SATLINK (-) BLK
9210 POWER (+) WHITE
VOLT REG OUTPUT (-) BLK
VOLT REG OUTPUT (+) WHITE
BATT (-) BLK
BATT (+) WHITE
9210 POWER (-) BLK
GREEN/YELLOW GROUND
RIGHT
B
A
GND
COM1
OM4

Figure 10

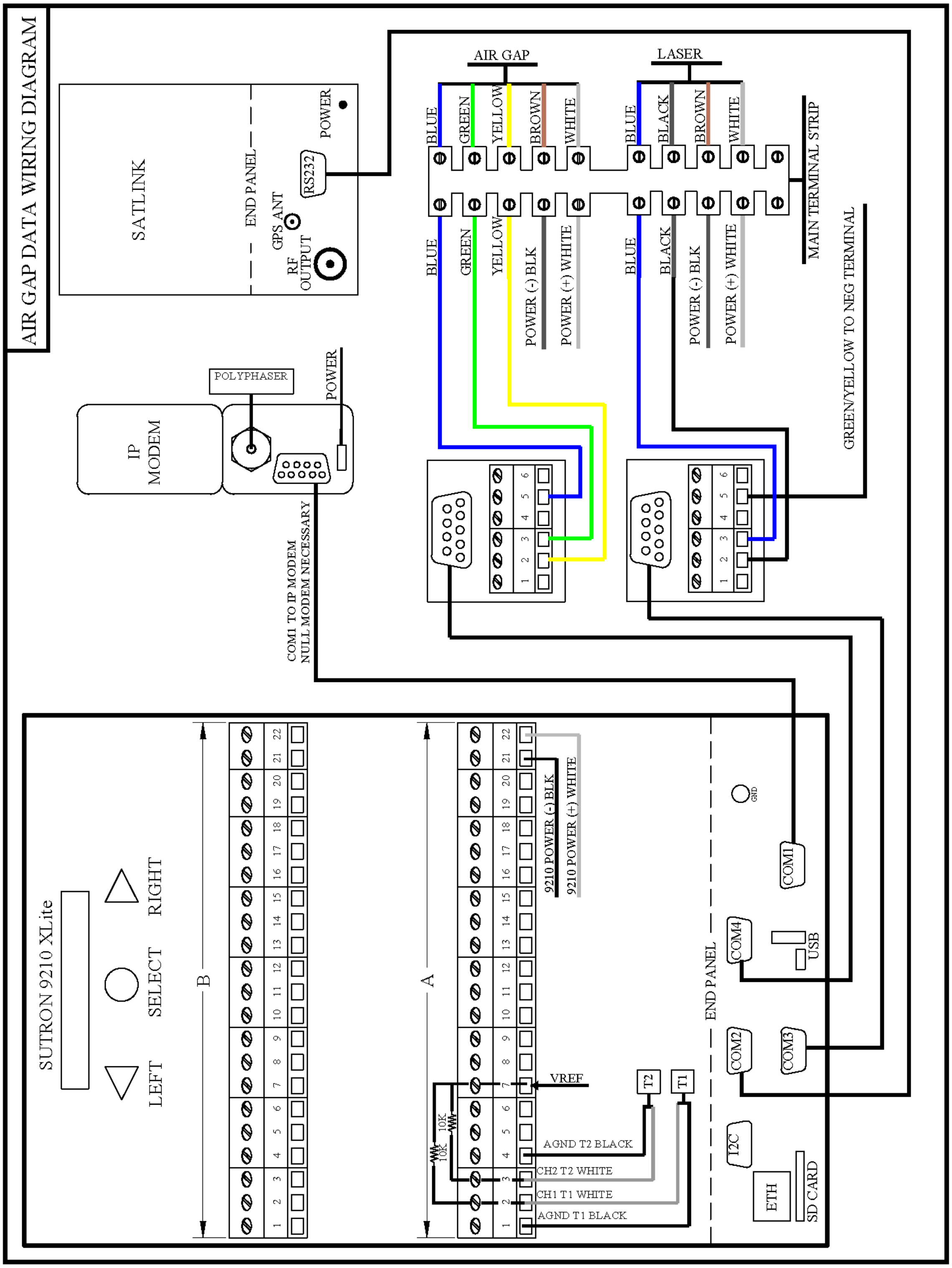
AIR GAP DATA WIRING DIAGRAM
SATLINK
END PANEL
POWER
RS232
GPS ANT
RF OUTPUT
AIR GAP
LASER
BLUE
GREEN
YELLOW
BROWN
WHITE
BLACK
POWER (-) BLK
POWER (+) WHITE
MAIN TERMINAL STRIP
GREEN/YELLOW TO NEG TERMINAL
POLYPHASER
IP MODEM
COM1 TO IP MODEM
NULL MODEM NECESSARY
SUTRON 9210 XLite
LEFT
SELECT
RIGHT
B
A
9210 POWER (-) BLK
9210 POWER (+) WHITE
VREF
T2
T1
AGND T2 BLACK
CH2 T2 WHITE
CH1 T1 WHITE
AGND T1 BLACK
10K
GND
COM1
COM4
USB
COM2
COM3
I2C
ETH
SD CARD

Figure 11

Figure 12

3.3 MIROS SETUP AND TESTING

1. Check the setup of the Miros microwave sensor for correct values (appendix D).
2. Connect a computer to the RS232 terminal block with a 9-pin serial cable and a null modem adapter.
3. On the computer, run ProComm or some other terminal emulator (such as Hyperterm), setting the COM port of the computer to 9600-N-8-1.
4. Apply power to the Miros sensor. You should see messages similar to this:

```
MIROS C54x bootloader ver 1.6.0 built on Sep 30 2004 [17:45:26]
Flash initialization OK. [Intel 28F640J3A]
External SRAM test on page 3        OK
Watchdog is enabled.
Space to enter command-mode [#####]

No interruption on primary port. Trying secondary


No activity detected on primary or secondary port.
Boot application id     : 0
Application CRC check   : OK [75E9h:75E9h]
Application name        : Rangefinder v7.1.3.out
Application description: No description.
Info: Data memory words copied: 00002FE8h
Info: Program memory words copied: 00009F80h
Info: Branching to address [0001:8079]
C
Miros Range Finder Ver. 7.1.3 built on Jul 21 2005 20:14:03
EPLD version 1.3
Flash initialization OK
Flash: Intel 28F640J3A
Config OK. Parameters read from FLASH
Noise spectrum is cleared
Processing starting

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3.3.1 Examine Setup Values

To examine the setup values:
Type **ALL** and press ENTER.

You will see the following values; make sure that these values are the same as those on the setup sheet (appendix D). **Do not** change any setup values unless instructed to do so by the CIL. Any changes made to these setup values must be recorded on the setup sheet in appendix D and included with the site report paperwork. For a complete description of the following setup parameters, see the Miros Range Finder Technical Handbook Section 2, Sensor User Manual, page 25.

min	100	
det	100.0 %	
wtc	4.7 sec	
win	1.0 m	
tout	5.0 sec	
ser	0	
freq	2 Hz	
htc	0.5 sec	
atc	59.5 sec	
ntc	0.0 sec	
top	1	
ch	2.0	50.0 m

MIROS Altimeter SW ver. 6.4a

Maximum range	50 m
Ant. beam width	5 deg

Type **ALTCONFIG** and press ENTER.

You will see a second set of values, like the ones above. **Do not** change any of these values unless instructed to do so by the CIL. The following values are the calibrations for the sensor; each sensor will have different calibrations.

Meas	375.0 mm/ch	-913.0 mm
Fft	256	
fft-time	226.45 msec	
tot-time	324.21 msec	
sweep-time	22.24 msec	
range	50 m	
ant	5 deg	
as-type	1	
as-gain	0.0 %	
as-offset	0 mV	

3.3.2 Change Setup Values

To change the setup value:

1. Type the parameter, the correct number, and then press ENTER**.**

   Example: Type *min* 100 (then press ENTER)

The system will save any changes made.

2. Type **ALL** and press ENTER to check the new value.
3. Record all setup values.

3.3.3 Check Data from the Miros

To check data from the Miros:

1. With the computer connected to the Miros sensor, run ProComm or some other terminal emulator (such as Hyperterm), setting the COM port of the computer to 9600-N-8-1. Then:

   Type **GV** and press ENTER. You will get a value from the sensor:

   aa.aaa bb.bbb where aa.aaa is the one time measured value in meters and bb.bbb is the averaged value

2. Each time you type the **GV** command and press ENTER you will get real-time data from the sensor.
3. Disconnect the computer cable and null modem adapter from the RS232 block.
4. Reconnect the flat ribbon cable from the 9210B DCP.

3.4 LTI LASER SETUP AND TESTING

Setup commands for the laser are sent by the DCP when Recording is turned on. No action by the user or installer is required. It is very important **NOT** to make changes to the laser or to change the software values unless instructed to do so by the CIL/SIL. The following explains how to check communications to the laser and make changes if needed. A copy of the laser manual is available at the CIL.

1. Connect a computer to the RS232 terminal block with a 9-pin serial cable and a null modem adapter.
2. On the computer, run Procomm or some other terminal emulator (such as Hyperterm), setting the COM port of the computer to 9600–N-8-1.
3. Apply power to the laser.
4. Type **$BM**. Press ENTER on the computer. You should see data from the laser.
5. If you receive an error code ERR 1, contact the CIL/SIL for assistance.

3.4.1 Sensor Calibration

During setup and testing of the air gap system, a calibration check is conducted on the LTI laser sensor. The sensor is mounted on the top of the reference I-beam and tested at 13 different points by moving the target in 3.05-m (10-ft) increments from 35.1 m to 68.6 m (115 ft to 225 ft). The I-beam is marked using a certified steel tape pulled taunt at 20 lbs in accordance with tape manufacturer's specifications. The ULS collects and logs 1-Hz data, which are rounded to a resolution of 1 cm. The averaged data from each of the 13 points are compared to the steel tape and recorded in a spread sheet. An example is shown in table 4.

Table 4

Tape (ft)	Tape (m)	ULS #001025	ULS - tape			
225	68.580	68.59	0.010			
215	65.532	65.57	0.038			
205	62.484	62.48	-0.004			
195	59.436	59.43	-0.006			
185	56.388	56.38	-0.008			
175	53.340	53.33	-0.010			
165	50.292	50.28	-0.012			
155	47.244	47.23	-0.014			
145	44.196	44.19	-0.006			
135	41.148	41.13	-0.018			
125	38.100	38.1	0.000			
115	35.052	35.05	-0.002			
AVG			-0.003			
STDEV			0.014			

3.4.2 Laser Setup

The factory defaults must be changed before the laser can be used or if the sensor is reset to factory settings. The laser sensor does not have a single command to display the setting. OSTEP has written two simple Procomm scripts, one that collects and stores the present setting of the sensor and the second that writes and saves the approved setting to the sensor. These scripts can be found in appendix E or from the CIL.

3.4.3 Getting Sensor Settings

The settings can be found either by connecting the computer directly to the sensor via the sensor's RS232 or through the 9210B DCP using the **Passthru** command. In either case, run the **Get_Laser_Setting** script in Procomm (appendix E). Make sure the **Get_Laser_Setting** script is loaded in the Aspect directory under Procomm.

Direct Connection

Using Procomm, connect the computer directly to the laser sensor via the RS232 port. Check that the port settings are 9600–N-8-1. Run the **Get_Laser_settings** from the drop-down menu. Procomm will connect to the laser, set it to the command mode, request the setting, and store the data in a file under the Capture directory. Step-by-step instructions are presented in the following paragraphs.

1. Connect the computer to the sensor via an RS232 cable. Start Procomm and set the system to use Direct Connect COM 1 (bottom left of screen) using a baud rate of 9600, 8 bits, no parity, and 1 stop bit as shown in fig. 13. For computers that do not have a serial port, select the correct COM port in Procomm for the USB port that has the serial adapter.

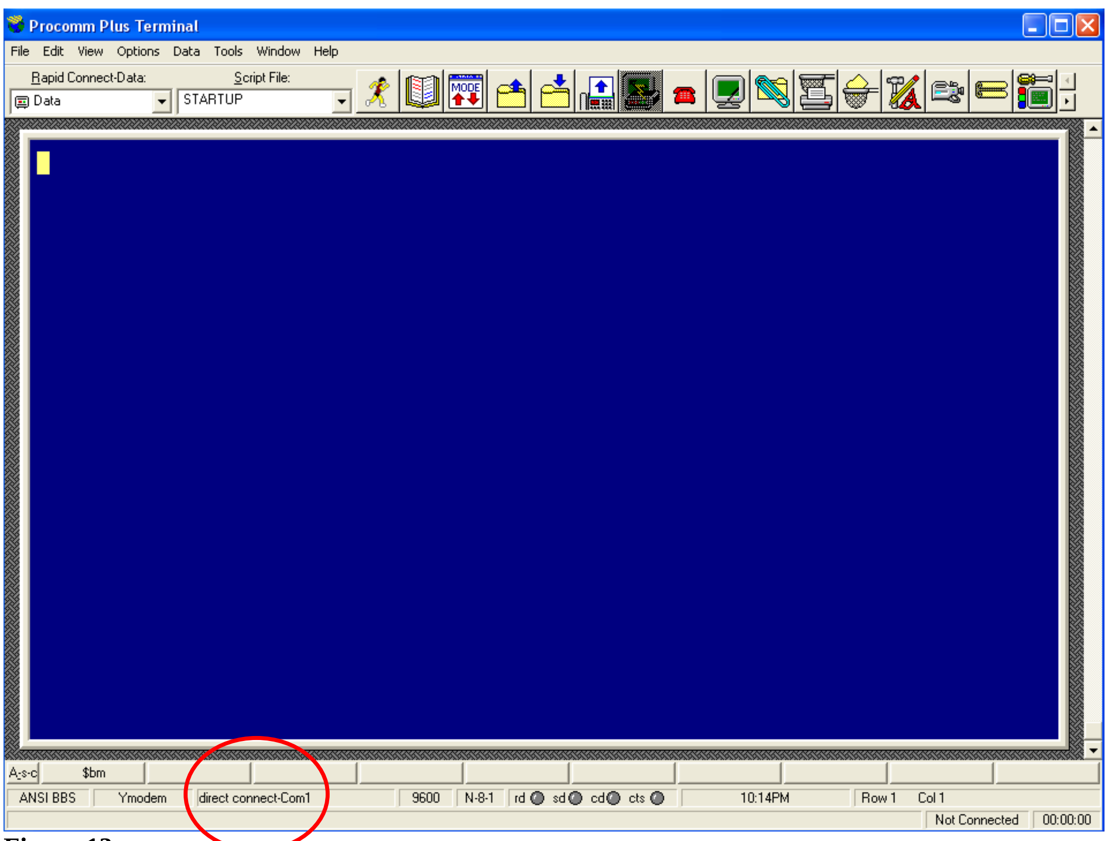


Figure 13

2. Test the connection by requesting a reading from the sensor.

   Type: $BM then press ENTER.

The sensor will respond with a $BM and two values as shown in fig. 14. The first value is the distance between the sensor and the target in meters (3.043). The second is a measure of the signal strength (64679). This reading assumes the sensor is in an operational mode. If the sensor is in the command mode, the sensor will respond with $ER, 86. This response is not a problem because you are just checking to make sure that the communications between the computer and the sensor are operating properly. The $ER, 86 response shows that you are connected to the sensor.

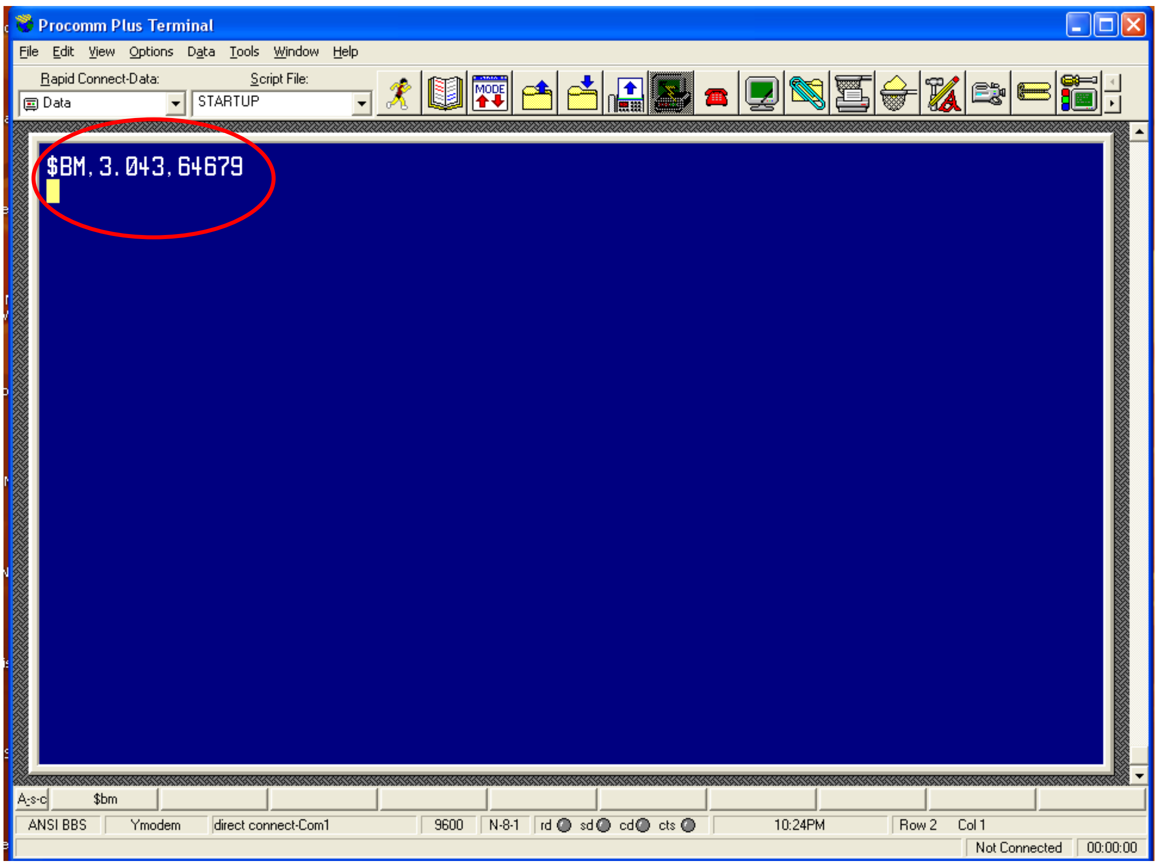


Figure 14

3. Using the mouse, select the **Get_Laser_settings** script from the **Script File** drop-down menu as shown in figure 15:

4. Press the **START/STOP SCRIPT** button.

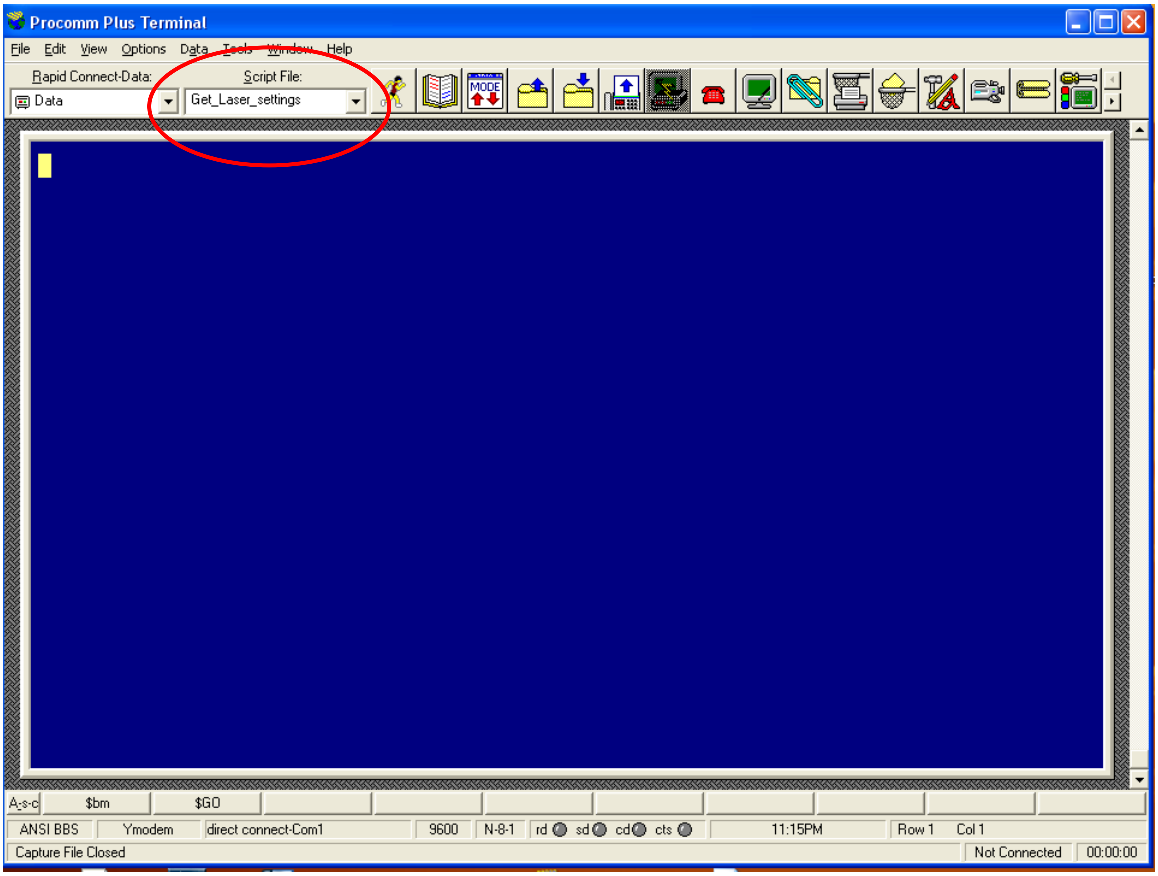


Figure 15

5. After pressing the **STOP/STOP SCRIPT** button the "running man" will be indented, as will the **CAPTURE** button. At the lower left of the screen, the Capture file status will change from closed to laser setting.cap (fig.16).

6. In a few seconds a user message will appear on the screen. Click **OK** for the script to continue.

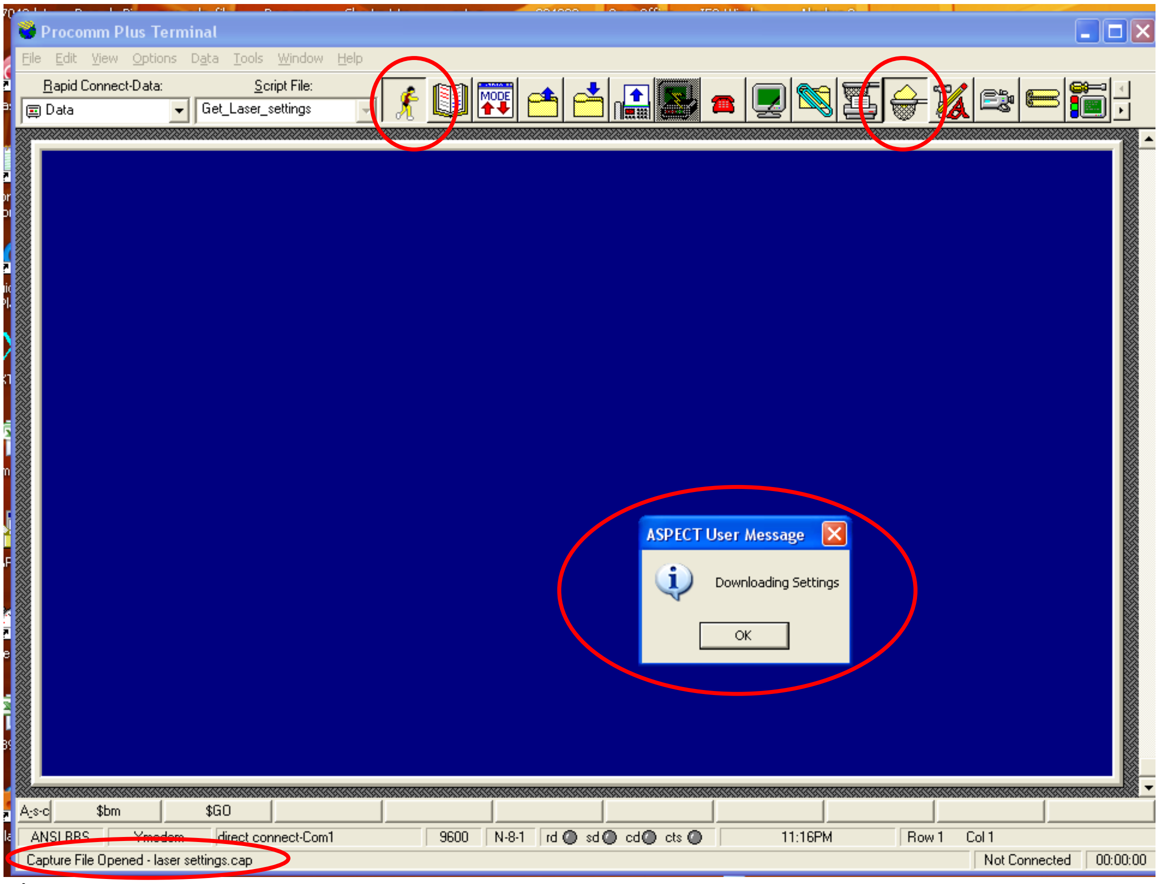


Figure 16

7. At this point the script will send a number of commands to the sensor to get its setup values (fig. 17). The first is a data request, the second switches the sensor into the command mode, and the third shows the software version of the sensor. Table 5 contains a list of the commands used by the script.

