System Design for Iridium ATON ADCP Real-Time Current Measurement System

Winston Hensley
Bob Heitsenrether
Christopher Haith
Paul Fanelli

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1.0 Introduction

During the early 2000s, the NOAA Center for Operational Oceanographic Products and Services (CO-OPS) developed a real-time, ocean current measurement system capable of being affixed to U.S. Coast Guard (USCG) aids-to-navigation (ATON) buoys. The system employs an acoustic Doppler current profiler (ADCP) sensor and is commonly referred to as the "ATON ADCP" system. Motivation for the design and development of the system came from the need to fulfill Physical Oceanographic Real-Time Systems (PORTS®) users' requests for real-time vertical current profile information in or near shipping channels. The first PORTS ATON ADCP systems were transitioned into operational use in 2005 [1,2].

Throughout 2015-16, CO-OPS Engineering Division's (ED) Ocean Systems Test and Evaluation Program (OSTEP) has been pursuing an effort to design, develop, and test a new and improved version of the ATON ADCP system. The improved system's design consists of a single buoy component (eliminating the legacy system's shore station) and relies on Iridium short burst data (SBD) as a primary means of real-time data telemetry. Details on OSTEP's related FY15-16 project plans, system requirements, and the latest prototype system design details can be found in references 3-7. Following OSTEP's recent completion of several successful laboratory and field tests with the improved ATON ADCP system (hereinafter referred to as the iATON system), ED developed a Transition-to-Operations Plan (TOP) for the iATON to support wider use across CO-OPS PORTS.

In accordance with the iATON TOP, this document provides a detailed description of the system design. Its purpose is to provide guidance on how to build and integrate an iATON system's components. Detailed procedures for field deployment will be provided in a subsequent Field Installation Guide.

2.0 High-Level System Design Description

The iATON system design involves an upgrade of the legacy system, which eliminates the line-of-sight radio link and shore-based, radio receiver station. It employs many of the same system components and retains several of the baseline legacy features. For the reader who is familiar with the legacy PORTS ATON ADCP system, a summary of the real-time data flow is shown below (Figure 1), followed by main components and features that have remained the same for the iATON followed by a list of system modifications.

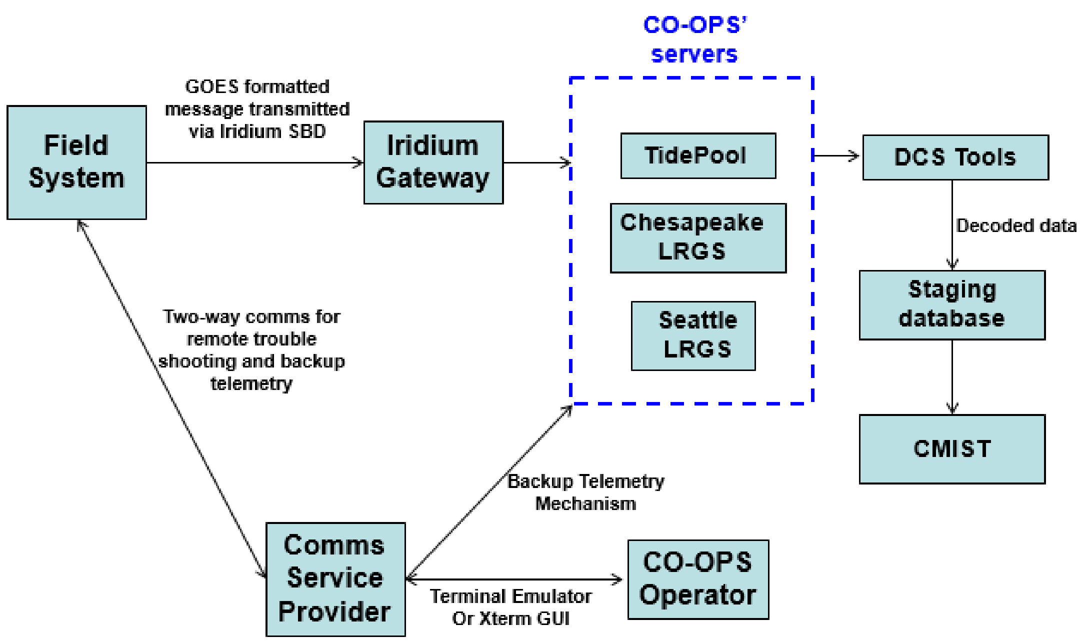


Figure 1: Real-Time Data Flow

Summary of Similarities:

- Nortek 1 MHz Aquadopp current profiler
- 6-minute sampling rate
- Sutron Xpert2 data collection platform (DCP)
- Non-rechargeable alkaline battery packs
- Teledyne Oceanscience, watertight enclosure
- The iATON is attached to a Teledyne Oceanscience's Clamparatus, which is used to mount the system to the ATON buoy.
- The communication system's antennas are mounted atop the ATON buoy superstructure using Delrin® clamps provided by Teledyne Oceanscience.

Summary of Modifications:

- No shore station required; all system components are affixed to the ATON buoy.
- An additional NEMA-4x weatherproof enclosure is installed, atop the Clamparatus,

which houses the DCP and telemetry electronics.

- The data telemetry system utilizes the Iridium satellite for real-time data telemetry.
- The system includes two antennas atop the ATON buoy's super structure, for Iridium and cellular IP modem, as opposed to the legacy system's one antenna for the radio-to-shore link antenna.
- The fully loaded Clamparatus of iATON system is currently approximately 30 pounds (lb) heavier than the legacy system (total weight is approximately 230 lb).

Figure 1 provides a high-level diagram of the iATON system's main components. A complete list of all system components, along with make and model details of each, is provided in section 3.0.

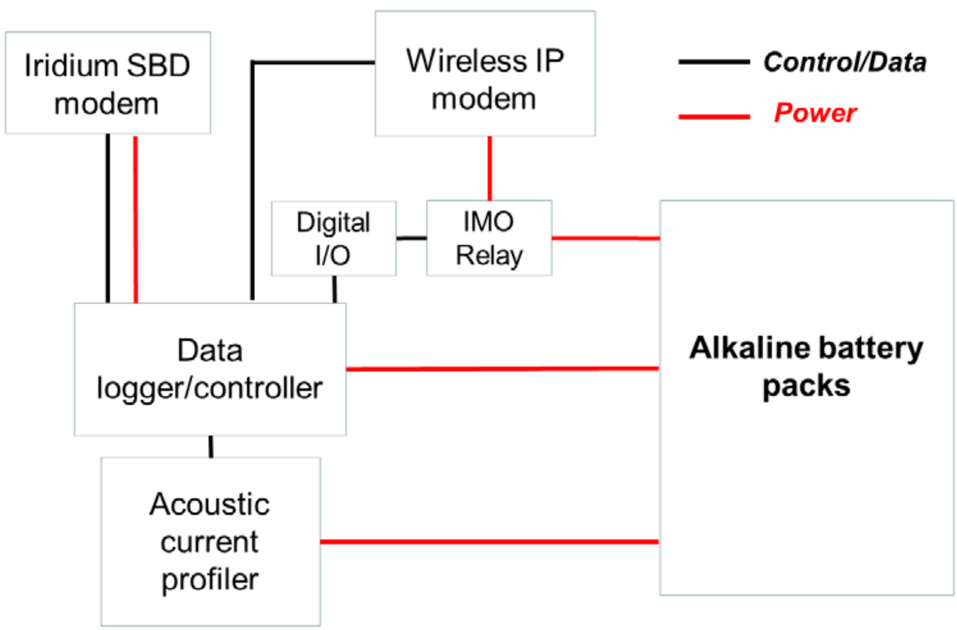


Figure 2. High level diagram of the iATON system's main component

Figure 2 shows a picture and the diagram of the legacy ATON ADCP system's Clamparatus which is re-used in the iATON system, for attaching the current profiler and system payload to the USCG ATON buoy, taken directly from reference 1. Under a contract with CO-OPS, the Oceanscience Group (now Teledyne Oceanscience) designed and built the Clamparatus and mounting device, which provides the mechanism for installation and maintenance without interfering with the ATON's primary mission of ensuring safe navigation. Most of the Clamparatus is aluminum and the tube that holds the current profiler is made of fiberglass reinforced with additional poured resin.