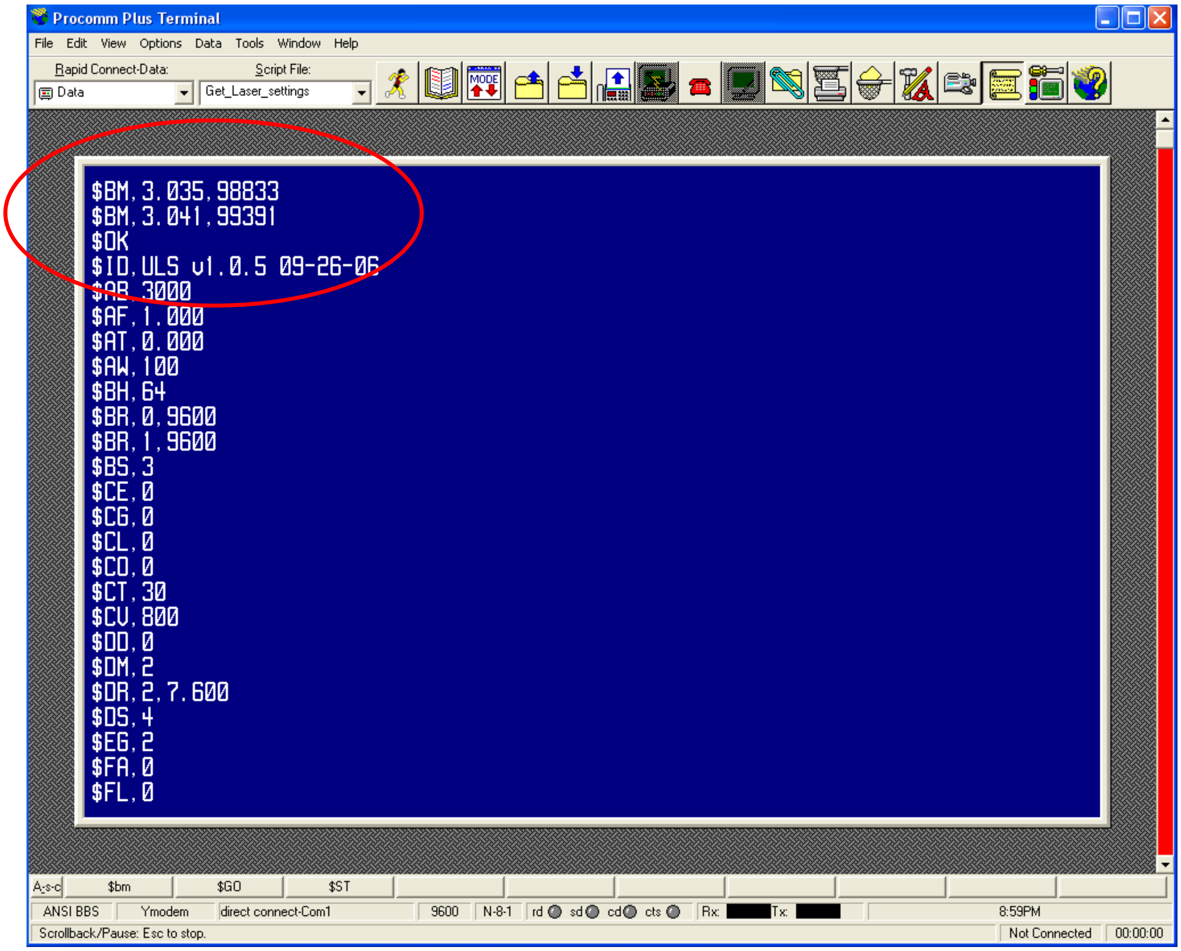


Figure 17

Table 5

Command	Function	Approved Settings	Notes
$AB	Average Bounds in Picoseconds	3000	
$AF	4-20 ma Fault Current Value	xxx	Not used if CL=0
$AT	Fault Timeout for 4-20 ma Current Loop	xxx	Not used if CL=0
$AW	Averaging Weight	100	
$BH	Bin Threshold	64	Not used if MM=1
$BR	Config Port Baud Rate	9600	
$BR,1	Output Port Baud Rate	9600	
$BS	Bin Size	3	Not used if MM=1
$CE	Cosine	0 off	
$CG	Check Gate	1	Enable
$CL	4-20ms Current Loop On/Off	0	Off
$CO	Continuous Measurement Output Mode	0	Off
$CT	Current Trip Threshold	30	Not used if MM=1
$CV	Cosine Value	xxx	Not used if CE=0
$DD	Dithering	0	Off
$DM	Display Mode	2	Distance and Intensity
$DR	Dampening	xxx	Not used if OP=0
$DS	Dampening	xxx	Not used if OP=0
$EG	Enable Gate	6	Enables short and long gates
$FA	First, Last, Most and All	0	First
$FL	Cooperative Filter	0	Non cooperative target
$FT	Flyer Trap	0	Not used if MM=1
$IL	Initial Lock	6000	
$LA	Detection Mode	0	Not used if MM=1
$LG	Long Gate	85	Long gate set to 85 meters
$MA	Measurement Auto Start On/Off	1	On, Sensor is measuring at power up
$MM	Measurement Mode	1	Set to averaging
$MO	Measurement Output Port	0	Data outputting to configuration port
$MP	Minimum Pulse Width Rejection	0	Disabled
$MU	Measurement Units	1	Output in meters
$MX	Maximum False Pulses	5	Not used if MM=1
$OF	Unit Offset	0	No offset entered
$OP	Output Processing	0	Off
$PA	Pointer Autostart On/Off	0	Off

Command	Function	Approved Settings	Notes
$PF	PRF Rate	4,000	
$PL	Power Level	0	High level
$PO	Pulses/Measure	4,000	
$PT	Pointer On/Off	0	Pointer is off
$SG	Short Gate	40	Short gate set to 40 meters
$TB	Time Between Events	0	Not used if MM=1
$TP	Trip Point	0	Not used if MM=1
$TT	Trip Point Time Out	106ae	Hex value within 25 counts of 106
$UA	Unit Address	xxx	Not used when in RS232 mode
$US	Unit Status	7	Read only
$WT	Windowing Time Out	xxx	Not used if OP=0
$WV	Windowing Error Range Value	xxx	Not used if OP=0
$XP	Maximum Pulse Width Rejection	xxx	Not used if OP=0
$BM	Data Request		Data is send to output port
$SU	Saves Settings		Save settings
$ST	Stops the sensor and places it in the command mode.		Set sensor to command mode
$GO	Starts the sensor. Use $BM to get data.		Starts the sensor
			A $ must precede the command to be accepted

8. At the end of the script, the sensor goes back into measurement mode. You will then see a data request ($BM) as shown on the last line in fig 18. Check the values and make sure they are close to the value at the beginning of the download (as in Fig 17). If you receive an error message, contact the CIL/SIL. Click **OK** in the User Message block to continue.

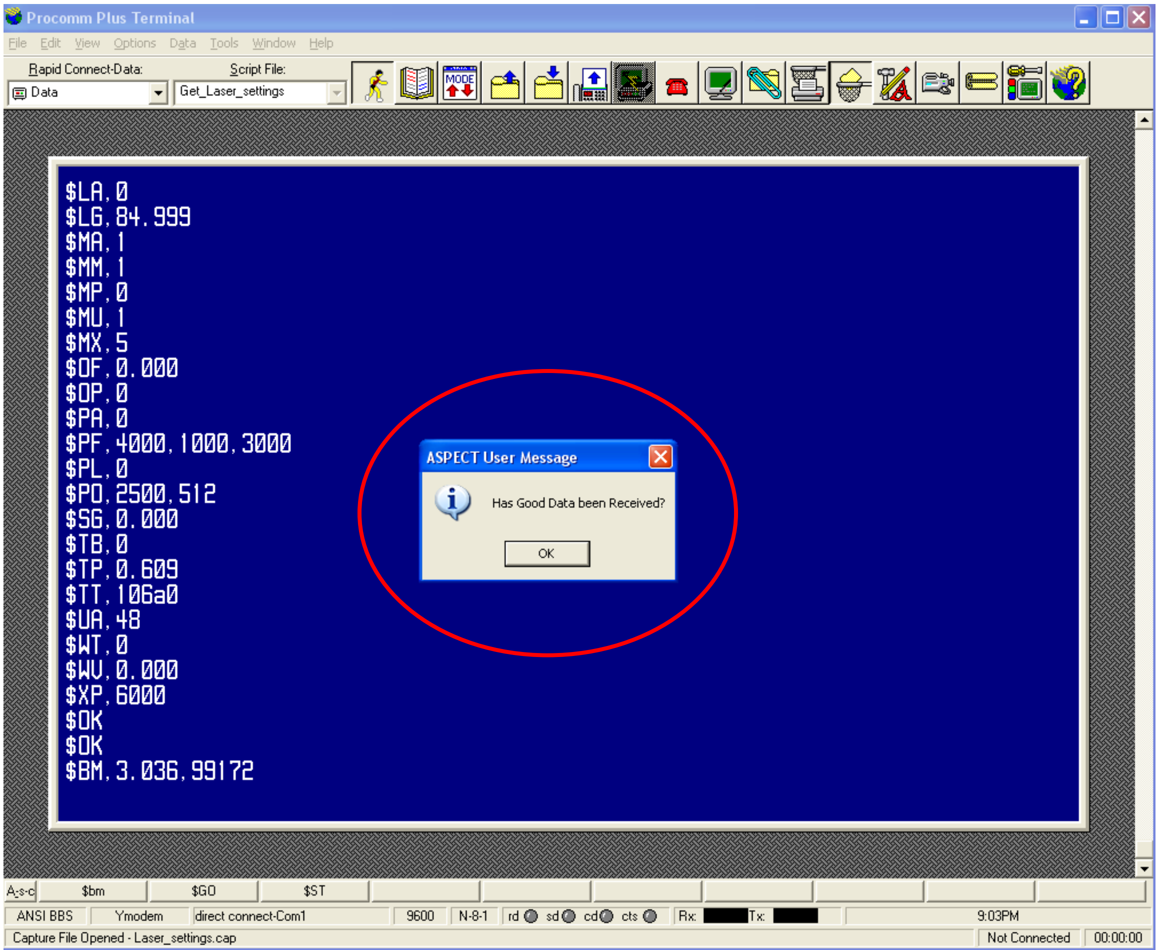


Figure 18

9. A new user message will appear when all settings have been downloaded. Click **OK** to close the Capture file and end the script (fig. 19).

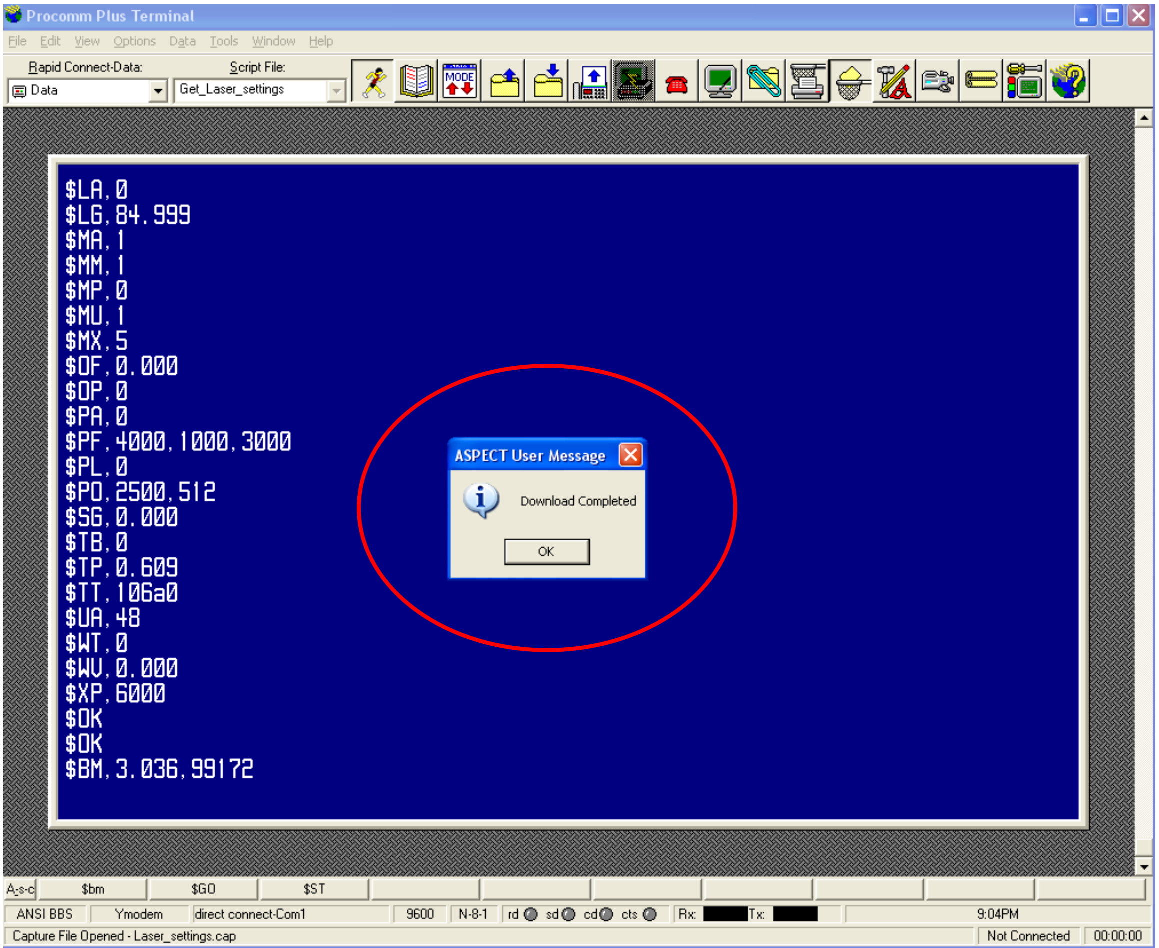


Figure 19

10. Exit Procomm and disconnect the cables.

11. The Capture file can be viewed by going into the Capture directory under the Procomm directory. The file name is **Laser Settings.cap**. The following shows an example of a file.

```
$BM,2.258,31603
$OK
$ID,ULS v1.0.5 09-26-06
$AB,3000
$AF,1.000
$AT,0.000
$AW,100
$BH,64
$BR,0,9600
$BR,1,9600
$BS,3
$CE,0
$CG,0
$CL,0
$CO,0
$CT,30
$CV,800
$DD,0
$DM,2
$DR,2,7.600
$DS,4
$EG,2
$FA,0
$FL,0
$FT,2500
$IL,6000
$LA,0
$LG,84.999
$MA,0
$MM,1
$MP,0
$MU,1
$MX,5
$OF,0.000
$OP,0
$PA,0
$PF,4000,1000,3000
$PL,0
$PO,2500,512
$SG,0.000
$TB,0
$TP,0.200
$TT,106a
$UA,48
$WT,0
$WV,0.000
$XP,6000
$OK
$OK
$BM,2.257,31421
```

Passthru Connection

Passthru is an Xpert utility that allows a user to connect to a device on one of the COM ports. The user logs into the Xpert using Procomm, stops recording, shuts down the Xpert application, and runs the Passthru utility. The following paragraphs provide step-by-step instructions for using the Passthru utility to get the laser setting.

1. Connect the computer to the sensor via an RS232 cable. Start Procomm and set the system to use Direct Connect COM 1 (bottom left of screen) using a baud rate of 115200, 8 bits, no parity and 1 stop bit as shown in fig. 20. If your computer does not have a serial port, select the correct COM port in Procomm for the USB port that has the serial adapter.

2. At the Login prompt, enter the username and password as shown in fig 20.

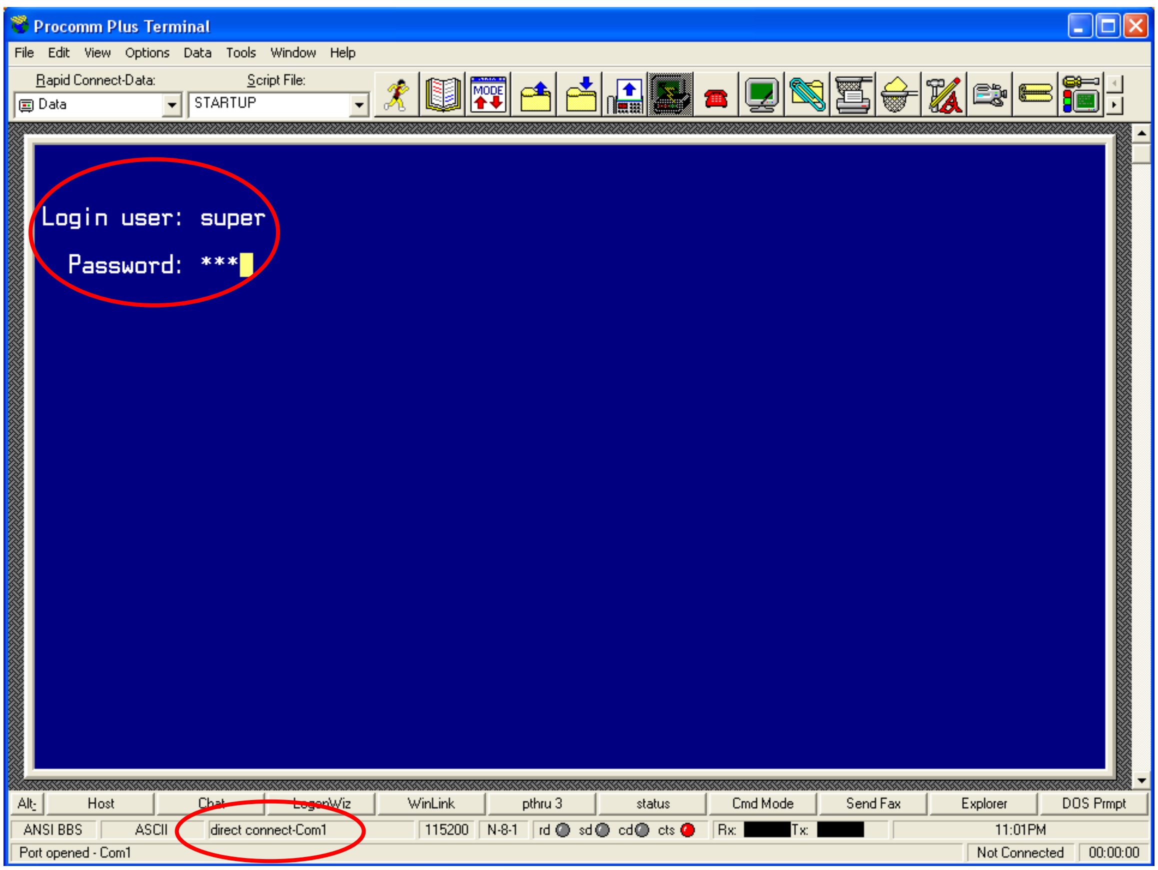


Figure 20

3. At the \Flash Disk> prompt:

   Type **recording off** and then press ENTER.

   The system will respond with ***Stopping***, and then with ***Recording is OFF***. It can take as much as two minutes for the system to stop recording.

   The system will respond with a second \Flash Disk>

   Type **shutdown** and then press ENTER**.**

   This will shut down the Xpert application, and again, this may take two minutes to complete.

   The system will respond with a third \Flash Disk>

   Type **passthru com4:9600,1,8,n** and then press ENTER**.**

   This command sets the COM port to a baud rate of 9600 with one stop bits, 8 data bits and No Parity.

4. Type **$BM** and then press ENTER (fig. 21).

The sensor will respond with a $BM and two values as shown in fig. 21. The first value is the distance between the sensor and the target in meters (3.044). The second is a measure of the signal strength (51475). This reading assumes the sensor is in an operational mode. If the sensor is in the command mode, it will respond with $ER, 86. This response is not a problem because you are just checking to make sure the communications between the computer and the sensor are operating properly. The $ER, 86 response shows that you are connected to the sensor.

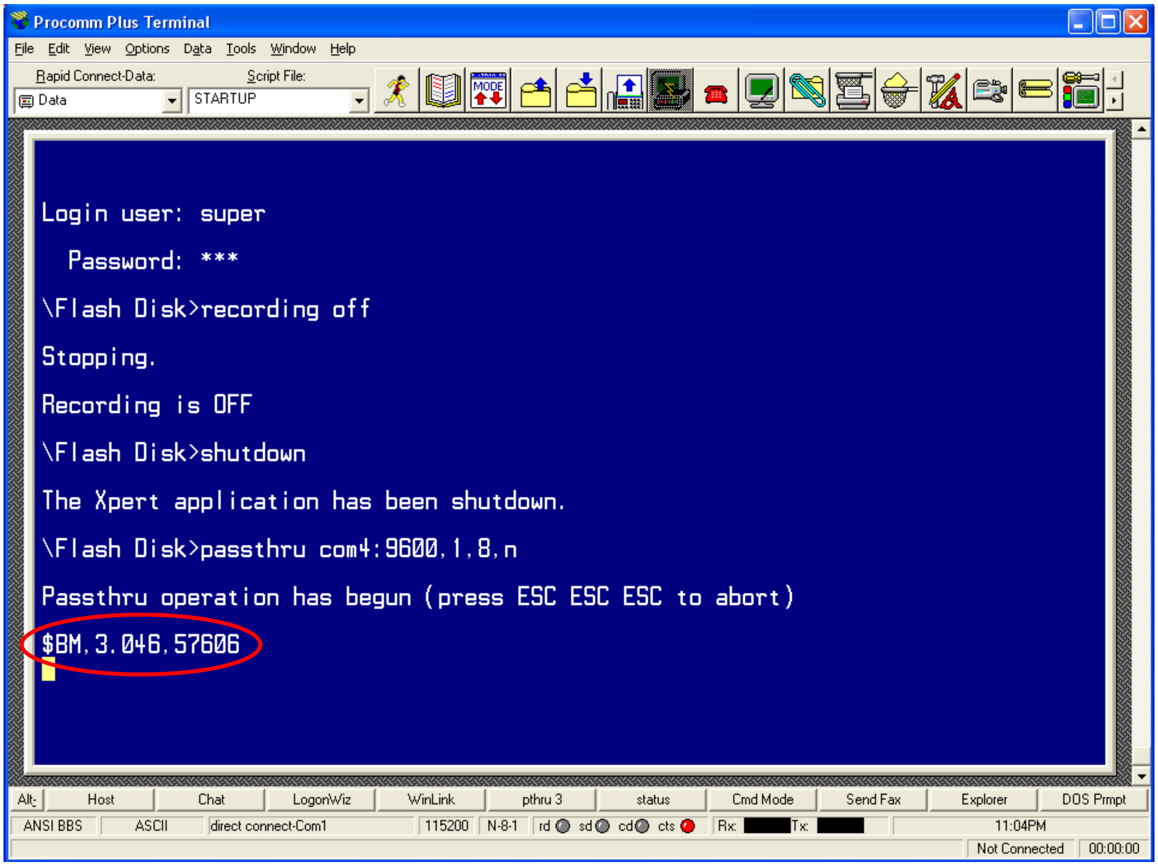


Figure 21

5. Using the mouse, select the **Get_Laser_settings** script from the **Script File** drop-down menu as shown in fig. 22.

6. Press the **START/STOP SCRIPT** button.

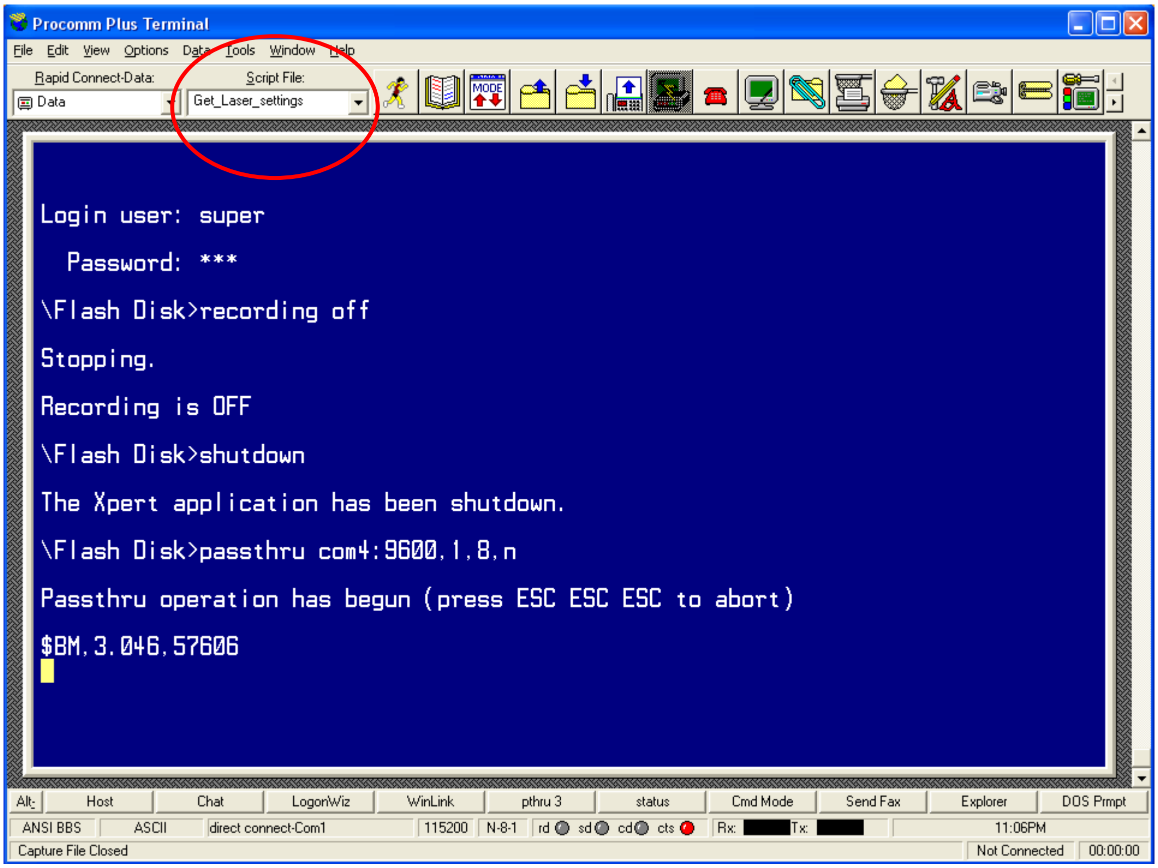


Figure 22

7. After you press the **STOP/STOP SCRIPT** button, the "running man" will be indented, as will the **CAPTURE** button. At the lower left of the screen the Capture file status will change from **closed** to **laser settings.cap** (fig. 23).

8. In a few seconds a user message will appear on the screen. Click **OK** for the script to continue.

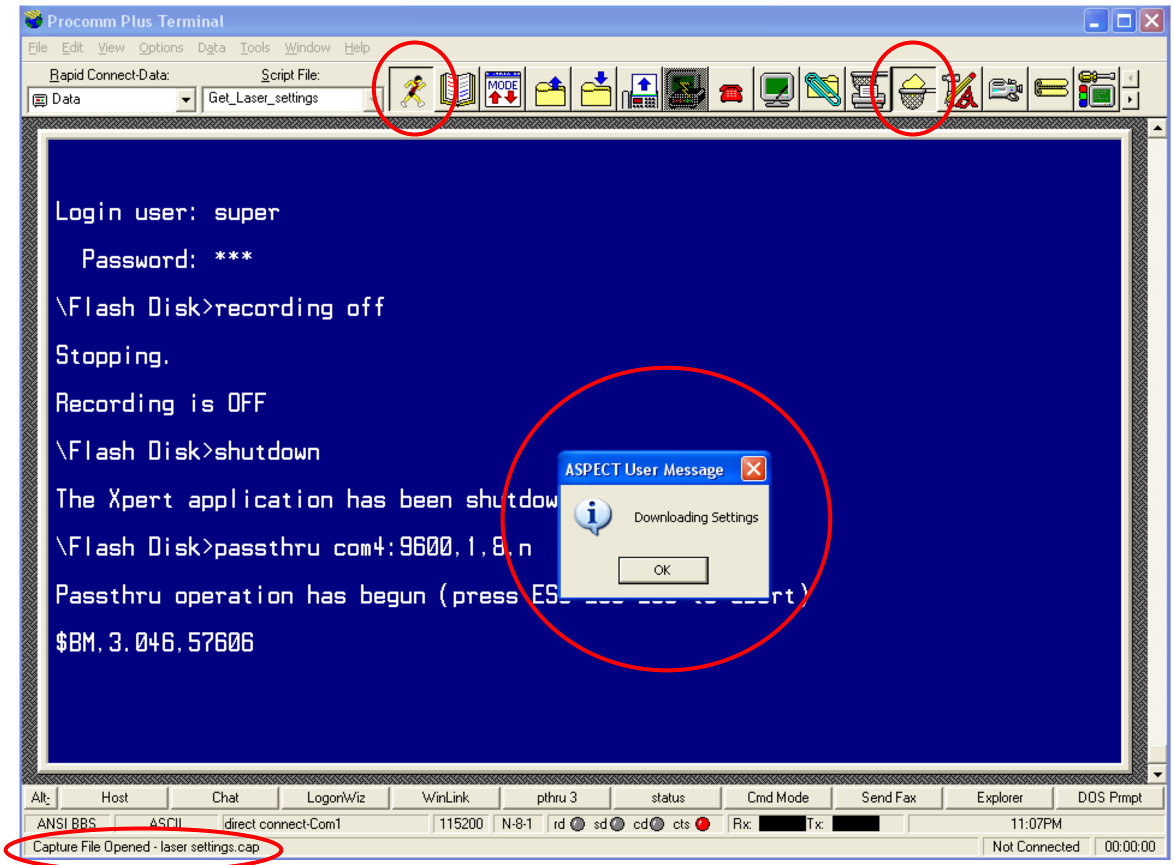


Figure 23

9. At this point the script will send a number of commands to the sensor to get its setup values. The first is a data request, the second switches the sensor into the command mode, and the third shows the software version of the sensor (fig. 24). See table 5 for a list of the commands used by the script.

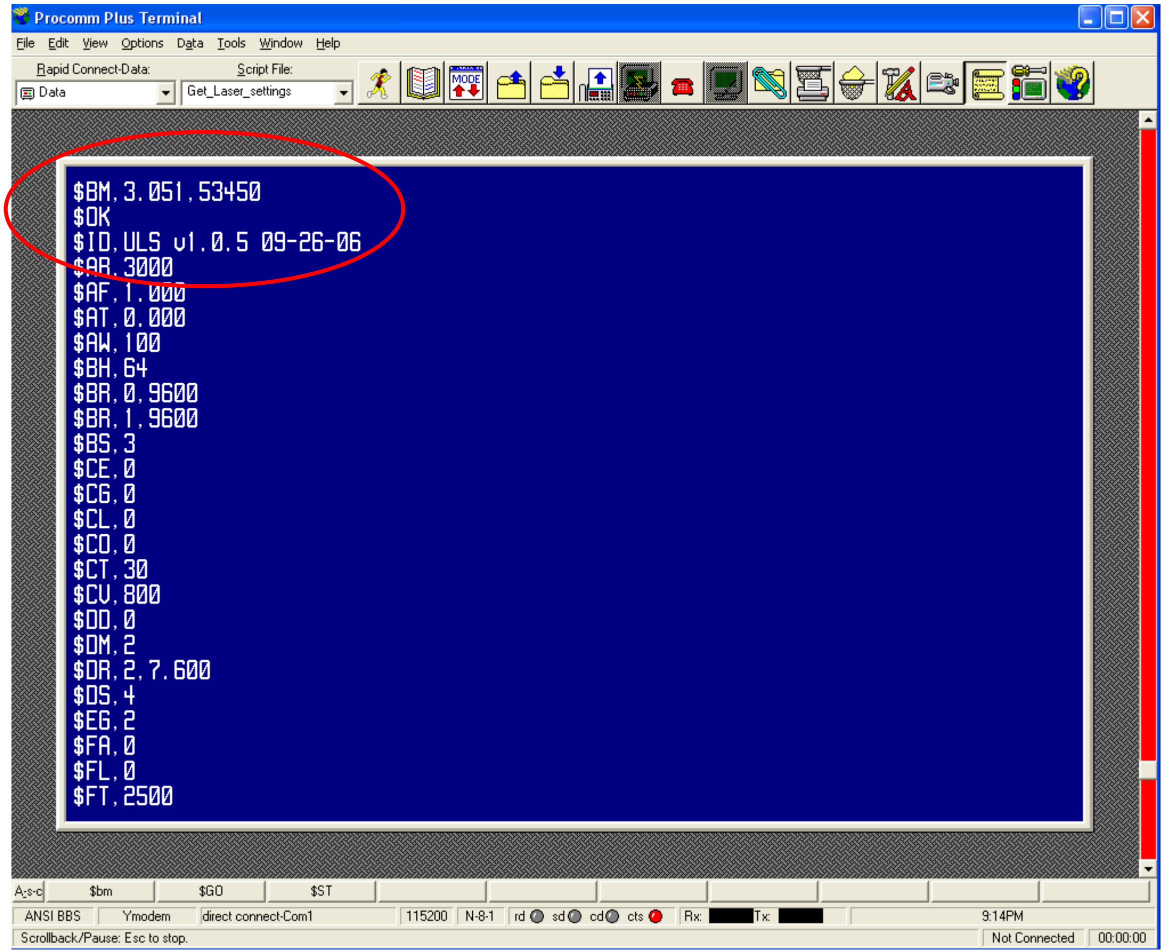


Figure 24

10. At the end of the script, the sensor goes back into measurement mode. You will then see a data request ($BM) as shown on the last line in fig 25. Check the values and make sure they are close to the value at the beginning of the download as in Fig 24. If you receive an error message contact the CIL/SIL. Click **OK** in the User Message block to continue.

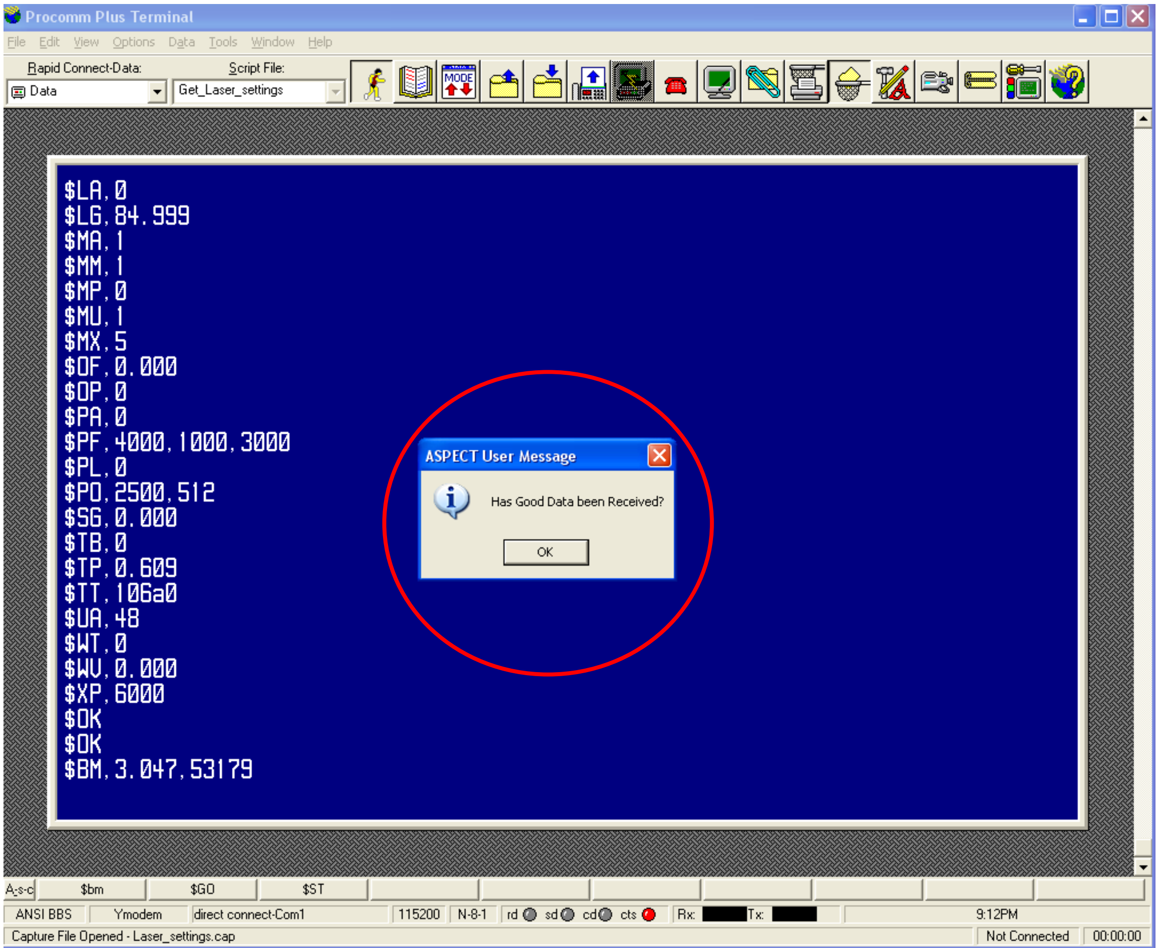


Figure 25

11. A new user message will appear when all settings have been downloaded. Click **OK** to close the Capture file and end the script (fig. 26).

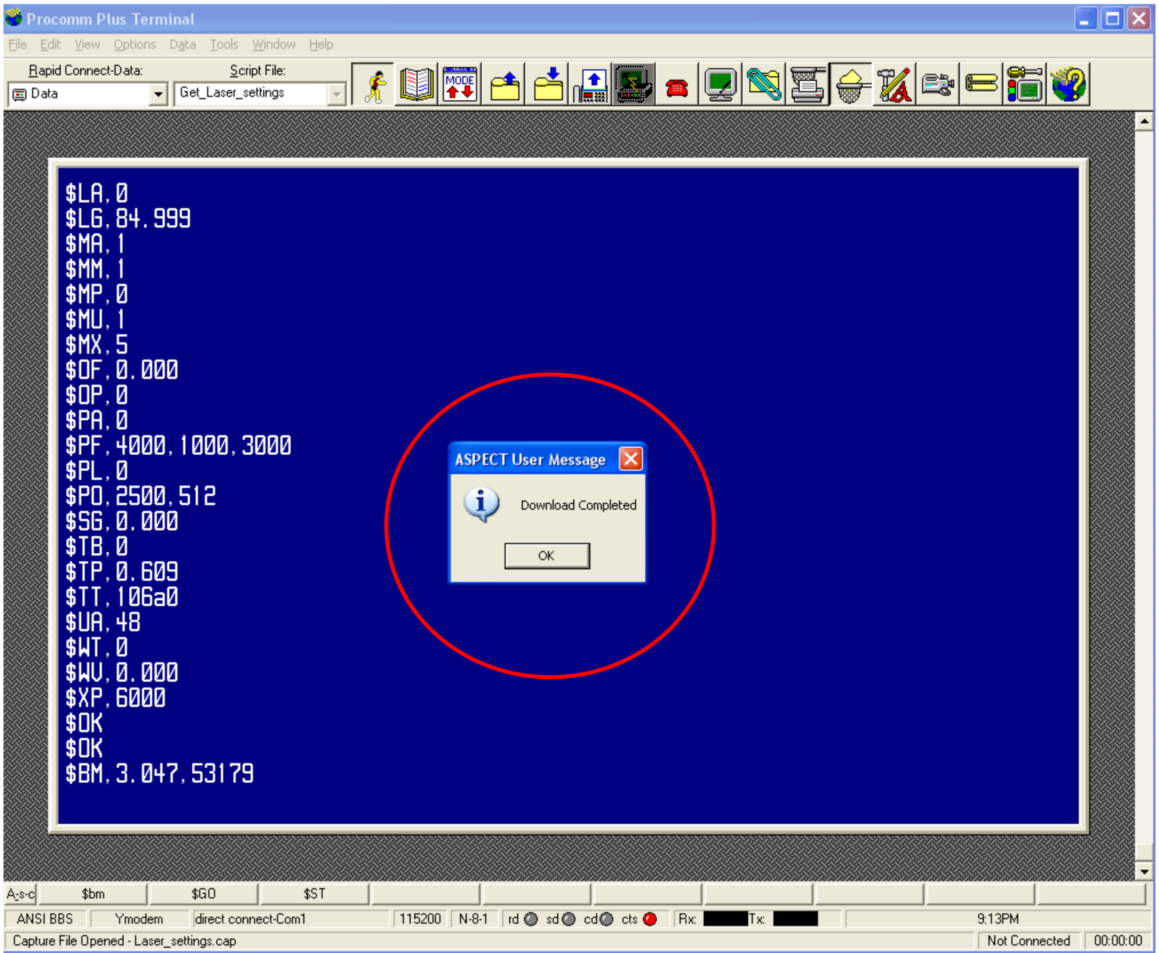


Figure 26

12. After the script stops, press the ESC key three times to exit the Passthru utility. The system will respond with the \Flash Disk> prompt.

13. Type **reboot** and then press ENTER to restart the Xpert (fig. 27).

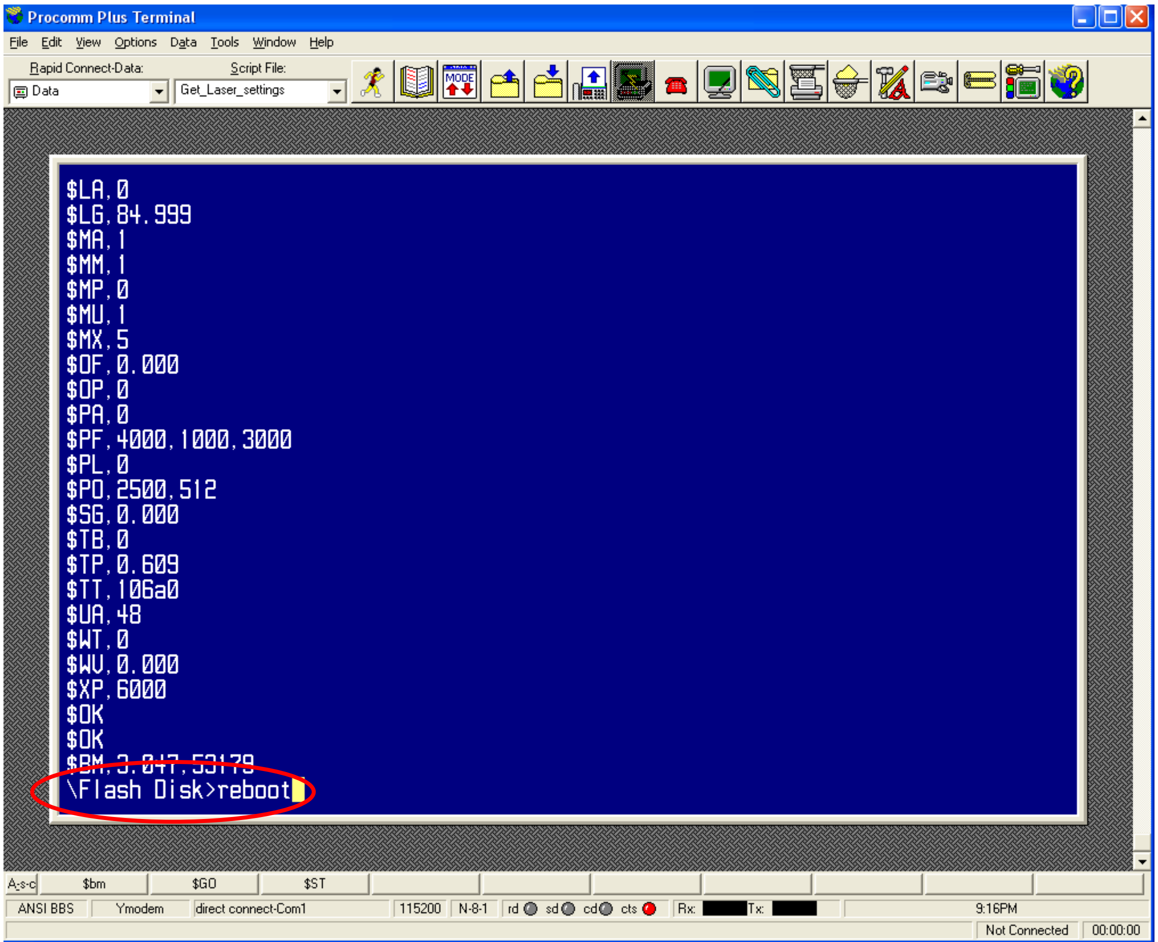


Figure 27

3.4.4 Sending Sensor Settings

The laser settings can be uploaded to the sensor by either connecting directly to the sensor via the RS232 serial port or through the Xpert 9210B DCP using the Passthru command. Either way, you will need to run the Send_Laser_Setting script in Procomm. Be sure to load the Send_Laser_Setting script in the Aspect directory under Procomm.

Direct Connection

Using Procomm, connect directly to the laser sensor via the RS232 serial port. Be sure that the port settings are 9600-N-8-1. Run the Send_Laser_Settings from the drop-down menu. Procomm will connect to the laser, set it to the command mode, and load the approved settings to the sensor. The following paragraphs provide step-by-step instructions.

1. Connect the computer to the sensor via an RS232 cable. Start Procomm and set the system to use Direct Connect COM 1 (bottom left of screen) using a baud rate of 9600, 8 bits, no parity and 1 stop bit as shown in fig. 28. If your computer does not have a serial port, select the correct port in Procomm for the USB port that has the serial adapter.

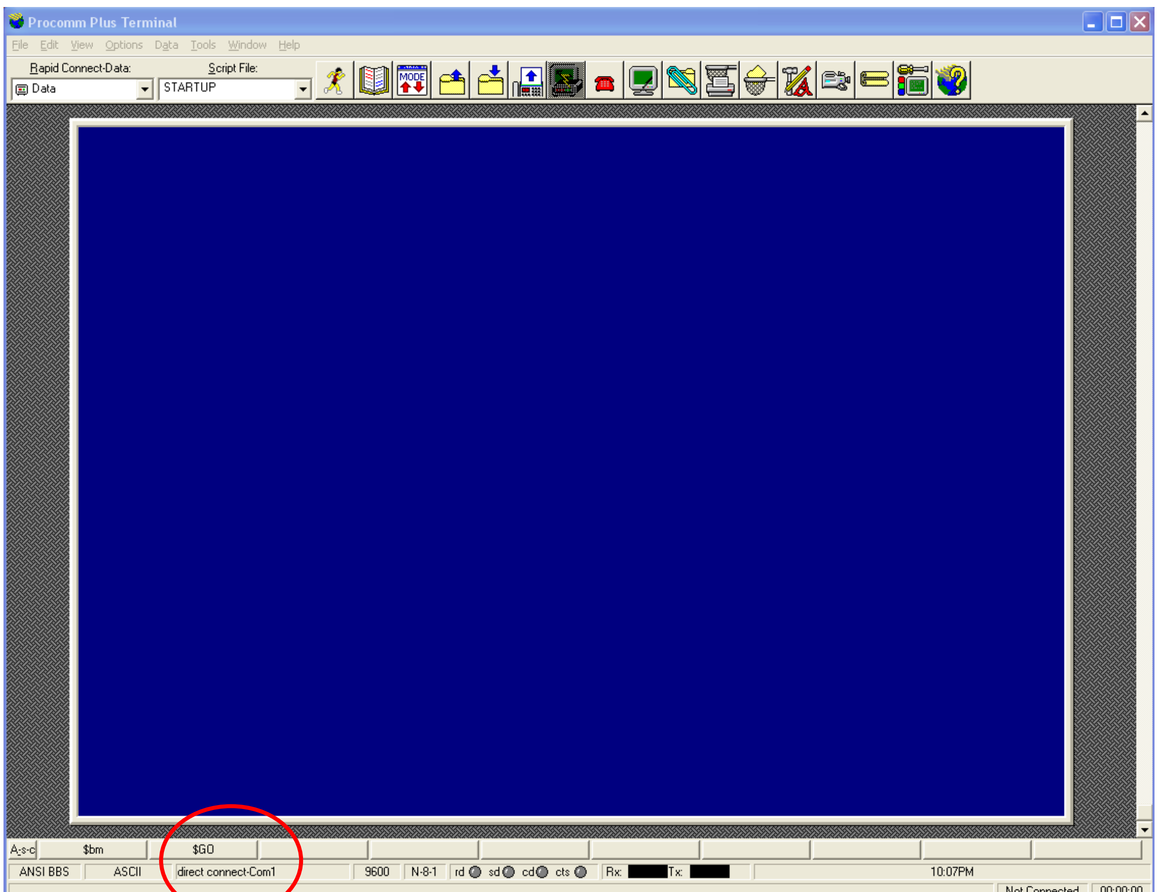


Figure 28

2. Test the connection by requesting a reading from the sensor.

   Type **$BM** and then press ENTER.

The sensor will respond with $BM and two values as shown in fig. 29. The first value is the distance between the sensor and the target in meters (3.039). The second is a measure of the signal strength (54074). This reading assumes the sensor is in an operational mode. If the sensor is in the command mode, it will respond with $ER, 86. This response is not a problem because you are just making sure that the communications between the computer and the sensor are operating properly. The $ER, 86 response shows that you are connected to the sensor (fig 29).

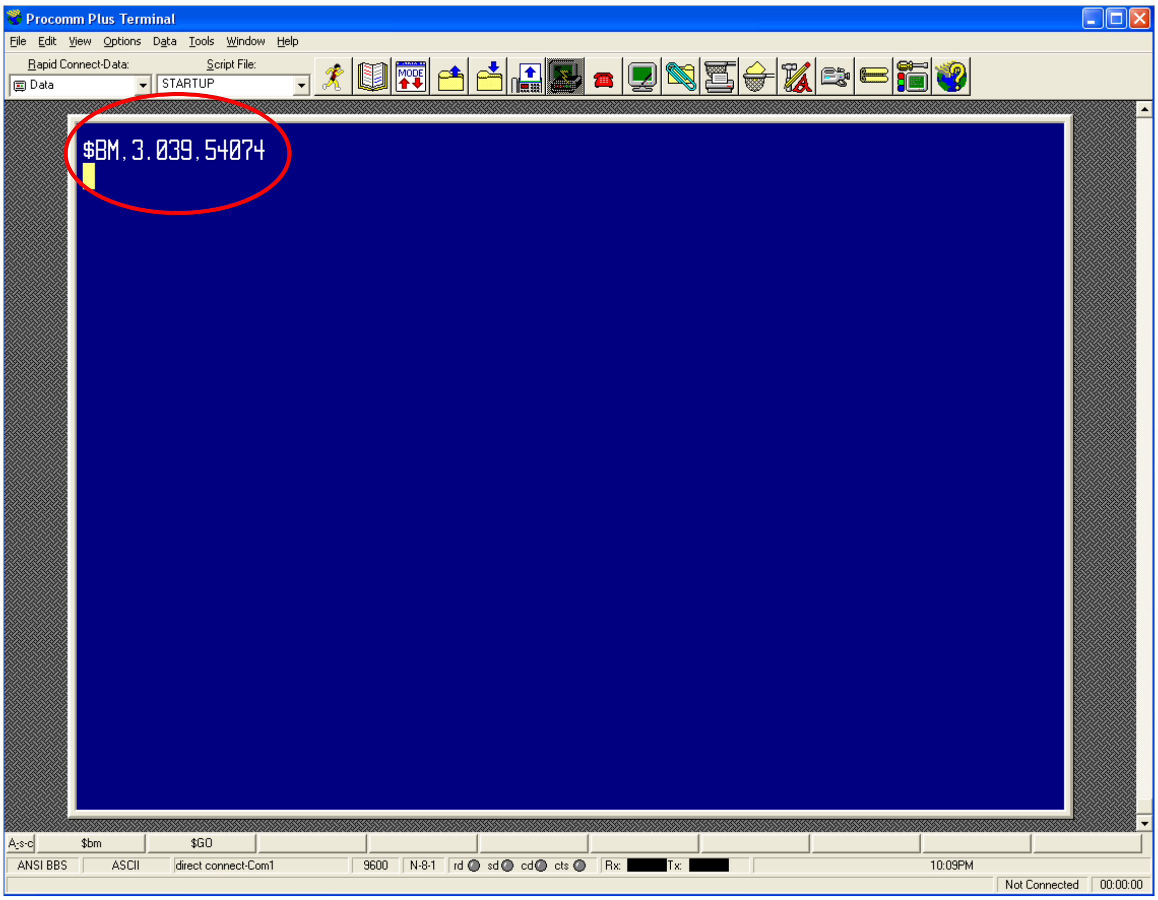


Figure 29

3. Using the mouse, select the Send_Laser_Settings script from the **Script File** drop-down menu as shown in fig. 30.

4. Press the **START/STOP SCRIPT** button.

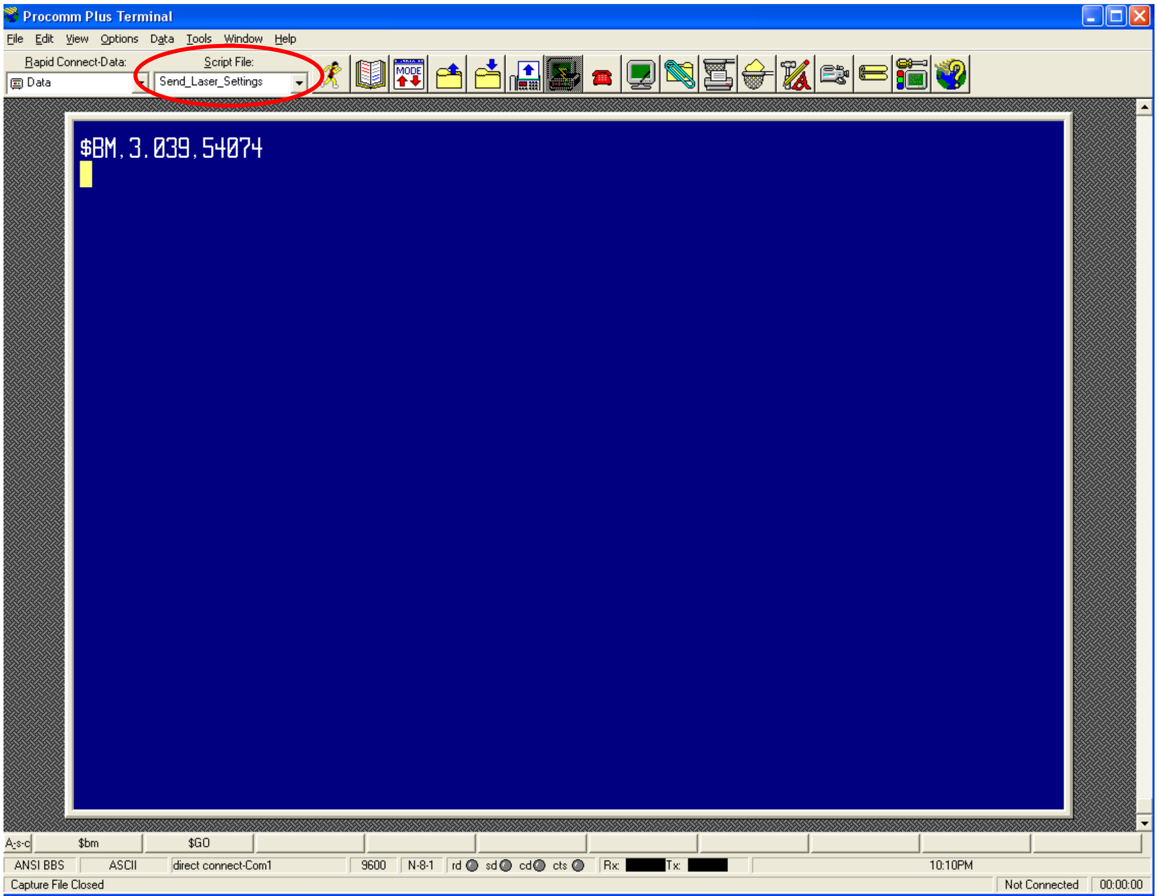


Figure 30

5. After you press the **START/STOP SCRIPT** button, the “running man” will be indented as will the **CAPTURE** button. At the lower left of the screen the **Capture file** status will change from closed to Laser_Settings.cap (fig 31).

6. In a few seconds a user message will appear on the screen. Click **OK** for the script to continue.

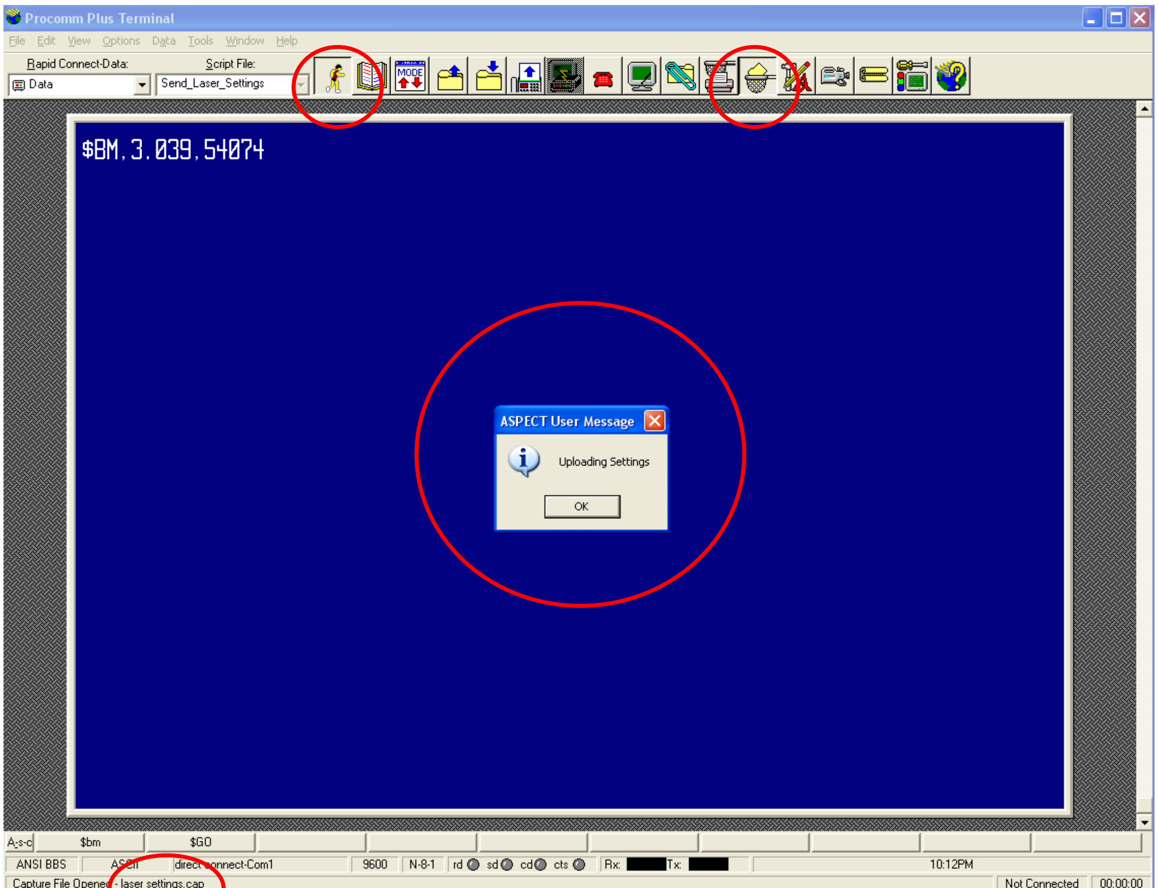


Figure 31

7. At this point the script will send a number of commands to the sensor, including the approved settings (fig 32). The first command is a data request, the second switches the sensor into the command mode, and the third shows the software version of the sensor. After the third command, the settings are uploaded. The sensor returns an **OK** for each successful command and an **ER, 1** for those commands that fail. A fail command is most likely caused by an older laser version, rather than a problem with the sensor. The script is written using the newest set of commands, and some commands may not be in all sensors. Contact the CIL/SIL if there are errors. You will need to provide the Get_Laser_Setting and Send_Settings.cap files. Table 5 contains a list of the commands used by the script.

8. At the end of the script, the sensor goes back into measurement mode. You will then see a data request ($BM) as shown on the last line in fig 32. Check the values and make sure they are close to the value at the beginning of the download (as in Fig 31). If you receive an error message, contact the CIL/SIL. Click **OK** in the User Message block to continue.

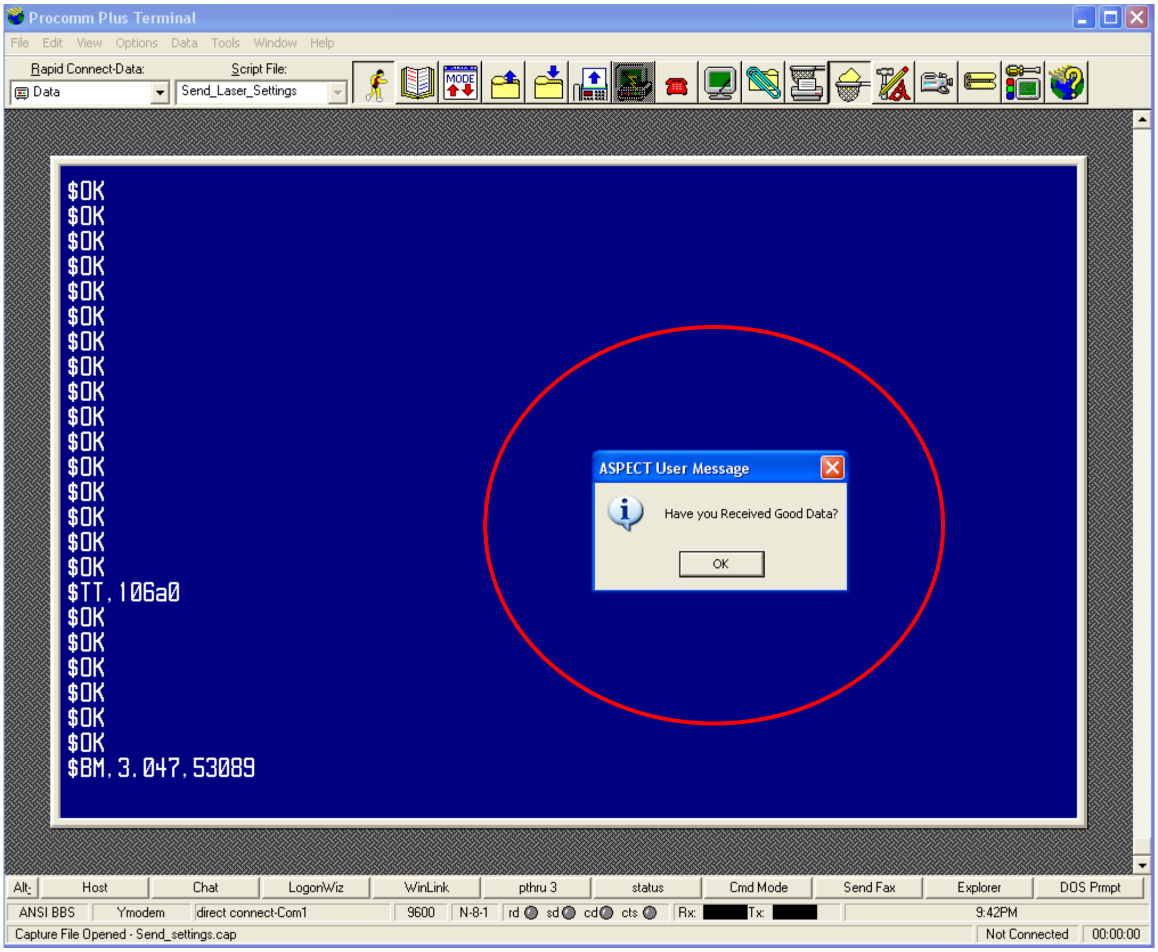


Figure 32

9. A new user message will appear when all settings have been sent to the sensor. Click **OK** to close the **Capture file** and end the script (fig. 33).

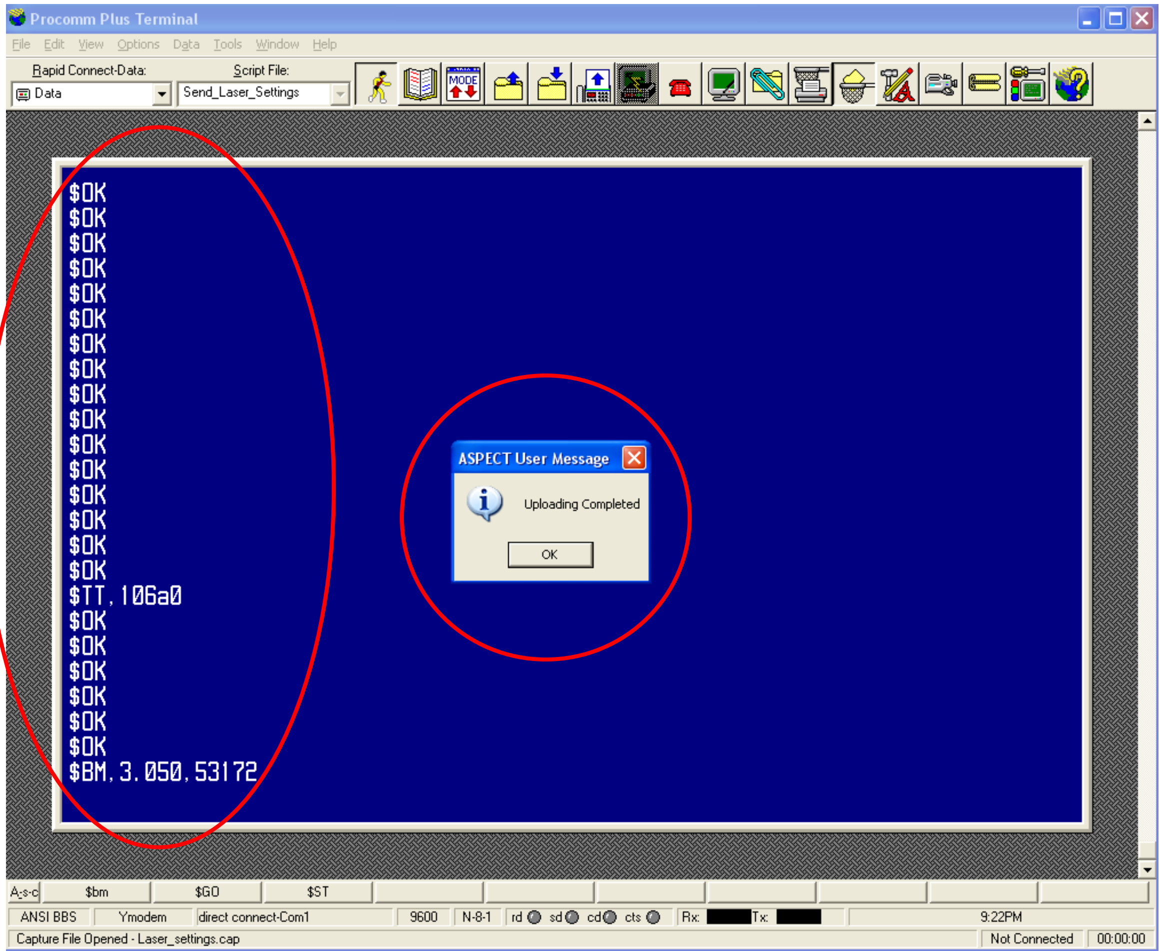


Figure 33

10. Exit Procomm and disconnect the cables.

11. The Capture file can be viewed by going into the Capture directory under the Procomm directory. The file name is Send_Settings.cap. The following provides an example of the **Capture file**.

```
$BM,3.049,53342
$OK
$ID,ULS v1.0.5 09-26-06
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$OK
$TT,106a0
$OK
$OK
$OK
$OK
$OK
$OK
$BM,3.047,53089
```

Passthru Connection

Passthru is an Xpert utility that allows a user to connect to a device on one of the COM ports. The user logs into the Xpert using Procomm, stops recording, shuts down the Xpert application, and runs the Passthru utility. The following shows step by step instructions using Passthru to get the laser setting.

1. Connect the computer to the sensor via a RS232 cable. Start Procomm and set the system to use Direct Connect COM 1 (bottom left of screen) using a baud rate of 115200, 8 bits, no parity, and 1 stop bit as shown in fig. 33. If your computer does not have a serial port, select the correct COM port in Procomm for the USB port that has the serial adapter.

2. At the Login prompt enter the username and password as shown in fig 34.

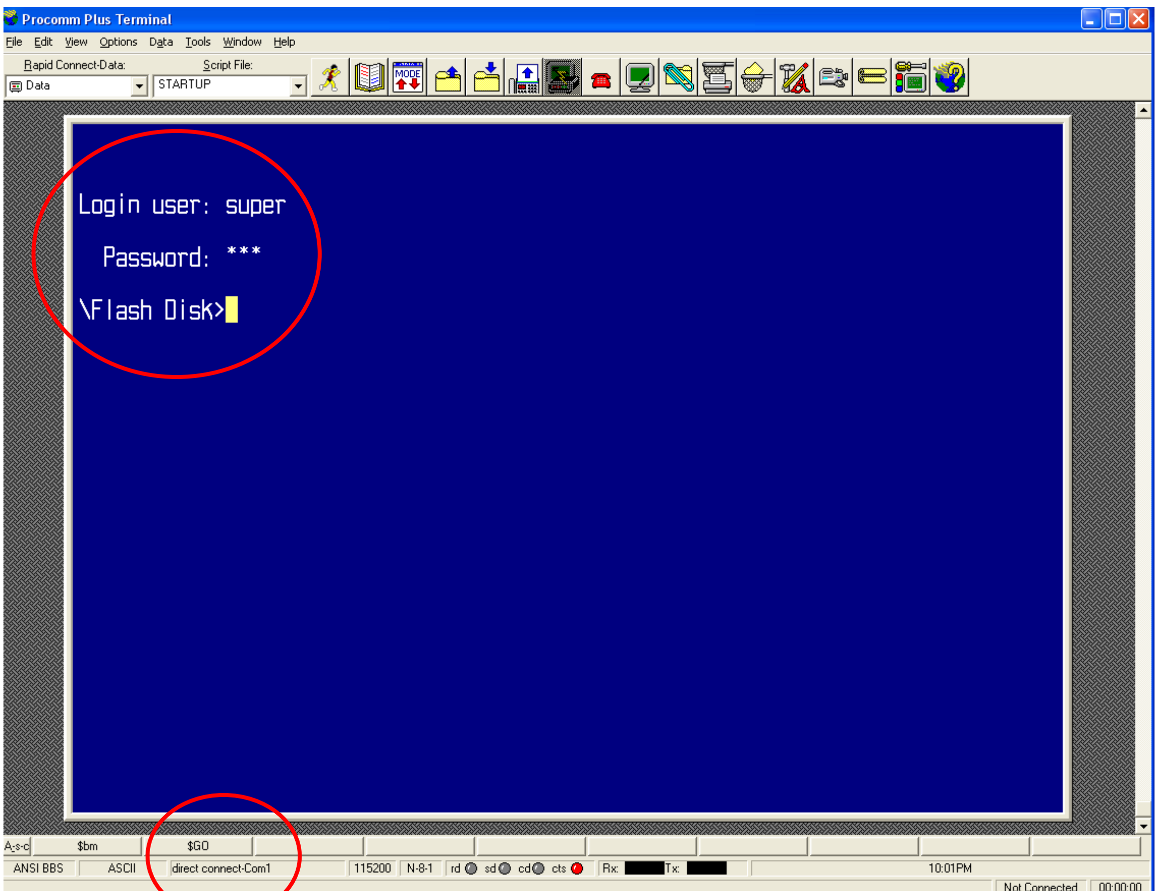


Figure 34

3. At the \Flash Disk> prompt
   Type **recording off** and then press ENTER.

   The system will respond with Stopping. Then with Recording is OFF. It can take as much as two minutes for the system to stop recording.

   The system will respond with a second \Flash Disk>

   Type: shutdown and press ENTER.

   This will shut down the Xpert application, again may take two minutes to complete.

   The system will respond with a third \Flash Disk>

   Type **passthru com4:9600,1,8,n** and then press ENTER**.**

   This command sets the com port to a baud rate of 9600 with one stop bits, 8 data bits and No Parity.

4. Type: **$BM** and then press ENTER.

The sensor will respond with a $BM and two values as shown in fig. 35. The first value is the distance between the sensor and the target in meters (3.044). The second is a measure of the signal strength (51475). This reading assumes the sensor is in an operational mode. If the sensor is in the command mode, the sensor will respond with $ER, 86. This response is not a problem because you are just checking the communications between the computer and the sensor. The $ER, 86 response shows that you are connected to the sensor.

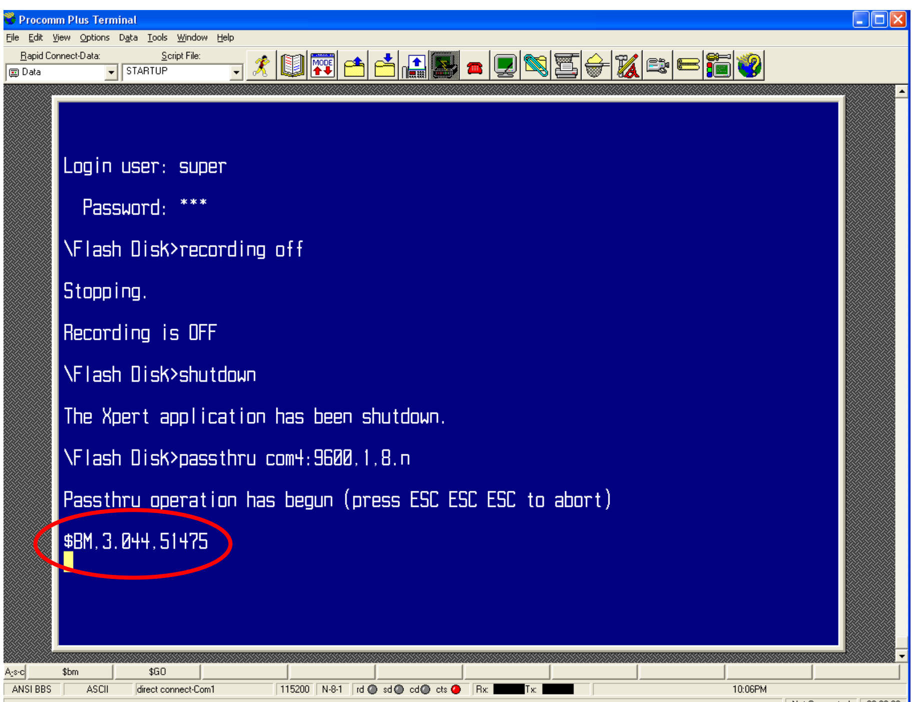


Figure 35

5. Using the mouse select the Send_Laser_Settings script from the Script file drop-down menu as shown in fig. 36.

Press the **START/STOP SCRIPT** button.

6. After you press the **STOP/STOP SCRIPT** button, the "running man" will be indented, as will the **CAPTURE** button. At the lower left of the screen, the **Capture file** status will change from closed to Laser Setting.cap (fig 36).
7. In a few seconds a user message will appear on the screen. Click **OK** for the script to continue.

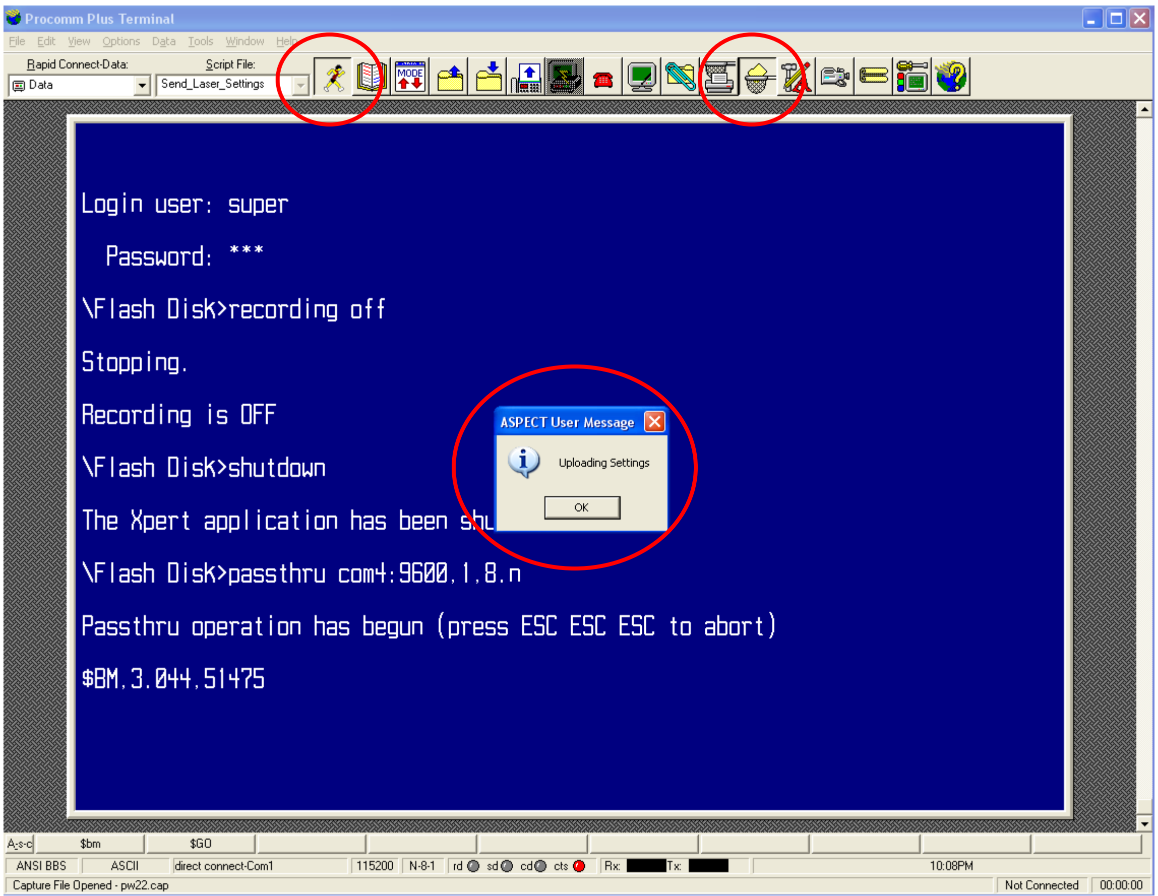


Figure 36

8. At this point the script will send a number of commands to the sensor, including the approved settings (fig. 37). The first command is a data request, the second switches the sensor into the command mode, and the third shows the software version of the sensor. After the third command, the settings are uploaded. The sensor returns an **OK** for each successful command and an **ER, 1** for commands that fail. A fail command is most likely caused by an older laser version rather than a problem with the sensor. The script is written using the newest set of commands, and some commands may not be in all sensors. Contact the CIL/SIL if there are errors. You will need to provide the Get_Laser_Setting and Send_Settings.cap files. Table 5 contains a list of the commands used by the script.

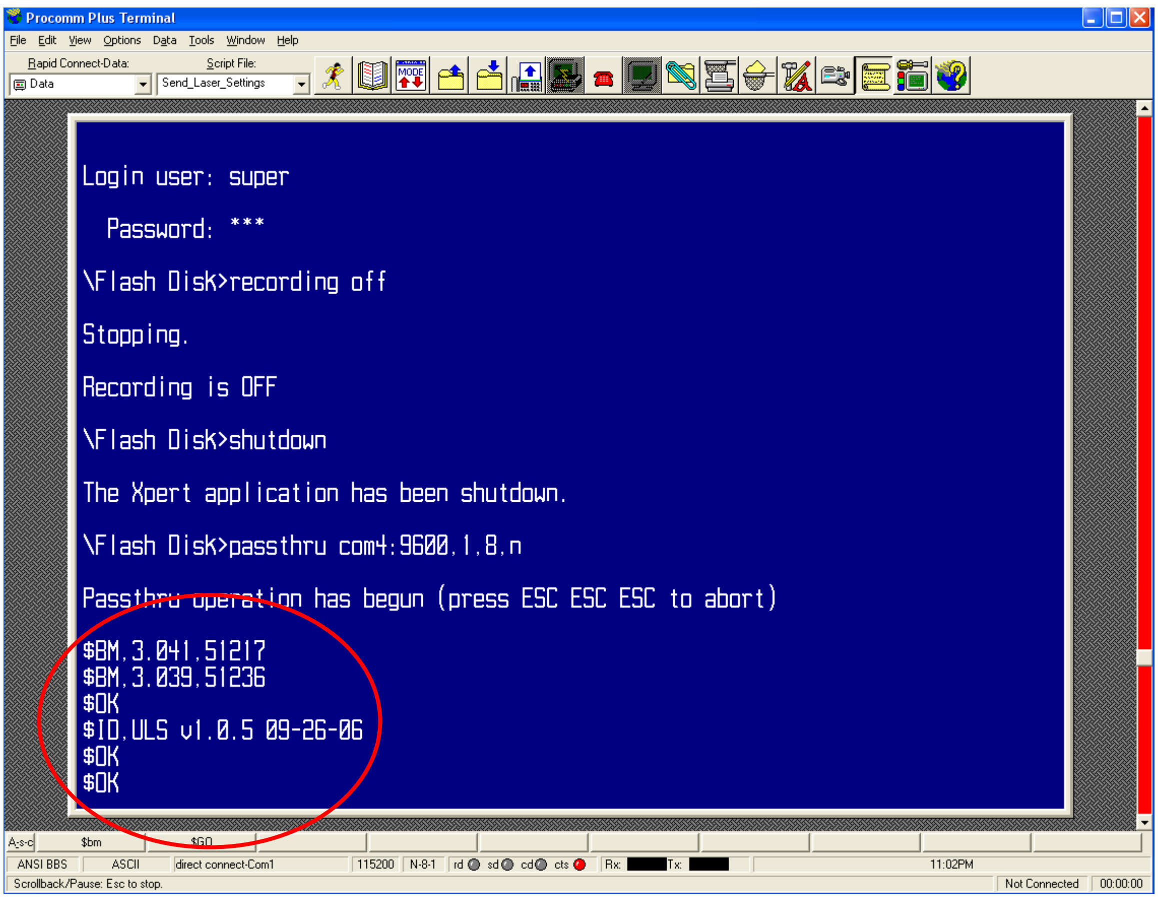


Figure 37

9. A new user message will appear when all settings have been sent to the sensor. Click **OK** to close the **Capture file** and end the script (fig. 38).

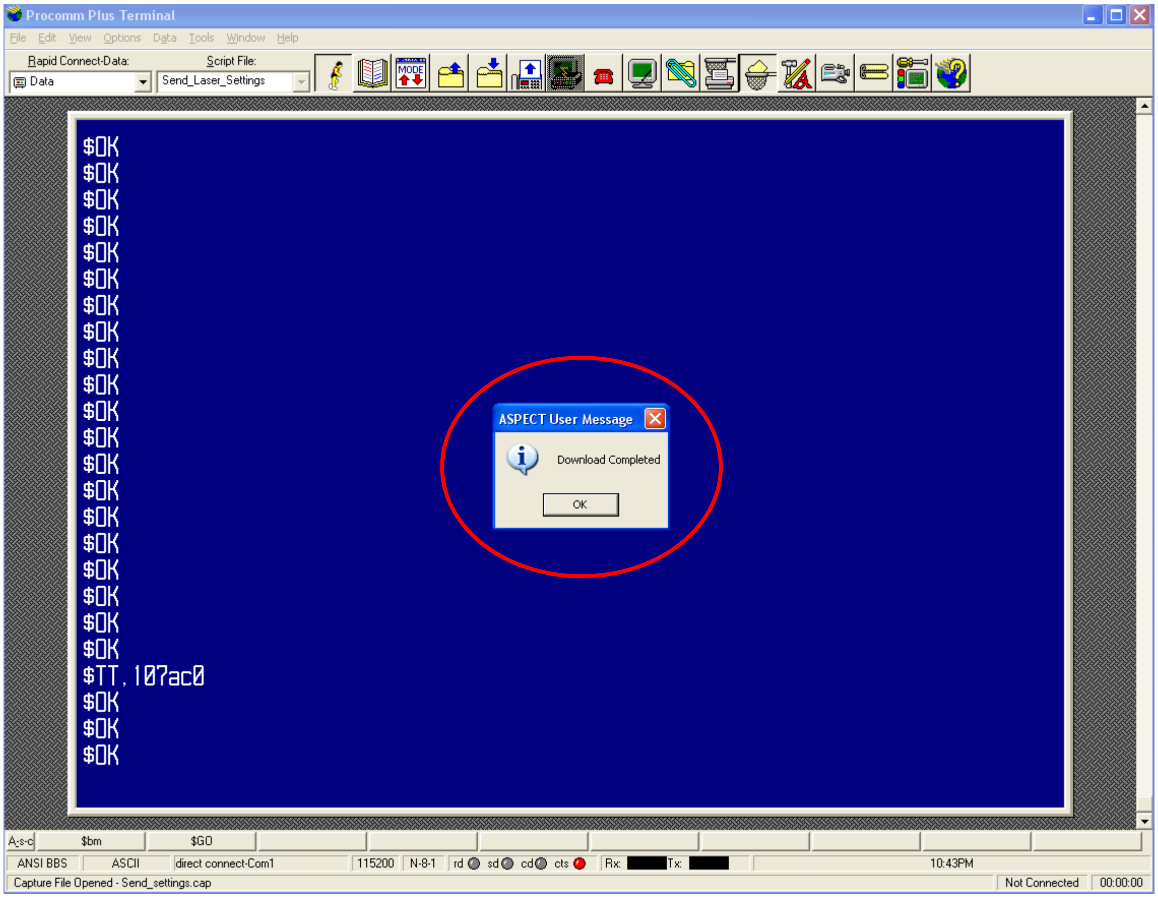


Figure 38

10. After the script stops, press ESC three times to exit the Passthru utility. The system will respond with the \Flash Disk> prompt (fig 39).

11. Type **reboot** and press ENTER to restart the Xpert.

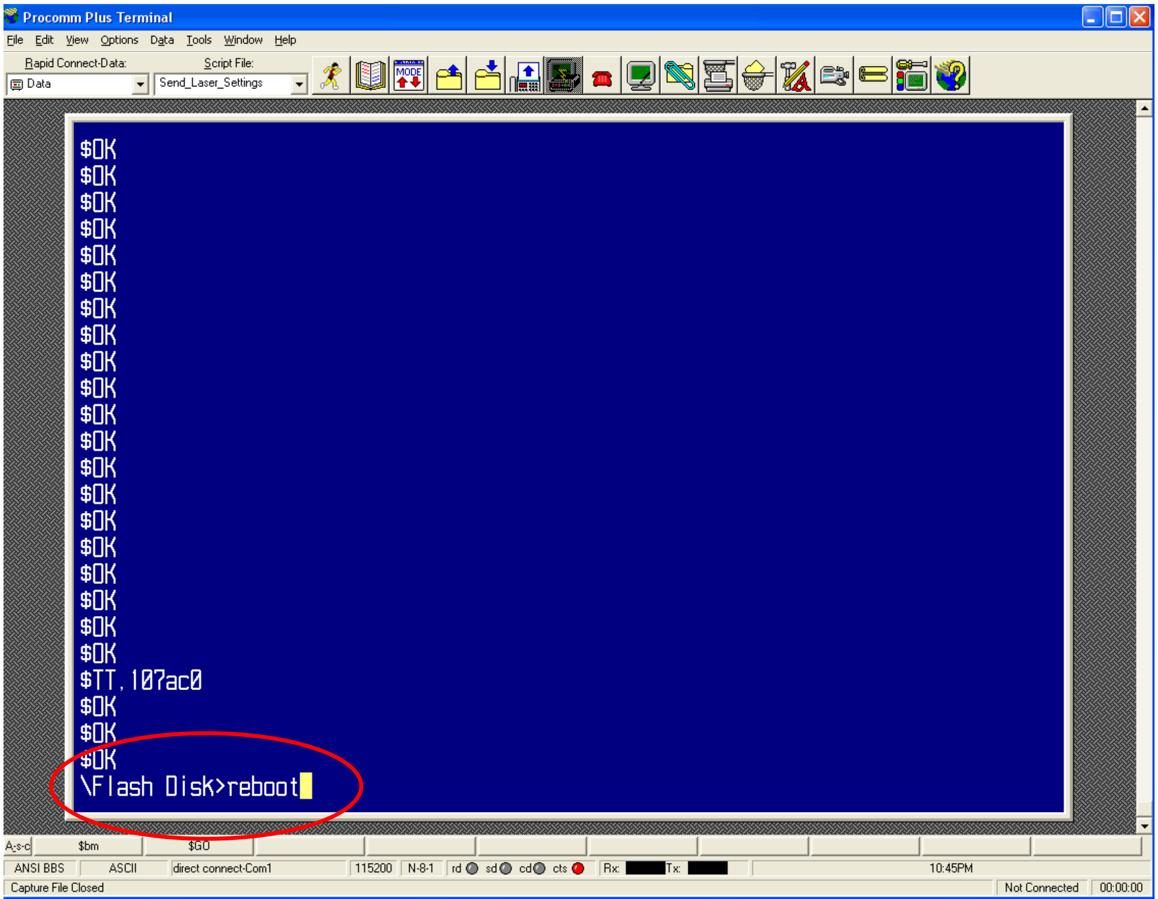


Figure 39

3.5 GET PORTS® DATA FROM THE DCP

To get PORTS® data from the DCP:

1. Using a computer, run ProComm or some other terminal emulator (such as Hyperterm), setting the COM port of the computer to 9600-N-8-1.

2. Press ESC. You will get the login/password prompts.

   Login:
   Type **P** and press ENTER.
   Password:
   DO NOT type in any value. Just press ENTER.

3. You should now see the following:

   NOS 85739281 07/11/2004 14:48:00
   Q1(44.660 0.038 2.00 29.537 29.366
   Q2(44.720 0.025 1.00
   L1< 12.662
   DAT 0.000
   SNS 0.000

Table 6 shows an interpretation of each line in the PORTS® data file.

Table 6

Line 1	
NOS	National Ocean Service
85739281	Station Number Chesapeake City Air Gap
07/11/2004	Date
Data collection time. PORTS data is reported every six minutes starting at six minutes after the hour. This is NOT the station time or date.	
Line 2	
Q1(	Denotes Microwave Air Gap data. Q = Air Gap Data 1 = 1st Air Gap sensor at this station (= GOES flag
44.660	Air Gap data in meters (m).
	The water is 44.664 m from the lowest point of steel on the bridge.
0.038	Standard deviation
2.00	Outlier count
29.537	The temperature value from temp 1
29.366	The temperature value from temp 2
Line 3	
Q2(	Denotes Laser data Q = Air Gap Data 2 = 2nd Air Gap sensor at the is station (laser) (= GOES flag
44.720	Laser data in meters (m)
0.025	Standard deviation
1.00	Outlier count
Line 4	
DAT	Station datum value, always 0.0 for Air Gap
Line 5	
SNS	Station datum offset, always 0.0 for Air Gap
0.000:	

References

NOS Tide Station User's Manual, Sutron Corporation, September 2004
http://www.sutron.com/products/tidestations.htm

Miros User Manual, Miros Microwave Rangefinder Technical Handbook, October 2002
www.miros.com

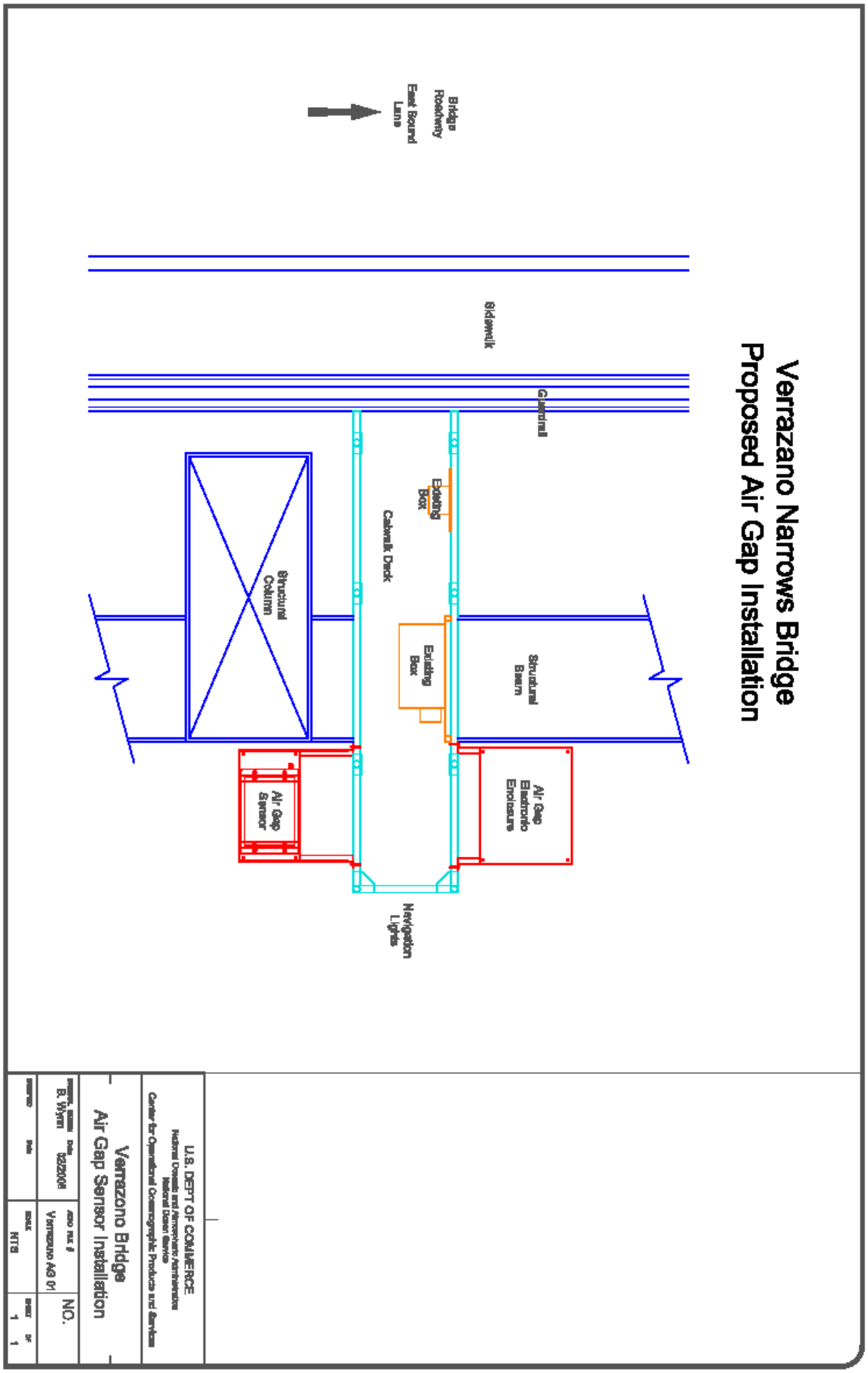
LTI User Manual, Laser Technology, Inc. ULS Hardware/Software Interface Specification, 1st Edition, 2005
www.lti.com

Sutron User Manual, Sutron Xpert Operations and Maintenance Manual, October, 2006
www.sutron.com/downloads/manuals.htm

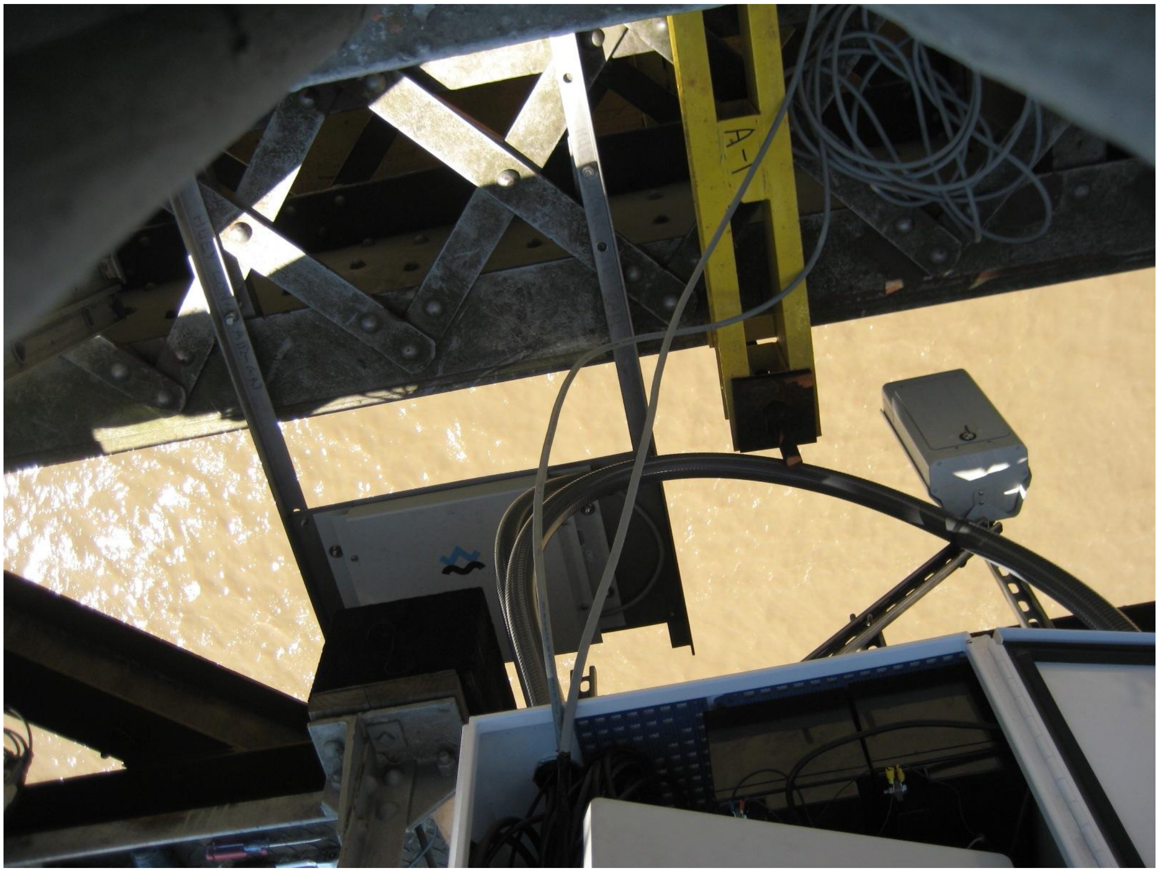
List of Appendices

Appendix A **Air Gap Mounting Diagrams**

Verrazano-Narrows Bridge

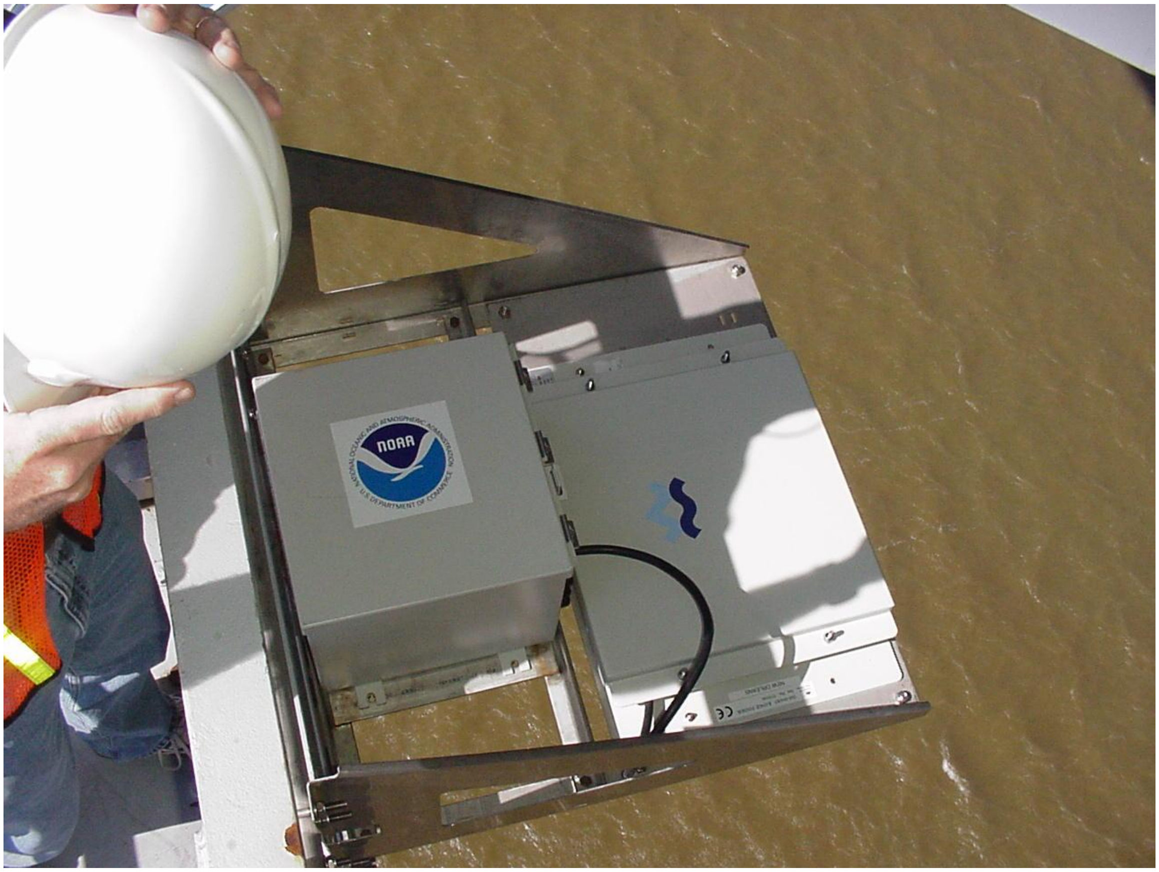


Huey Long Bridge

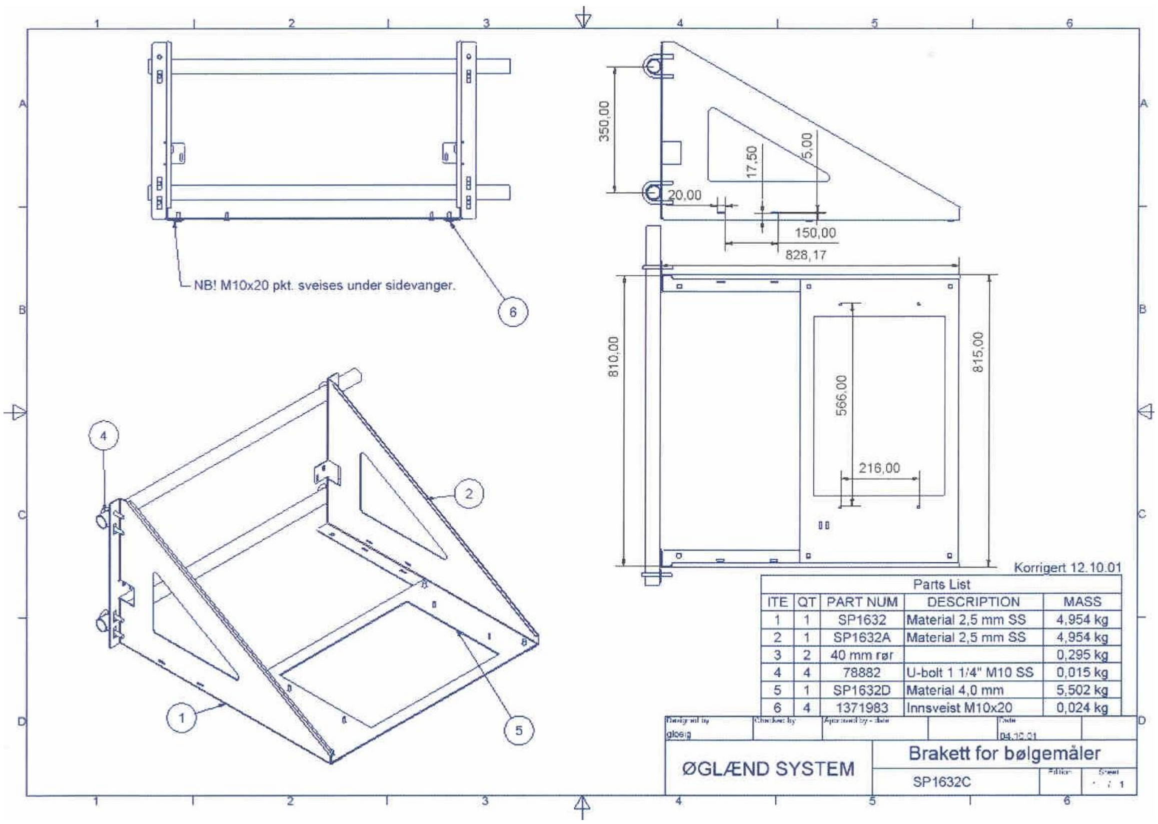


I-210 Bridge

Crescent City Connector



Miros Mounting Bracket for Crescent City (New Orleans, Louisiana)



Appendix B
CO-OPS Bridge Clearance Site Reconnaissance Procedures

Bruce L. Servary, Jr.
Civil Engineer

Requirements and Development Division
Center for Operational Oceanographic Products and Services
National Ocean Service
National Oceanic and Atmospheric Administration

TABLE OF CONTENTS

1. Introduction

The National Ocean Service (NOS), Center for Operational Oceanographic Products and Services (CO-OPS), operates a number of short and long term monitoring systems. CO-OPS provides the infrastructure, science, and technical expertise to monitor, assess, and disseminate coastal oceanographic and Great Lakes products and services necessary to support NOS missions of environmental stewardship, assessment, and prediction; safe navigation; and hazard mitigation.

In order to support the NOS and CO-OPS missions, new bridge clearance stations are regularly required. The best method for assembling the information needed to install these stations is a reconnaissance. The primary objective of the reconnaissance is to determine the optimal location and configuration for data collection platforms (DCP), antennas, sensors, and support components. For a Bridge Clearance station, recovering historic bench marks and scouting locations for setting new bench marks is also essential. The reconnaissance consists of personnel visiting the site sufficiently far in advance of site preparation to:

- Locate an acceptable site.
- Obtain measurements and information necessary to design the station.
- Arrange for any permits/license agreements required.
- Arrange for utilities.
- Prepare a cost estimate and work schedule.
- Allow time for the procurement and fabrication of special support components (if necessary).

If possible, property owners should be contacted in advance to obtain oral or written permission to use or modify the site, otherwise, meet with the property owner as soon as site is visited. An advance letter of permission, permit, security clearance, or some other written instrument may be required by the owner. A license agreement may have to be executed before any work can be done. Even if the site is an existing NWLON station, some advance notice may be required or appreciated by the owner.

Accurate measurements and information is best obtained onsite. The locale can be investigated to determine which particular site will best accommodate the preliminary design and all the other site requirements. Any special installation requirements, such as explosion proof conduit can also be determined through discussions with local authorities.

Once the reconnaissance information is collected and a report issued, the design is finalized, and a cost estimate and installation schedule can be determined.

2. Background

NOS is a Federal agency devoted to exploring, understanding, conserving, and restoring the Nation's coasts and oceans. NOS promotes safe navigation, supports coastal communities, sustains coastal habitats, and mitigates coastal hazards. NOS balances environmental protection with economic prosperity and leads the effort to ensure that our Nation's coastal areas remain safe, healthy and productive.

CO-OPS establishes standards for the acquisition and processing of water level, bridge clearance and current data; collects and documents user requirements that serve as the foundation for all resulting program activities; designs new and/or improved oceanographic observing systems; develops software to improve data processing capabilities; maintains and operates oceanographic observing systems; performs operational data analysis/quality control; produces/disseminates oceanographic products; and archives the resulting oceanographic data.

A bridge clearance station is a standalone system that collects, stores, and transmits the bridge clearance or air gap from the low steel of a bridge to the water. The primary requirement of a station is to accurately measure bridge clearance information with low power consumption, high reliability, and defined accuracy. The typical station includes a microwave sensor mounted with a clear view of the water, a redundant laser sensor and a data collection platform with Geostationary Operational Environmental Satellite (GOES) transmitter and rechargeable batteries. The station also includes sensors that measure air temperature inside the DCP enclosure and at the microwave sensor. At most locations power is provided by the bridge lighting system; however in some cases solar panels are required. The sensor should be located at the midpoint of the navigation channel or the highest point of the bridge roadway and is determined during the PORTS requirement assessment meetings.

3. Bridge Clearance System Equipment

- DCP with GOES
- DCP enclosure
- Microwave sensor
- Laser sensor
- Sensor and enclosure mounts
- Air Temperature Probes (2)
- Solar Panel (if needed)
- Step Down transformer (if needed)
- GOES antenna
- IP or Radio modem and antenna

4. Equipment Needed for Reconnaissance

The following equipment, forms, and information is needed to perform a complete reconnaissance:

- Digital Camera/Videotape Recorder
- Published Bench Mark Sheet
- NGS Datasheets for area
- Shovel/digging implement
- Metal detector

- Sample License Agreement/Letter of Permission
- Weighted measuring tape
- Wooden measuring tape
- Engineering sketch pad
- Inclinometer
- Carpenters level or plumb bob
- Hand-held GPS
- IP modem, battery and antenna
- Hand held Laser
- Compass
- Chart section
- Site Reconnaissance Field Notes form (appendix A)

5. Office Information

After the site has been selected for the installation of the bridge clearance station, the first step is to gather all relevant information. In some cases, the site has an existing or historic water level station nearby and office files can be consulted for much of the information. To find out if an historic water level station exists, consult the Index of Water Level Stations at http://www.co-ops.nos.noaa.gov/station_index_map.shtml.

Program requirements may also provide some direction. Contact the bridge operator; this could be the local state DOT office or Bridge Authority. Explain the need of the bridge clearance system and its use in safe navigation with the local Port or Pilots group. You may need to provide them with written information on the project before obtaining permission to go on the bridge. Make sure to ask about required safety equipment that is needed for the bridge recon. If the bridge does not have a walkway, a lane closure may be needed. Ask the bridge operator when the next closure is planned and arrange your visit at that time. The system should be installed on the South or West side of the bridge so that there is a clear view of the sky for the GOES and GPS systems as well as the solar panels if needed. Explain to the bridge operator the need to inspect the correct side of the bridge. You may be required to provide a safety vessel during the inspection or pay for the lane closure, the bridge operator should be able to provide the names of companies that can provide these services.

If there is a historical site, assemble as much of the following information as possible:

- Tidal datums and bench mark elevations.
- To Reach statement and bench mark recovery notes.
- Support structure and harbor bottom elevations.
- Support structure plan and sun transit.
- Environmental data.
- Instrument shelter and utilities description.
- GOES transmission information (azimuth and elevation).
- Solar incidence.
- Ancillary sensor(s) requirements.

To Reach statements and bench mark recovery notes are needed to find the historic site and recover as many historic bench marks as possible. This information can be found on the CO-OPS published bench mark sheet web page http://tidesandcurrents.noaa.gov/bench.html.

Datasheets retrieved from the NGS web site are essential for replacing destroyed historic marks and for providing a connection to the North American Vertical Datum of 1988 (NAVD88). The web site is http://www.ngs.noaa.gov/cgi-bin/ds_radius.prl.

The GOES satellite antenna azimuth and elevation angles are required to select an antenna site free of obstructions that may interfere with the transmission. GOES satellite azimuths are referenced in true degrees. If a compass is used to position the antenna, the local magnetic declination must be applied.

Solar incidence is needed to provide the proper orientation and elevation of the solar panel to provide maximum charging voltage.

Requirements for ancillary sensors should be determined in advance to allow adequate lead time for site preparation configuration and installation.

6. Site Visit

After compiling all information possible in the office, it is time to visit the site. Setup a meeting with the bridge operator and arrange for the safety vessel or other required support.

Record all information on the Site Reconnaissance Field Notes form in appendix A. Ask permission to take pictures of the site.

Following receipt of owner permission, perform the following measurements at the structure:

- Using the laser measure from the man cage or roadway barrier to the water surface
- Time of man cage or roadway barrier to water surface measurement
- Distance from the man cage or roadway barrier to the low steel
- Size of the man cage
- Size of all railing
- Size of roadway barriers
- Distance to power source
- IP Testing. Set up the IP and contact the shop to make a test connection to the unit. The shop will provide you with the RSSI reading which should be recorded on Site Reconnaissance Field Notes form

Record contact information for the following individuals:

- Facility owner
- Local contact – the person who must be notified whenever the station is visited.

Make the following observations:

- Sky clearance in the direction of the GOES antenna and solar panels.
- GPS latitude/longitude of station & bench mark locations. Record position to the thousandths of a second.

Take digital photographs of the following:

- Proposed location of the bridge clearance sensor
- Proposed location of DCP
- Recovered bench marks
    - Bench mark faces
    - At least two distance photos from different directions showing landmarks in the background
    - Locations for new marks

7. Documentation

Submit the following documentation upon completion of the reconnaissance:

- Site Reconnaissance Field Notes
- Bench Mark recovery notes
- All digital photos of the bridge, proposed sensor and DCP locations, and proposed bench mark installation locations if insufficient marks recovered.
- Site view drawing showing proposed sensor and DCP locations; North directional arrow; recovered bench marks; proposed bench mark install locations

Appendix A – Site Reconnaissance Field Notes

National Oceanic and Atmospheric Administration
National Ocean Service
Center for Operational Oceanographic Products and Services
Bridge Clearance
Site Reconnaissance Field Notes

GENERAL SITE INFORMATION

Station Number	Station Name	Date
Project Name	**Station Type** — Permanent; Temporary; PORTS:	
Site Name	**Site Location** — City / County / State / Zip code	

How To Reach

Property Owner: **Address:** **Phone:** **Cell Phone:** **Fax:**	**Local Contact:** **Address:** **Phone:** **Cell Phone:** **Fax:**

Communications or Agreements Made To Date

Contact dates?
Letter, phone or meeting?
Details of Discussion?
Follow-up needed?
MOU or permits needed?

SITE DESCRIPTION		GEOGRAPHIC/OCEANIC DESCRIPTION	
Facility	Public; Private; Accessibility	**Geographic & Hydraulic Features**	Open Coast; Sheltered Harbor; Bay; Sound; Marsh Tide Range; Wave Height; Currents
Support Structure	Man cage, open beam, concrete barriers, guard rail with or without a fence. Open or closed bridge structure.	**Test Reading**	Hand held laser readings and time of readings. Include distance from low steel if known. Location of laser unit
Power	AC, type and voltage Solar, type of mounts	**IP Tests**	RSSI reading
		Proposed Sensor & DCP Locations	

INSTRUMENTATION	SUPPORT STRUCTURES
Data Collection Platform To Be Installed	**Type Of mount needed**
Sensor(s) To Be Installed	**Nearby water level stations (name, station number and distance from site**

TOOLS/SUPPLIES	
Special Tools or Equipment Required	**Boat** **Generator** **Welder**

Supply List	Lumber Hardware Pipes
Nearby Supplies/Services	
VERTICAL CONTROL/BENCHMARKS	
Level Procedures to be Performed	2nd Order, Class 1 3rd Order, Class 1 Other
Bench Marks (Designation/Stamping/Mark Type/Setting/Stability Code)	# Recovered # to be Installed Estimated length of run Quality of Bench Marks GPS Suitability
SERVICES/UTILITIES	
Telephone Requirements	# of lines required Origination Point Length of run Overhead/trench Estimated cost Type of cable Type of conduit
Telephone Company Info	Name Number Mail Address Contact
Electrical Requirements	# of lines required Origination Point Length of run Overhead/trench Estimated cost Type of cable Type of conduit
Electrical Contractor Info	Name Number Mail Address Contact
Other Contractors Info	Marine Concrete Diving Welding Price quotes received
Additional Information	

Appendix C Xpert Software Setup for Miros and LTI Sensors

XPERT Software

Using Xterm connect to the system and from the main screen fig. C 1, click on the **FILE TRANSFER** button on the right side.

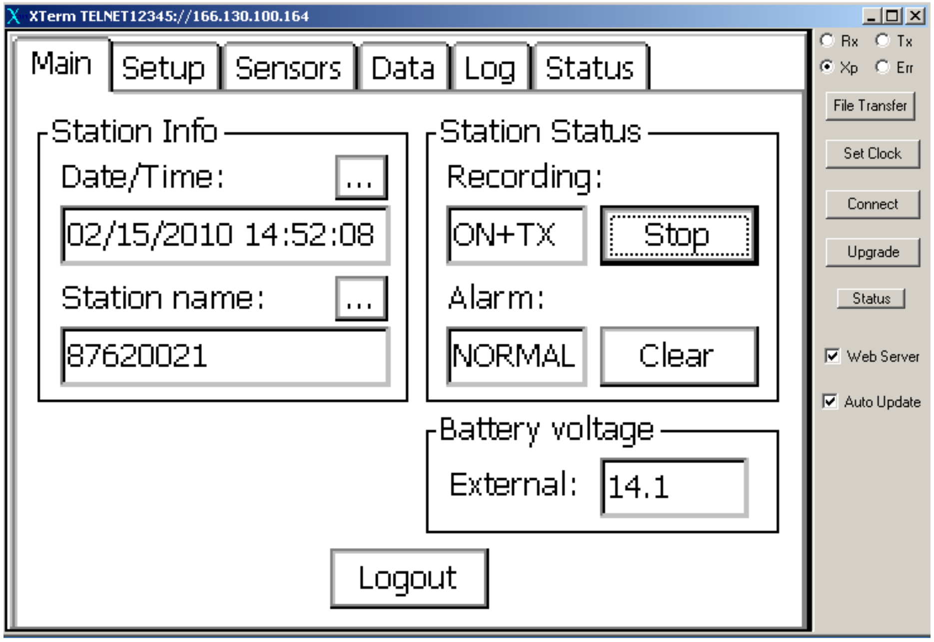


Figure C 1

This will bring up the File Transfer screen (fig. C 2).

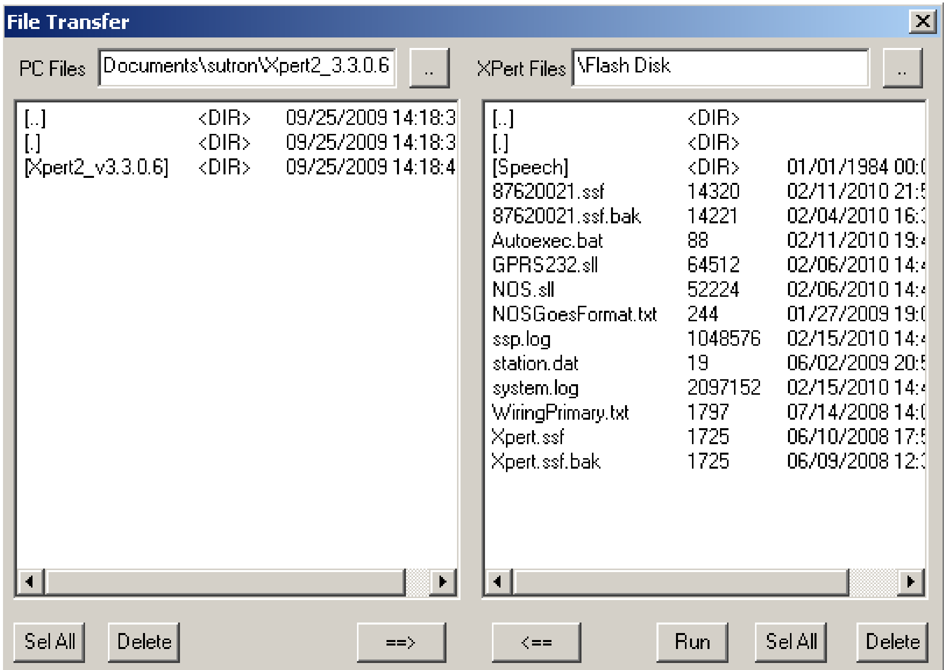

File Transfer
PC Files
Documents\sutron\Xpert2_3.3.0.6
XPert Files
\Flash Disk
[..] <DIR> 09/25/2009 14:18:3
[.] <DIR> 09/25/2009 14:18:3
[Xpert2_v3.3.0.6] <DIR> 09/25/2009 14:18:4
[..] <DIR>
[.] <DIR>
[Speech] <DIR> 01/01/1984 00:
87620021.ssf 14320 02/11/2010 21:
87620021.ssf.bak 14221 02/04/2010 16:
Autoexec.bat 88 02/11/2010 19:
GPRS232.sll 64512 02/06/2010 14:
NOS.sll 52224 02/06/2010 14:
NOSGoesFormat.txt 244 01/27/2009 19:
ssp.log 1048576 02/15/2010 14:
station.dat 19 06/02/2009 20:
system.log 2097152 02/15/2010 14:
WiringPrimary.txt 1797 07/14/2008 14:
Xpert.ssf 1725 06/10/2008 17:
Xpert.ssf.bak 1725 06/09/2008 12:
Sel All
Delete
==>
<==
Run
Sel All
Delete

Figure C 2

You should see the following files on the right side section of the screen:

File Name	**Function**
87620021.ssf	Station setup file. The file name will be the station name for your station and contains all the setup information the DCP needs to set the other files, create log files and set up the Satlink
87620021.ssf.bak	A backup version of the above (87620021.ssf) file.
Autoexec.bat	Sets the COM ports and starts the Xpert software.
GPRS232.sll	RS232 setup file. Sets the port being used to communicate with the Miros and laser sensors. See page C-6 for additional information.
NOS.ssl	Formats the data that is transmitted via GOES and the PORTS® tag.
NOSGOES format.txt	Allows the user to set the order of the data being transmitted via GOES and the PORTS® tag.
SSP.log	The log that all the data is stored on.
Station.dat	This files stores the station name (number) and sets the screen contrast.
System.log	Logs all system actions including error and warnings. A good troubleshooting tool if a system error is suspected.
WiringPrimary.txt	A list of the wiring connections for the system. Not on all systems.
Xpert.ssf	The basic Xpert software. Should only be used when advised by the CIL/SIL.
Xpert.ssg.bak	A backup copy of the above (Xpert.ssf) file.

In older operating systems there was a file called Users.dat. This file contained the users' names, passwords and other information. Due to security concerns this file is no longer stored on the Flash Disk or viewable via Xterm or the command line. It is loaded during system setup and testing. Additional users can be added as before by selecting the USERS section of the Setup menu. For additional information contact the CIL.

Miros Air Gap Sensor (Radar)

Sensor description

The Miros Range Finder is a radar-based water level sensor. Typically the unit is fastened under a bridge deck to measure the distance from the bridge to the water surface. Range Finders are capable of accurately measuring distances up to 85 meters. A typical Range Finder sensor is illustrated in fig. C 3. The sensor head is approximately 2 ft × 2 ft × 4 in.

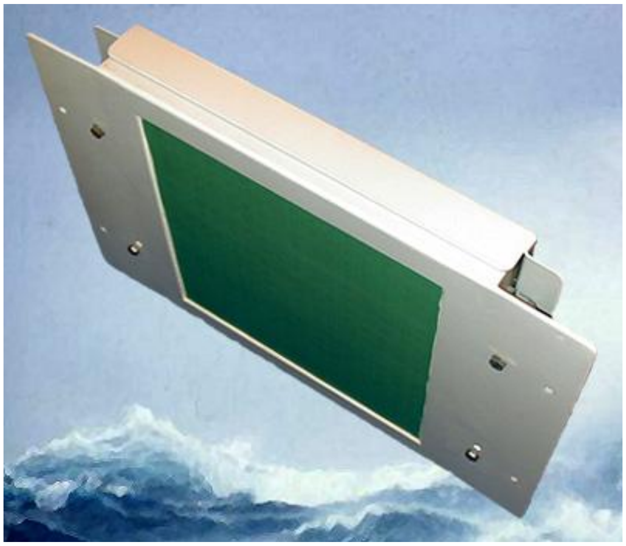


Figure B 3

Sensor Installation

The Miros sensor is installed external to the Tide Station enclosure. Follow installation procedures as recommended by the manufacturer to suspend the sensor head from the bridge structure. Make sure the area within the sensor's cone of measurement is free of obstructions. Extend the serial interface cable from the sensor to RS232 termination card inside the enclosure. Use one of the pre-punched holes in the lower left side of the enclosure to admit the cable. Seal around the cable with an appropriate packing gland or sealing material.

Sensor Wiring

NOS standard wiring for the Miros microwave sensor is to connect the RS232 termination card to COM 3, as illustrated in fig. C 4.

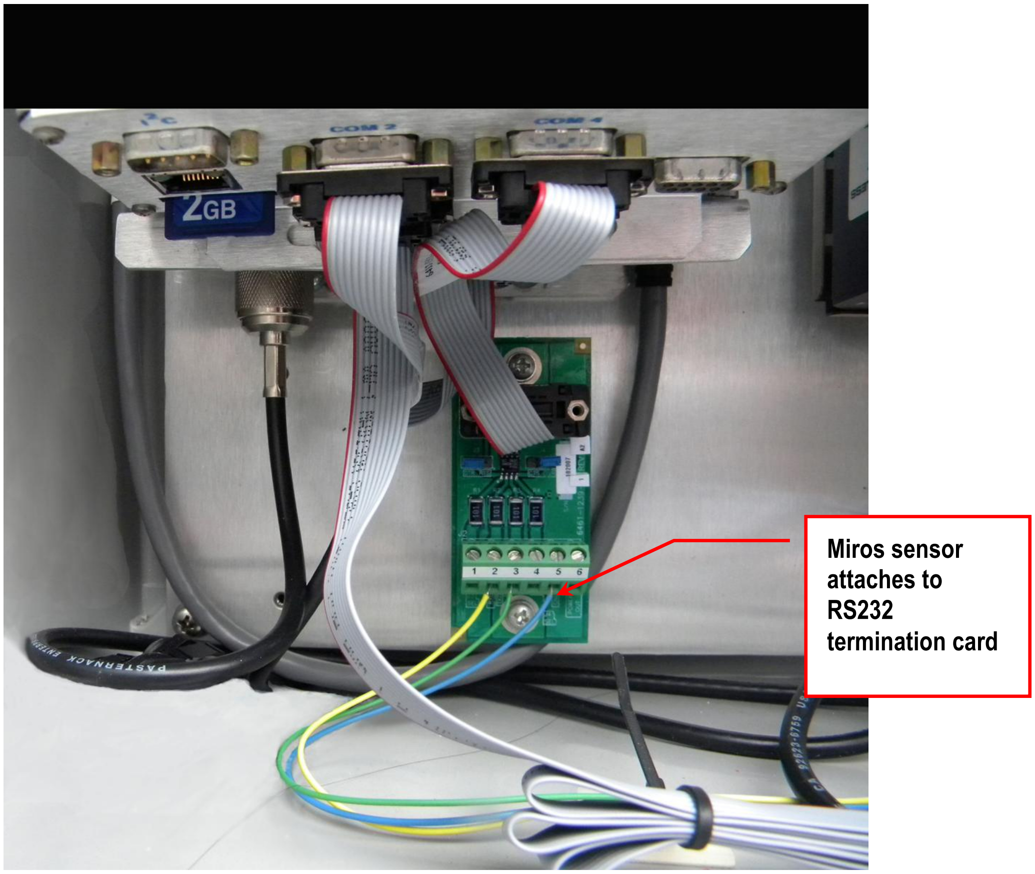


Figure C 4

Xpert Software Setup

General Sensor Setup

The Miros sensor uses the GPRS232.ssf, which can be found in the Extra ssf directory that is included with the Xpert OS software and can be copied onto the Xpert's Flash Disk. Figure C 5 illustrates the Miros setup.

The GPRS232 block opens the appropriate serial port and reads data from the sensor. The GPRS232 block is sampled by a DQAP block that performs averaging according to the NOS standard. DQAP does a two-pass average, where the average is computed, outliers are removed (those values over 3 standard deviations from the computed mean), and the average is recomputed. The DQAP block provides four outputs. These outputs are the DQAP average, the standard deviation, the outlier count, and the sample count. The average, standard deviation, and outlier count are incorporated in the self-timed GOES transmissions.

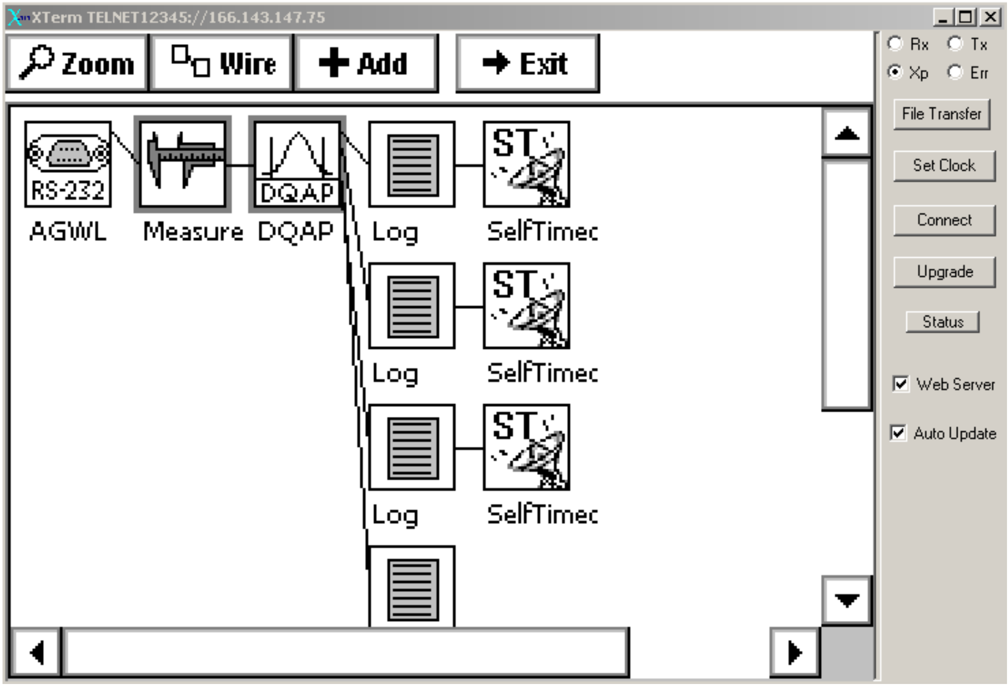


Figure C 5

Specific Setup Properties

Select the COM port that the sensor is wired to, normally the Miros is connected to COM 3 with a baud rate of 9600, no parity, 8 bits and 1 stop bit. The timeout should be set to 6000. Figure C 6 shows the GPRS232 block setting.

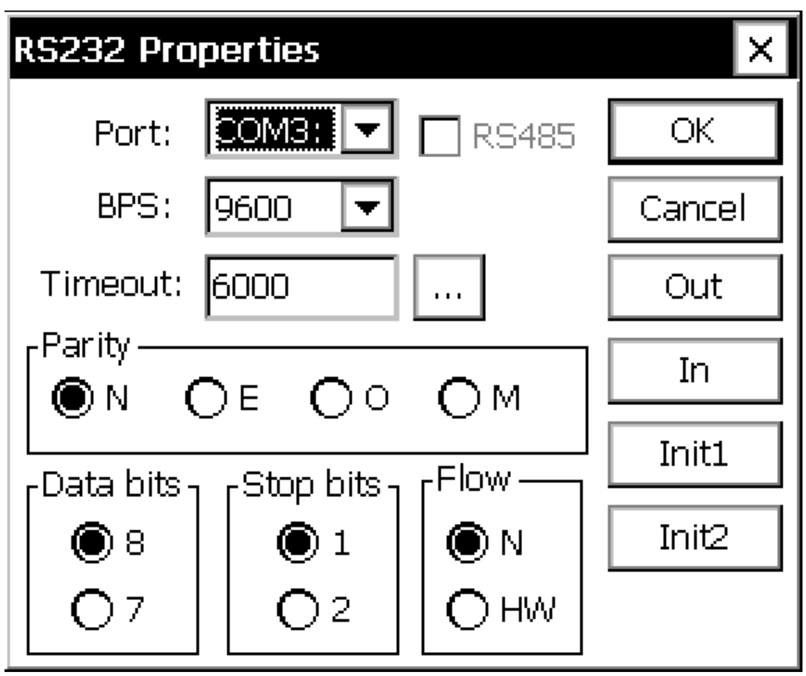


Figure C 6

The GPRS232 block can send custom commands through the selected COM port to the sensor. When the Miros polling command, GV, is sent, the sensor will respond with a reading. Pressing the **OUT** button will bring up the Outbound Message screen and should be set up as shown in fig. C 7. Clicking the **OK** button will save the setting and return you to the RS232 Property screen.

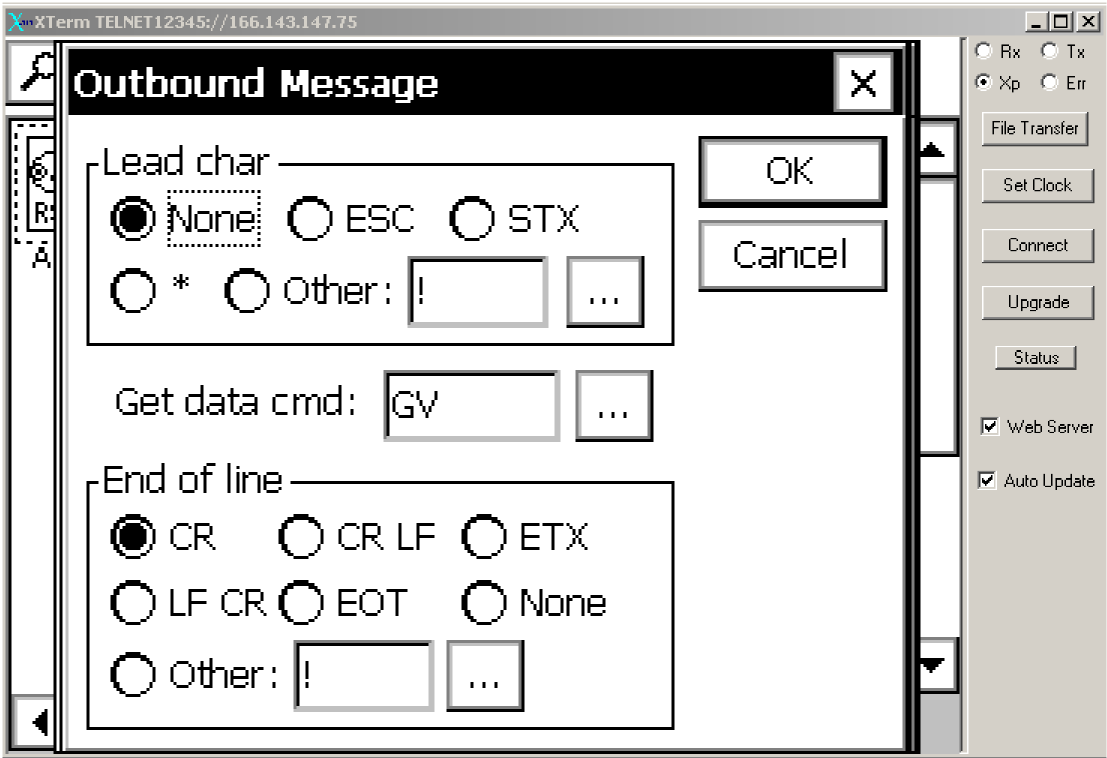


Figure C 7

There is also an Inbound Message portion to the GPRS232 block. Pressing IN on the RS232 Property screen will display the Inbound Message screen. Figure C 8 shows the setups needed for this screen. Please note that these setups are only for the Miros. The GPRS232 block is used in several applications and care should be taken when making changes to this screen. Click the **OK** button to save the setting and return to the RS232 Property screen.

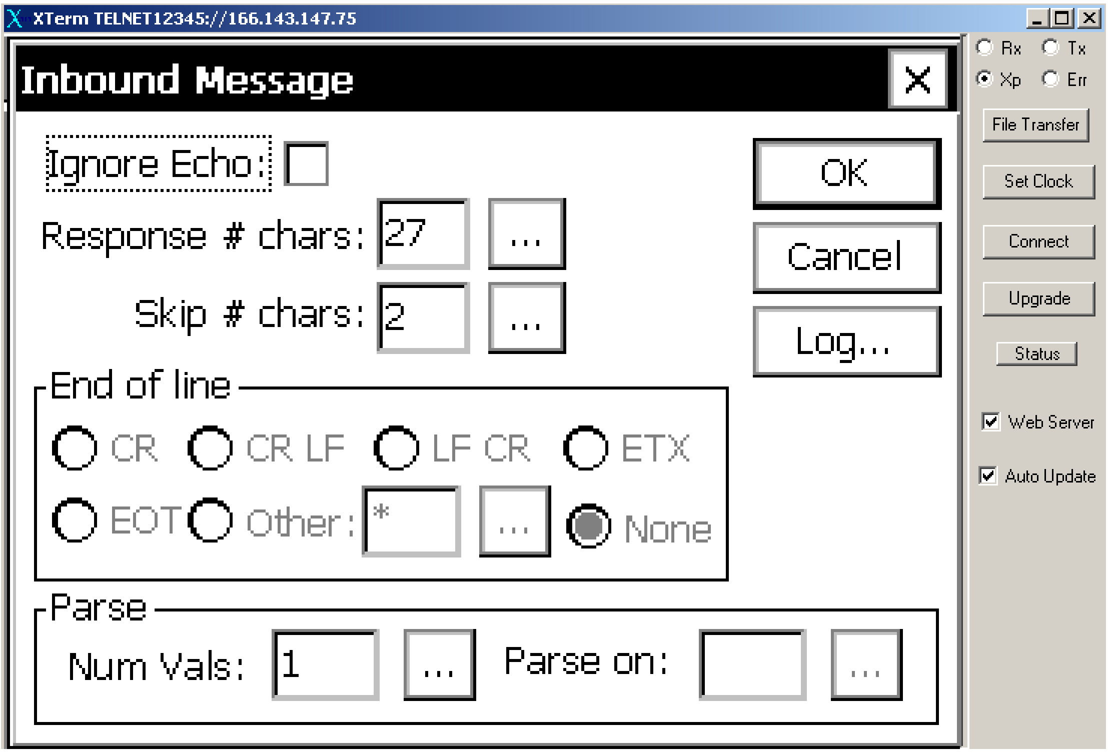


Figure C 8

The GPRS232 block can send up to 10 commands to the attached sensor when Recording is started from the Main Xpert screen. Each command is sent with the same End of Line as set in Outbound Message screen in fig. C 9. For the Miros sensor, the command SER0 is sent to set the sensor to the polled mode. Click the **OK** button (fig. C 9) to save the setting and return to the RS232 Property screen.

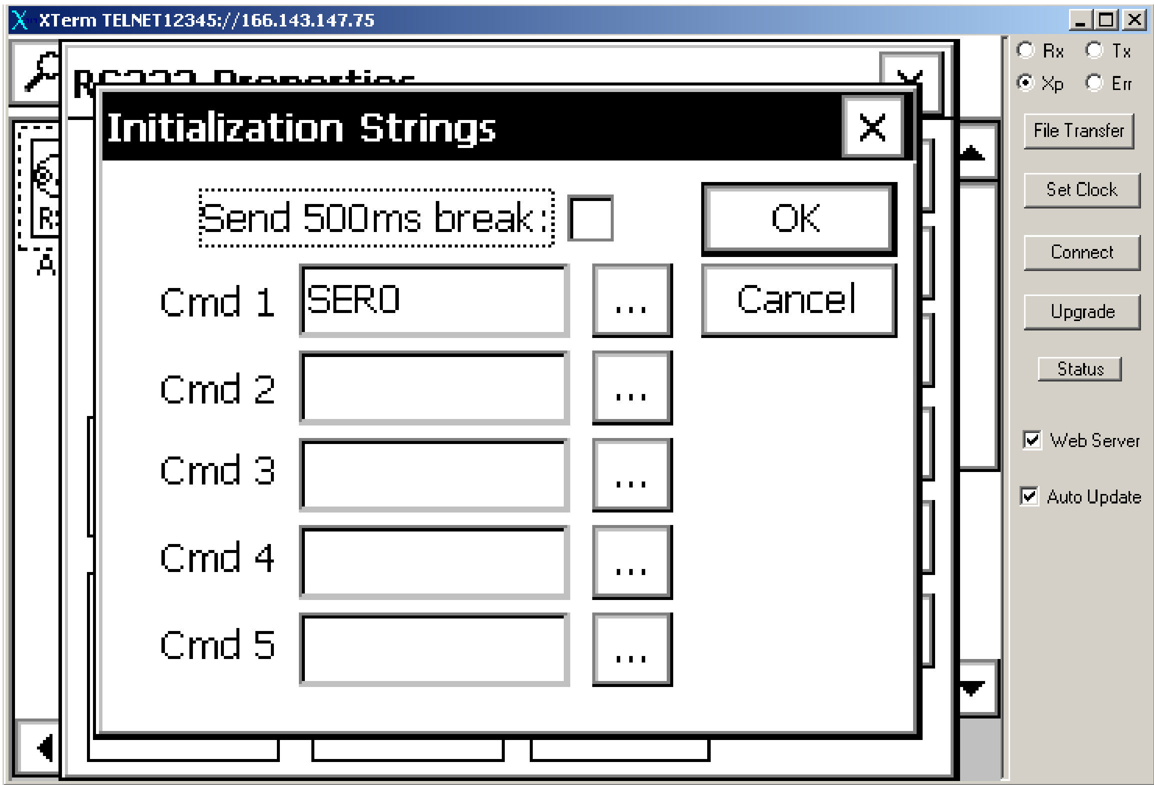


Figure C 9

Universal Laser Sensor (ULS)

Sensor description

The Laser Technology, Incorporated Universal Laser Sensor (ULS), shown in fig. C 10, is relatively small (see wristwatch on the left in fig. C 10), and boasts a "cooperative target" (highly reflective) range of over one mile. The maximum cooperative target resolution is 1 mm. The sensor is powered by 12Vdc and consumes 170 ma (maximum).

Figure B 10

The sensor has serial digital, 4-20 ma and analog outputs. Refer to the Laser Technology Web site, www.lasertech.com , for additional information and specifications.

Sensor Installation

The ULS is installed external to the tide station enclosure. The sensor mounts vertically, using #8 screws in the slotted back plate. National Ocean Service incorporates a bubble level on top of the case (left view, fig. C 10) to aid in setting the vertical alignment. The black bracket on the side of the case provides an optional optical sight. The design incorporates a bright red laser pointer that can be used to align the sensor on a specific location or target. The pointer is turned on and off by specific commands issued through the serial interface. Refer to table C 1 (page C-12).

Follow installation procedures as recommended by the manufacturer to suspend the sensor head from the bridge structure. Make sure the area within the sensor's line of sight to the water surface is free of obstructions. Extend the serial interface cable from the sensor to the RS232 termination card inside the enclosure. Use one of the pre-punched holes in the lower left side of the enclosure to admit the cable. Seal around the cable with an appropriate packing gland or sealing material.

Sensor Wiring

NOS standard wiring for the LTI laser sensor is to connect the RS232 termination card to COM 4, as illustrated in fig. C 11.

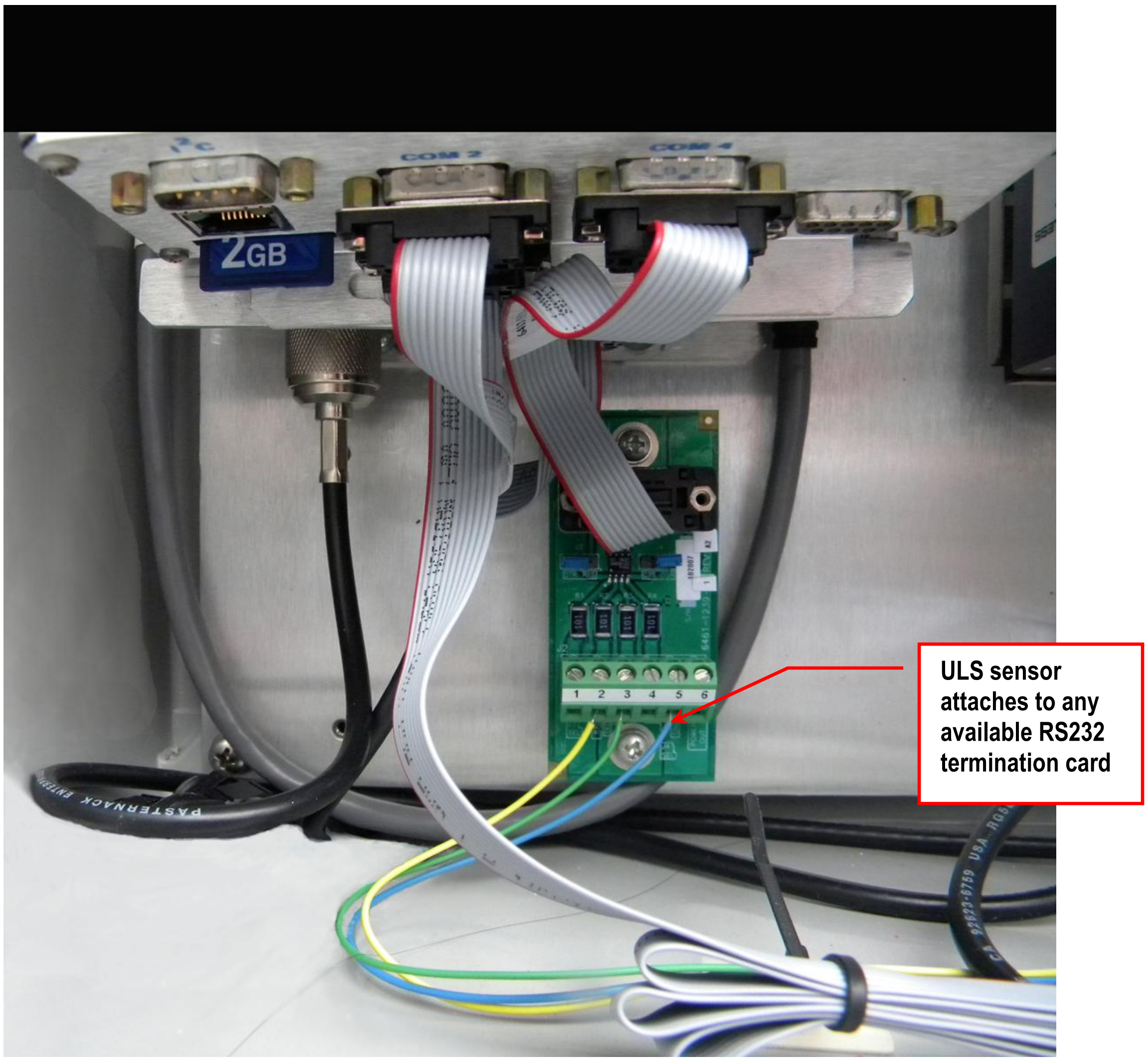


Figure C 11

Xpert Software Setup

ULS Setup

The ULS, unlike a simple analog temperature sensor, is not ready for use directly out of the box. The sensor offers multiple output types, as well as a variety of adjustments and settings to enhance signal performance and flexibility, all of which may or may not be needed.

You can change sensor behavior by issuing commands to the sensor through the RS232 serial configuration port. You may use either a dedicated Microsoft Windows application provided with the sensor or a serial communications program such as Hyperterm or Procomm. A special command is provided to make changes permanent by writing them to the sensor's Flash memory. The serial configuration port is set up for 9600 bps, no parity, 8-bits, one stop bit. (9600, N, 8, 1).

Several ULS parameters are critical for proper operation. Table C 1 lists the critical parameters that **MUST** be checked before a sensor can be deployed. Note that NOS standard practice is to set up the sensor in the lab prior to deployment. Field personnel do not normally need to worry about the sensor settings.

Table C 1

Command	Function	Approved Settings	Notes
$AB	Average Bounds in Picoseconds	3000	
$AF	4-20 ma Fault Current Value	xxx	Not used if CL=0
$AT	Fault Timeout for 4-20 ma Current Loop	xxx	Not used if CL=0
$AW	Averaging Weight	100	
$BH	Bin Threshold	64	Not used if MM=1
$BR	Config Port Baud Rate	9600	
$BR,1	Output Port Baud Rate	9600	
$BS	Bin Size	3	Not used if MM=1
$CE	Cosine	0 off	
$CG	Check Gate	1	Enable
$CL	4-20ms Current Loop On/Off	0	Off
$CO	Continuous Measurement Output Mode	0	Off
$CT	Current Trip Threshold	30	Not used if MM=1
$CV	Cosine Value	xxx	Not used if CE=0
$DD	Dithering	0	Off
$DM	Display Mode	2	Distance and Intensity
$DR	Dampening	xxx	Not used if OP=0
$DS	Dampening	xxx	Not used if OP=0
$EG	Enable Gate	6	Enables short and long gates
$FA	First, Last, Most and All	0	First
$FL	Cooperative Filter	0	Non cooperative target
$FT	Flyer Trap	0	Not used if MM=1
$IL	Initial Lock	6000	
$LA	Detection Mode	0	Not used if MM=1
$LG	Long Gate	85	Long gate set to 85 meters
$MA	Measurement Auto Start On/Off	1	On, Sensor is measuring at power up
$MM	Measurement Mode	1	Set to averaging
$MO	Measurement Output Port	0	Data outputting to configuration port
$MP	Minimum Pulse Width Rejection	0	Disabled
$MU	Measurement Units	1	Output in meters
$MX	Maximum False Pulses	5	Not used if MM=1
$OF	Unit Offset	0	No offset entered
$OP	Output Processing	0	Off

Command	Function	Approved Settings	Notes
$PA	Pointer Autostart On/Off	0	Off
$PF	PRF Rate	4,000	
$PL	Power Level	0	High level
$PO	Pulses/Measure	4,000	
$PT	Pointer On/Off	0	Pointer is off
$SG	Short Gate	40	Short gate set to 40 meters
$TB	Time Between Events	0	Not used if MM=1
$TP	Trip Point	0	Not used if MM=1
$TT	Trip Point Time Out	106ae	Hex value within 25 counts of 106
$UA	Unit Address	xxx	Not used when in RS232 mode
$US	Unit Status	7	Read only
$WT	Windowing Time Out	xxx	Not used if OP=0
$WV	Windowing Error Range Value	xxx	Not used if OP=0
$XP	Maximum Pulse Width Rejection	xxx	Not used if OP=0
$BM	Data Request		Data is send to output port
$SU	Saves Settings		Save settings
$ST	Stops the sensor and places it in the command mode.		Set sensor to command mode
$GO	Starts the sensor. Use $BM to get data.		Starts the sensor
			A $ must precede the command to be accepted

Note carefully the settings for Short Gate and Long Gate. These parameters have the potential to prevent the sensor from operating. Make sure that the gate settings match your physical location. Be absolutely sure to save any changes you make to the settings in table C 1 by using the $SU command.

The PRF and Pulses/Measurement parameters are also critical. These parameters are most likely to have been set to something else at the factory. Check them and make sure they are correct.

Xpert Software Setup

The ULS uses the RS232 block, so make sure the GPRS232.sll is loaded on the Xpert Flash Disk.

The RS232 block issues commands to the sensor and reads the serial data from the sensor. The ULS is configured to output two serial values. The first value is the range (distance from the sensor to the water surface), and the second value is the signal intensity.

The ULS block is sampled by a DQAP block that performs averaging according to the NOS standard. DQAP does a two-pass average in which the average is computed, outliers are removed (those values over 3 standard deviations from the computed mean), and the average is recomputed (fig. C 12 and fig. 13). The DQAP block provides four outputs. These outputs are the DQAP average, the standard deviation, the outlier count, and the sample count. For ULS applications the average, standard deviation, and outlier count are logged.

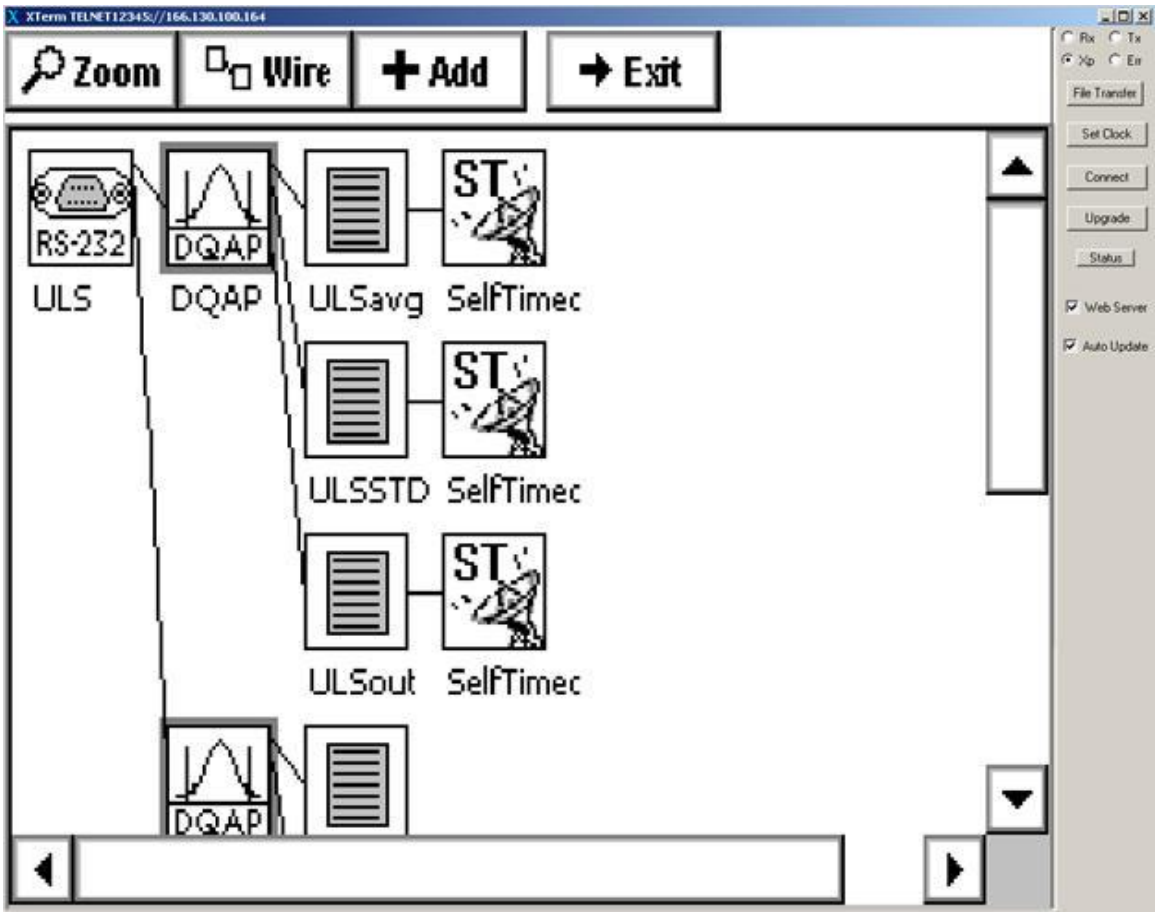


Figure C 12

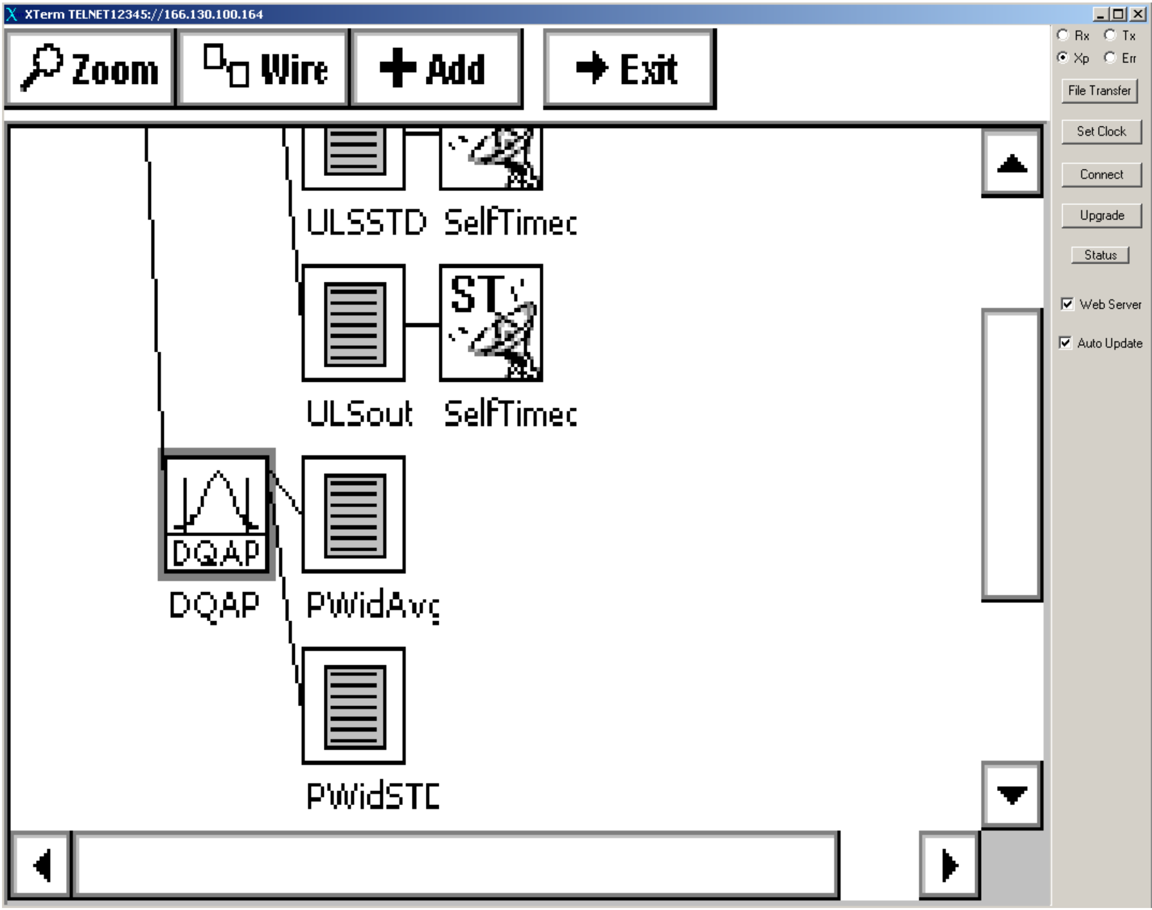


Figure C 13

Specific Setup Properties

Generally, you should not need to modify the properties provided in the setups. If properties must be modified, they will most likely be associated with the RS232 block settings. The most common change is the serial port that the ULS is connected to. Normally COM 4 is used for the ULS sensor. See the following paragraphs and figures for information about how to change the settings.

NOS standard wiring for the LTI laser sensor is to connect the RS232 termination card to COM 4, as illustrated in fig. C 14.

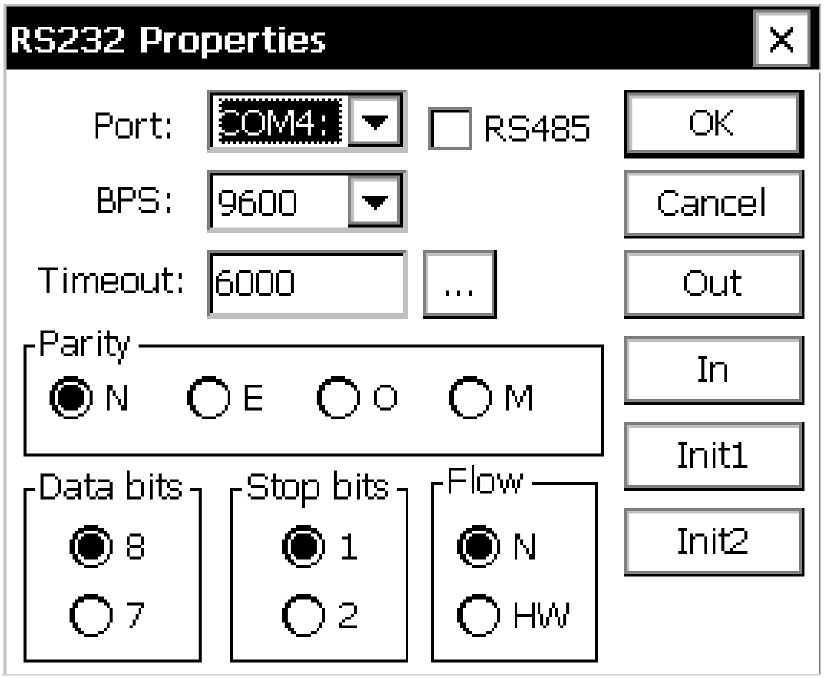


Figure C 14

Figures C 15 and C 16 illustrate the **In and Out** settings for the ULS. The ULS echoes the input command and requires that four (4) characters be skipped. The returned data values are separated by commas. The ULS uses carriage returns (CR) to terminate commands and responses. The **Get Data** command is **$BM**.

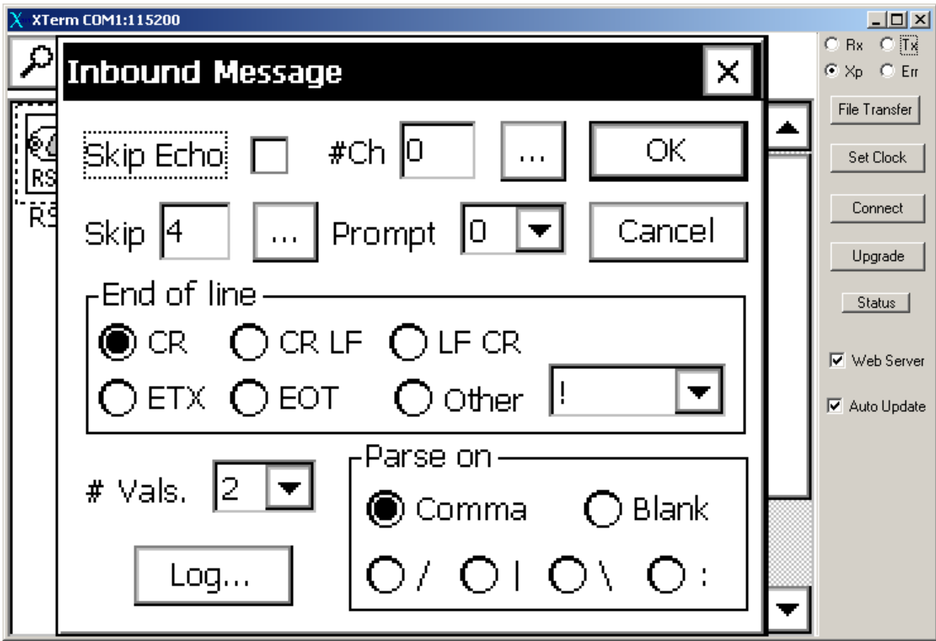


Figure C 15

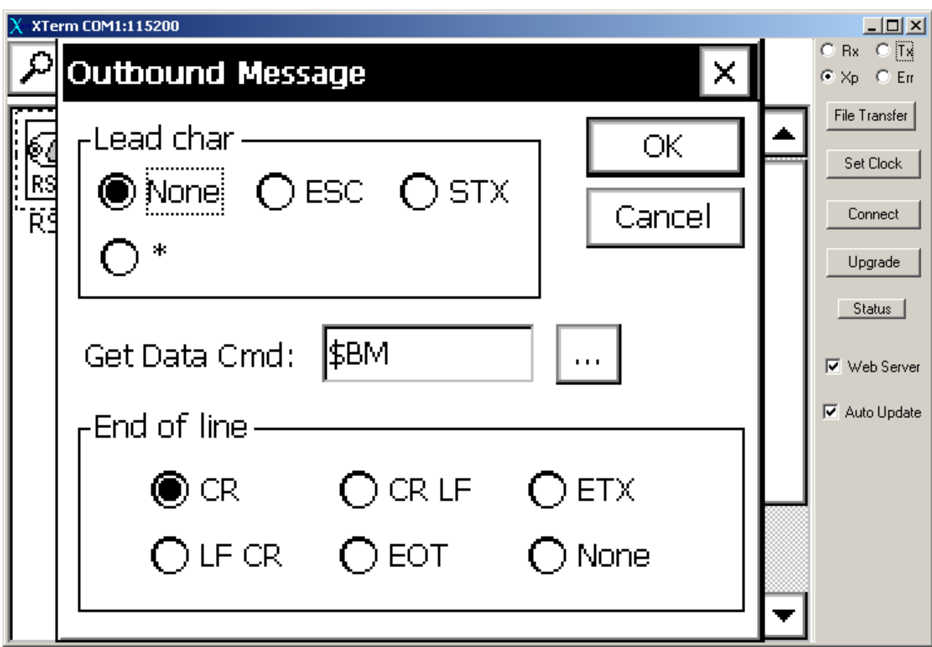


Figure C 16

The RS232 block provides INIT (Initialization) capability for a serial sensor. However, only 10 initialization commands can be issued. The setup includes initialization for the critical parameters listed in table C 2. Examples are shown in fig. 17 and fig. 18. For additional information, refer to Table C 1.

Table C 2

ULS Parameter	Command	Required Value
Stop	$ST	
Continuous Operation	$CO	0
Dithering	$DD	0
Measurement Mode	$MM	1
Measurement Units	$MU	1
PRF Rate	$PF	4000
Power Level	$PL	0
Pulses/Measure	$PO	4000
Saves User Settings	$SU	
Starts Sensor	$GO	

Figure C 17 illustrates the Initialization settings incorporated into the RS232 block of the standard setup.

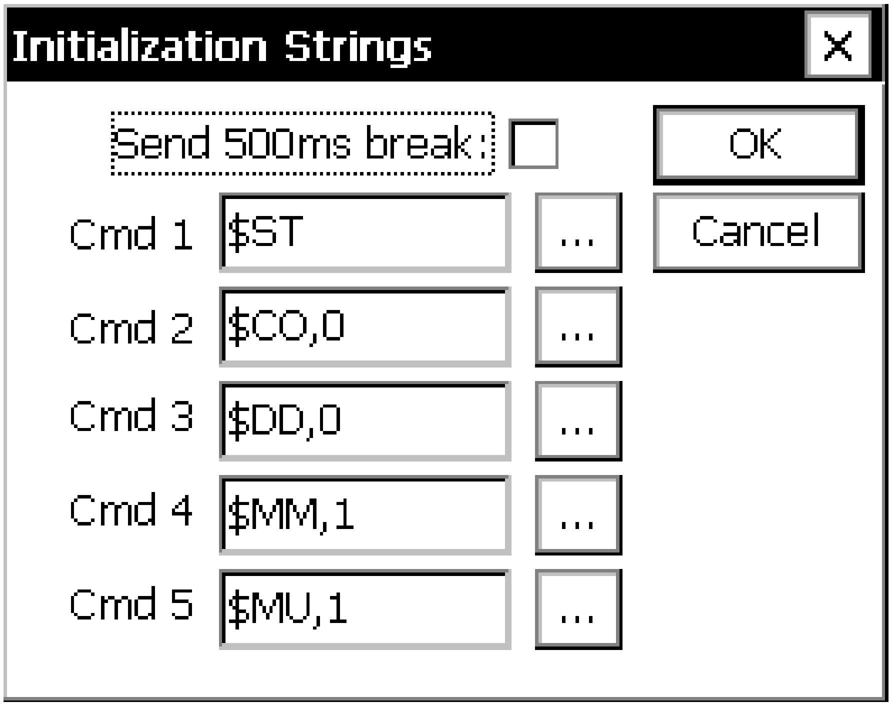


Figure C 17

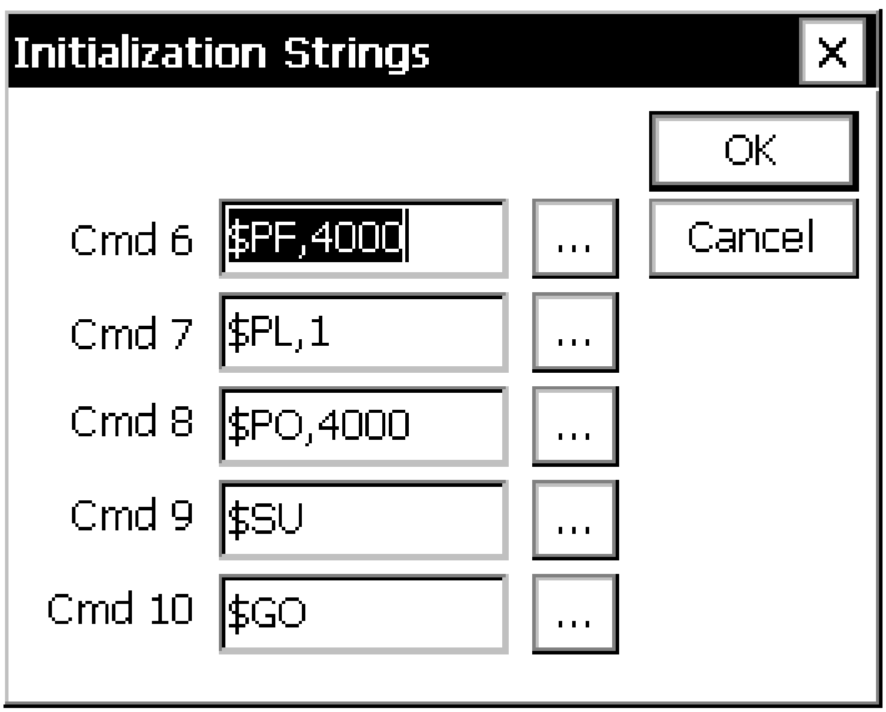


Figure C 18

Appendix D **Miros Setup Sheets**

Station Setup Sheet for All Command

Factory Setting	Station Setting
min 100	
det 100.0 %	
wtc 4.7 sec	
win 1.0 m	
ser tout 5.0 sec 0	
freq 2 Hz	
htc 0.5 sec	
atc 59.5 sec	
ntc 0.0 sec	
top 1	
ch 2.0 50.0 m	
MIROS Altimeter SW ver. 6.4a	
Maximum range 50 m	
Ant. beam width 5 deg	

Station Setup Sheet for Altconfig Command

Miros S/N ___________________Location _______________________________Date____________________

Factory Setting	Station Setting
meas 375.0 mm/ch -885.0 mm	
Fft 256	
fft-time 226.44 msec	
tot-time 377.43 msec	
sweep-time 22.21 msec	
Range 50 m	
Ant 5 deg	
as-type 1	
as-gain 0.0 %	
as-offset 0 mV	

Appendix E **Procomm Scripts**

Get_Laser_Settings Script and the Log File It Produces

```
;***************************************************************************
;*                                                                         *
;* This procedure logs into a LTI Universal Laser Sensor, displays         *
;* and logs the settings. The script can be used when directly connected to the *
;* sensor or through a telephone or IP modem.                              *
;* A second script called Send_Laser_settings can be used to load approved settings *
;* the Laser                                                               *
;*                  wkrug 12/01/09                                         *
;*                                                                         *
;***************************************************************************
proc main
    capture on                              ;
    set capture file "Laser_settings"       ;Opens the Capture file
    Usermsg "DownLoad Settings?"            ;Waits for the Use's OK
    pause 5                                 ;Waits 5 seconds
    transmit "$BM^M"                        ;Measurement
    pause 2;                                ;Waits 2 seconds
    transmit "$ST^M"                        ;Stop
    pause 2                                 ;
    transmit "$ID^M"                        ;Software Version.
    pause 2                                 ;
    transmit "$AB^M"                        ;Average Bounds in Picoseconds
    pause 2                                 ;
    transmit "$AF^M"                        ;4-20 ma Fault Current Value
    pause 2                                 ;
    transmit "$AT^M"                        ;Loop
    pause 2                                 ;
    transmit "$AW^M"                        ;Averaging Weight
    pause 2                                 ;
    transmit "$BH^M"                        ;Bin Threshold
    pause 2                                 ;
    transmit "$BR,0^M"                      ;Config Port Baud Rate
    pause 2                                 ;
    transmit "$BR,1^M"                      ;Output Port Baud Rate
    pause 2                                 ;
    transmit "$BS^M"                        ; Bin Size
    pause 2                                 ;
    transmit "$CE^M"                        ; Cosine
    pause 2                                 ;
    transmit "$CG^M"                        ;Check Gate
    pause 2                                 ;
    transmit "$CL^M"                        ;4-20 ms Current Loop On/Off
    pause 2                                 ;
    transmit "$CO^M"                        ;Mode
    pause 2                                 ;
    transmit "$CT^M"                        ;Current Trip Threshold
    pause 2                                 ;
    transmit "$CV^M"                        ;Cosine Value
    pause 2                                 ;
    transmit "$DD^M"                        ;Dithering
```

```
pause 2                                ;
transmit "$DM^M"                       ;Display Mode
pause 2                                ;
transmit "$DR^M"                       ;Dampening
pause 2                                ;
transmit "$DS^M"                       ;Dampening
pause 2                                ;
transmit "$EG^M"                       ;Enable Gate
pause 2                                ;
transmit "$FA^M"                       ;First, Last Most and All
pause 2                                ;
transmit "$FL^M"                       ;Cooperative Filter
pause 2                                ;
transmit "$FT^M"                       ;Flyer Trap
pause 2                                ;
transmit "$IL^M"                       ;Initial Lock
pause 2                                ;
transmit "$LA^M"                       ;Detection Mode
pause 2                                ;
transmit "$LG^M"                       ;Long Gate
pause 2                                ;
transmit "$MA^M"                       ;Measurement Auto Start On/Off
pause 2                                ;
transmit "$MM^M"                       ;Measurement Mode
pause 2                                ;
transmit "$MP^M"                       ;Minimum Pulse Width Rejection
pause 2                                ;
transmit "$MU^M"                       ;Measurement Units
pause 2                                ;
transmit "$MX^M"                       ;Maximum False Pulses
pause 2                                ;
transmit "$OF^M"                       ;Unit Offset
pause 2                                ;
transmit "$OP^M"                       ;Output Processing
pause 2                                ;
transmit "$PA^M"                       ;Pointer Autostart On/Off
pause 2                                ;
transmit "$PF^M"                       ;PRF Rate
pause 2                                ;
transmit "$PL^M"                       ;Power Level
pause 2                                ;
transmit "$PO^M"                       ;Pulses/Measure
pause 2                                ;
transmit "$SG^M"                       ;Short Gate
pause 2                                ;
transmit "$TB^M"                       ;Time Between Events
pause 2                                ;
transmit "$TP^M"                       ;Trip Point
pause 2                                ;
transmit "$TT,^M"                      ;Trip Point Time Out
pause 2                                ;
transmit "$UA^M"                       ;Unit Address
pause 2                                ;
transmit "$WT^M"                       ;Windowing Time Out
pause 2                                ;
transmit "$WV^M"                       ;Windowing Error Range Value
```

```
    pause 2                                 ;
    transmit "$XP^M"                        ;Maximum Pulse Width Rejection
    pause 2                                 ;
    transmit "$SU^M"                        ;Saves Settings
    pause 2                                 ;
    transmit "$GO^M"                        ; Starts the Sensor. Use $BM to get data.
    pause 2                                     ;
    transmit "$BM^M"                            ;Data Request
    pause 2                                     ;
    Usermsg "Has Good Data been Received?"      ;Wait for OK if the system displays good data
    Usermsg "Download Completed"                ; Download completed msg, wait for OK
    capture off                                 ;
endproc
```

Log File the Get_Laser_Settings Script Produces

```
$BM,2.258,31603
$OK
$ID,ULS v1.0.5 09-26-06
$AB,3000
$AF,1.000
$AT,0.000
$AW,100
$BH,64
$BR,0,9600
$BR,1,9600
$BS,3
$CE,0
$CG,0
$CL,0
$CO,0
$CT,30
$CV,800
$DD,0
$DM,2
$DR,2,7.600
$DS,4
$EG,2
$FA,0
$FL,0
$FT,2500
$IL,6000
$LA,0
$LG,84.999
$MA,0
$MM,1
$MP,0
$MU,1
$MX,5
$OF,0.000
$OP,0
$PA,0
$PF,4000,1000,3000
$PL,0
$PO,2500,512
$SG,0.000
$TB,0
$TP,0.200
$TT,106a
$UA,48
$WT,0
$WV,0.000
$XP,6000
$OK
$OK
$BM,2.257,31421
```

Send_Laser_Settings Script and the Log File It Produces

```
*******************************************************************************
;*                                                                          *
;* This procedure sends the setup parameters to the Laser Tech ULS as listed *
;* settings. The script can be used when directly connected to the sensor or *
;* through a telephone or IP modem. A second script called Get_Laser_settings *
;* can be used to download the Laser settings to a file                     *
;*                   wkrug 12/01/09                                          *
;*******************************************************************************
proc main
   capture on                          ;
   set capture file "Send_settings"    ;Opens the Capture file
   Usermsg "Uploading Settings"        ;Waits for the User's OK
   pause 5                             ;Waits 5 seconds
   transmit "$BM^M"                    ;Get Data
   pause 2                             ;Waits 2 seconds
   transmit "$ST^M"                    ;Stop
   pause 2                             ;
   transmit "$ID^M"                    ;Software Version
   pause 2                             ;
   transmit "$AB,3000^M"               ;Average Bounds in Picoseconds
   pause 2                             ;
   transmit "$AF,1^M"                  ;4-20 ma Fault Current Value
   pause 2                             ;
   transmit "$AT,0^M"                  ;Fault Timeout for 4-20 ma Current Loop
   pause 2                             ;
   transmit "$AW,100^M"                ;Averaging Weight
   pause 2                             ;
   transmit "$BH,64^M"                 ;Bin Threshold
   pause 2                             ;
   transmit "$BR,0,9600^M"             ;Config Port Baud Rate
   pause 2                             ;
   transmit "$BR,1,9600^M"             ;Output Port Baud Rate
   pause 2                             ;
   transmit "$BS,3^M"                  ;Bin Size
   pause 2                             ;
   transmit "$CE,0^M"                  ;Cosine
   pause 2                             ;
   transmit "$CG,1^M"                  ;Check Gate
   pause 2                             ;
   transmit "$CL,0^M"                  ;4-20 ms Current Loop On/Off
   pause 2                             ;
   transmit "$CO,0^M"                  ;Continuous Measurement Output Mode
   pause 2                             ;
   transmit "$CT,30^M"                 ;Current Trip Threshold
   pause 2                             ;
   transmit "$CV,800^M"                ;Cosine Value
   pause 2                             ;
   transmit "$DD,0^M"                  ;Dithering
   pause 2                             ;
   transmit "$DM,2^M"                  ;Display Mode
   pause 2                             ;
   transmit "$DR,2,7.60^M"             ;Dampening
   pause 2                             ;
```

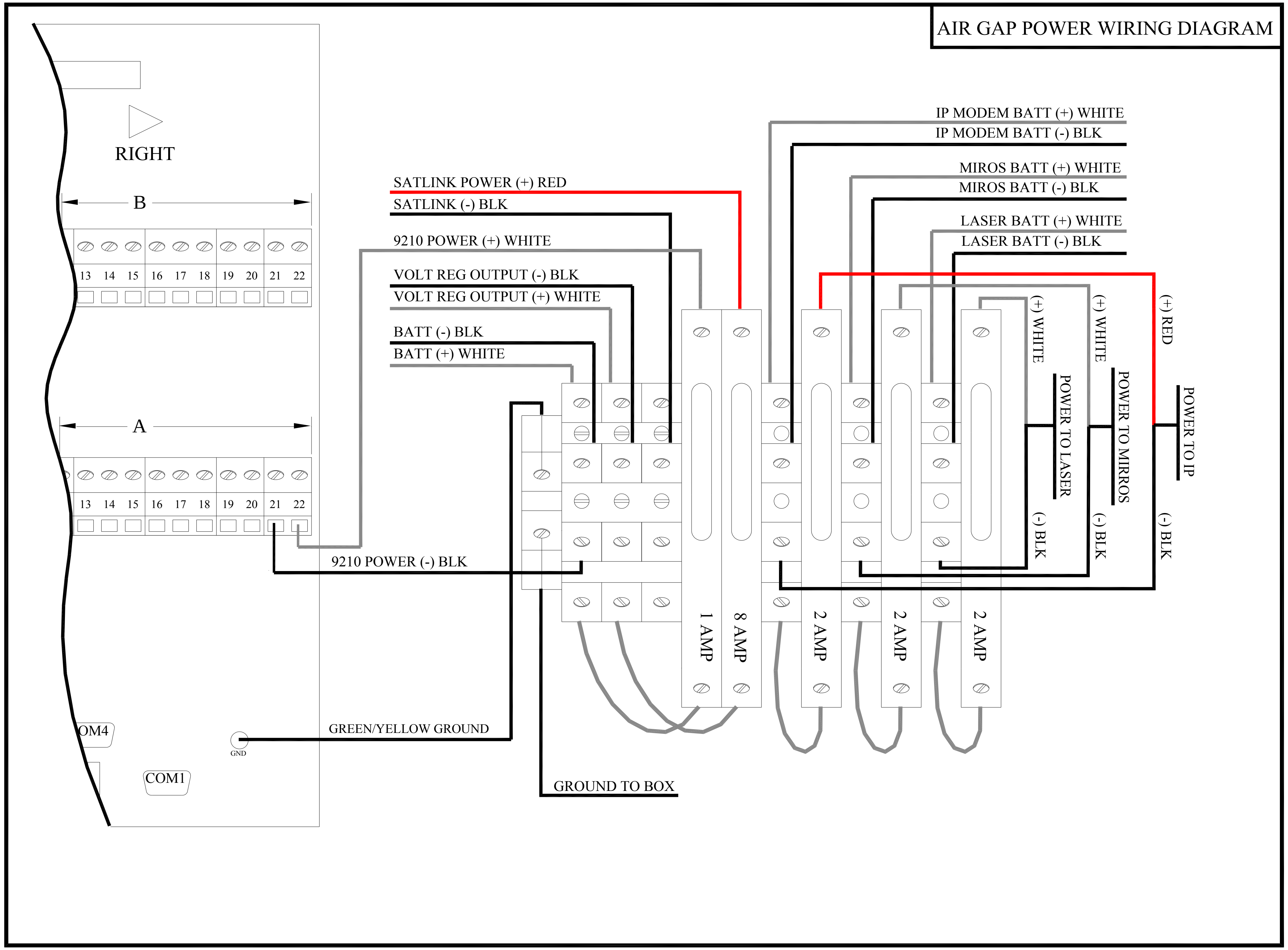
```
transmit "$DS,6^M"          ;Dampening
pause 2                     ;
transmit "$EG,6^M"          ;Enable Gate
pause 2                     ;
transmit "$FA,0^M"          ;First, Last, Most and All
pause 2                     ;
transmit "$FL,0^M"          ;Cooperative Filter
pause 2                     ;
transmit "$FT,0^M"          ;Flyer Trap
pause 2                     ;
transmit "$IL,6000^M"       ;Initial Lock
pause 2                     ;
transmit "$LA,0^M"          ;Detection Mode
pause 2                     ;
transmit "$LG,85^M"         ;Long Gate
pause 2                     ;
transmit "$MA,1^M"          ;Measurement Auto Start On/Off
pause 2                     ;
transmit "$MM,1^M"          ;Measurement Mode
pause 2                     ;
transmit "$MP,0^M"          ;Minimum Pulse Width Rejection
pause 2                     ;
transmit "$MU,1^M"          ;Measurement Units
pause 2                     ;
transmit "$MX,5^M"          ;Maximum False Pulses
pause 2                     ;
transmit "$OF,0.000^M"      ;Unit Offset
pause 2                     ;
transmit "$OP,0^M"          ;Output Processing
pause 2                     ;
transmit "$PA,0^M"          ;Pointer Autostart On/Off
pause 2                     ;
transmit "$PF,4000^M"       ;PRF Rate
pause 2                     ;
transmit "$PL,0^M"          ;Power Level
pause 2                     ;
transmit "$PO,4000^M"       ;Pulses/Measure
pause 2                     ;
transmit "$PT,0^M"          ;Pointer On/Off
pause 2                     ;
transmit "$SG,40^M"         ;Short Gate
pause 2                     ;
transmit "$TB,0^M"          ;Time Between Events
pause 2                     ;
transmit "$TP,0^M"          ;Trip Point
pause 2                     ;
transmit "$TT,106a0^M"      ;Trip Point Time Out
pause 2                     ;
transmit "$TT^M"            ; TT sometime needs a second command
pause 2                     ;
transmit "$UA,0^M"          ;Unit Address
pause 2                     ;
transmit "$WT,0^M"          ;Windowing Time Out
pause 2                     ;
transmit "$WV,0^M"          ;Windowing Error Range Value
pause 2                     ;
```

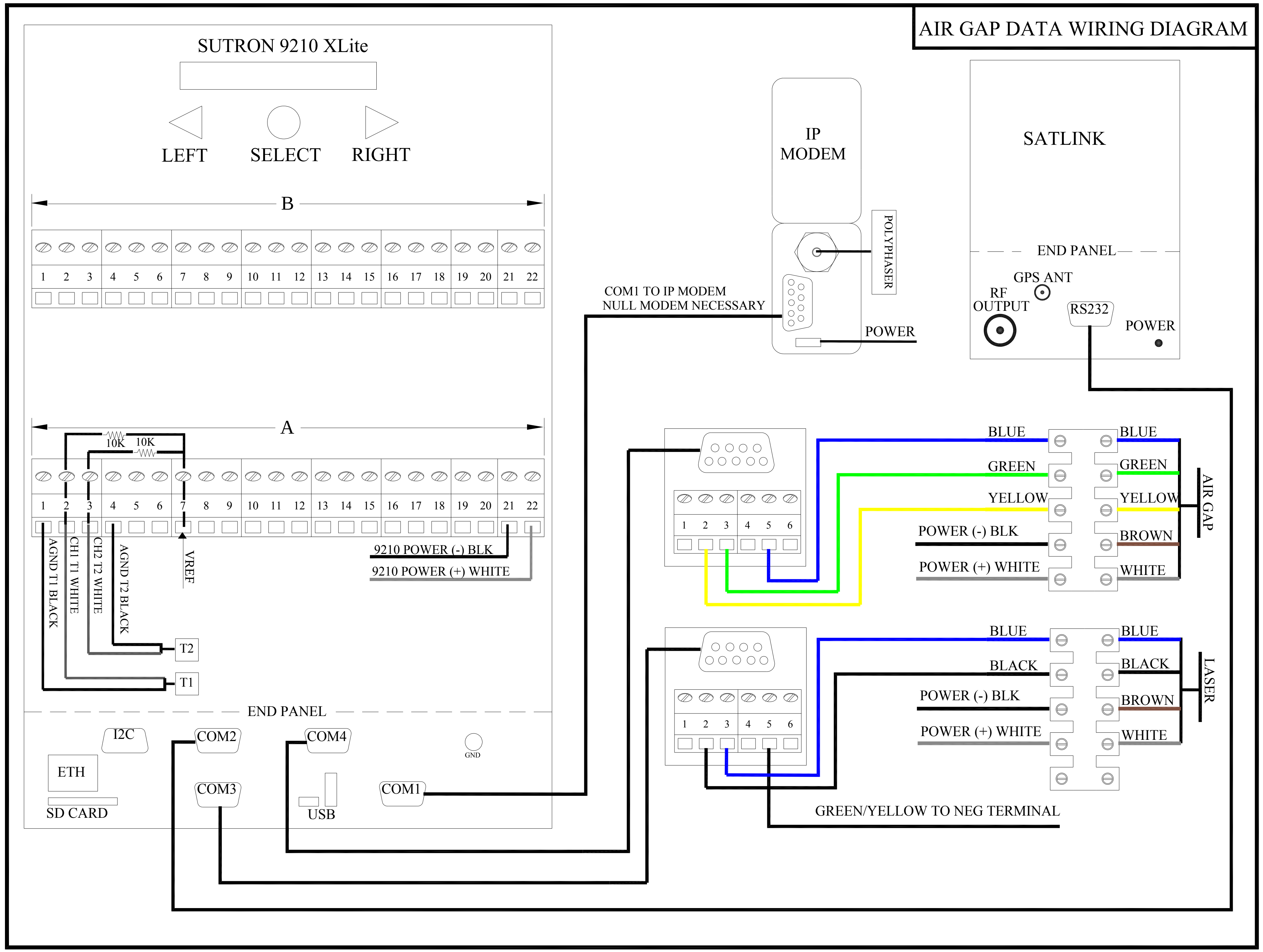
```
    transmit "$XP,6000^M"              ;Maximum Pulse Width Rejection
    pause 2                            ;
    transmit "$SU^M"                   ;Saves the settings
    pause 2                            ;
    transmit "$GO^M"                   ; Start it all up
    pause 2                            ;
    transmit "$BM^M"                   ;Get a data reading
    pause 2                            ;
    Usermsg "Have you Received Good Data?"     ;Data check, wait for OK
    pause 2                            ;
    Usermsg "Uploading Completed"      ; Download completed msg, wait for OK
    capture off                        ;
endproc
```

Log File the Send_Laser_Settings Script Produces

```
    $BM,3.049,53342
    $OK
    $ID,ULS v1.0.5 09-26-06
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
    $TT,106a0
    $OK
    $OK
    $OK
    $OK
    $OK
    $OK
$BM,3.047,53089
```

Appendix F **Air Gap Power Wiring Diagram and Data Wiring Diagrams**


AIR GAP POWER WIRING DIAGRAM
RIGHT
B
A
13 14 15 16 17 18 19 20 21 22
SATLINK POWER (+) RED
SATLINK (-) BLK
9210 POWER (+) WHITE
VOLT REG OUTPUT (-) BLK
VOLT REG OUTPUT (+) WHITE
BATT (-) BLK
BATT (+) WHITE
9210 POWER (-) BLK
GREEN/YELLOW GROUND
GND
GROUND TO BOX
COM1
OM4
IP MODEM BATT (+) WHITE
IP MODEM BATT (-) BLK
MIROS BATT (+) WHITE
MIROS BATT (-) BLK
LASER BATT (+) WHITE
LASER BATT (-) BLK
1 AMP
8 AMP
2 AMP
2 AMP
2 AMP
(+) WHITE
POWER TO LASER
(-) BLK
(+) WHITE
POWER TO MIROS
(-) BLK
(+) RED
POWER TO IP
(-) BLK



AIR GAP DATA WIRING DIAGRAM
SUTRON 9210 XLite
LEFT
SELECT
RIGHT
B
A
10K
10K
AGND T1 BLACK
CH1 T1 WHITE
CH2 T2 WHITE
AGND T2 BLACK
VREF
T2
T1
9210 POWER (-) BLK
9210 POWER (+) WHITE
END PANEL
I2C
COM2
COM4
ETH
COM3
COM1
USB
SD CARD
GND
IP MODEM
POLYPHASER
POWER
COM1 TO IP MODEM
NULL MODEM NECESSARY
SATLINK
END PANEL
GPS ANT
RF OUTPUT
RS232
POWER
BLUE
GREEN
YELLOW
POWER (-) BLK
POWER (+) WHITE
BROWN
WHITE
AIR GAP
BLACK
LASER
GREEN/YELLOW TO NEG TERMINAL

Acronyms and Abbreviations

A	Ampere
dB	decibel
dBm	decibel referenced to 1milliwatt
C	Celsius
CD	compact disk
CIL	Chesapeake Instrument Laboratory
cm	centimeter
CO-OPS	Center for Operational Oceanographic Products and Services
CWFM	continuous wave frequency modulated
DAS	data acquisition system
dB	decibel
DCP	data collection platform
deg	degree
F	Fahrenheit
ft	feet
GMT	Greenwich Mean Time
GOES	geostationary operational environmental satellite
GHz	gigahertz
GB	gigabyte
GV	get value
kg	kilogram
I/O	input/output
IP	Internet protocol
lbs.	pounds
LOS	line-of-sight
LTI	Laser Technology, Incorporated
m	meter
mA	milliamp
MB	megabyte
MOA	Memorandum of Agreement
mm	millimeters
mW	milliwatts
nJ	nanojoule
NOS	National Ocean Service
nm	nautical miles
NOAA	National Oceanic and Atmospheric Administration
OSTEP	Ocean Systems Test and Evaluation Program
PRF	pulse firing rate
POC	point of contact
PORTS®	Physical Oceanographic Real-time System
RAM	random access memory
SIL	Seattle Instrument Laboratory
ULS	Universal Laser Sensor
V	Volt
Vac	Volt alternating current
Vdc	Volt direct current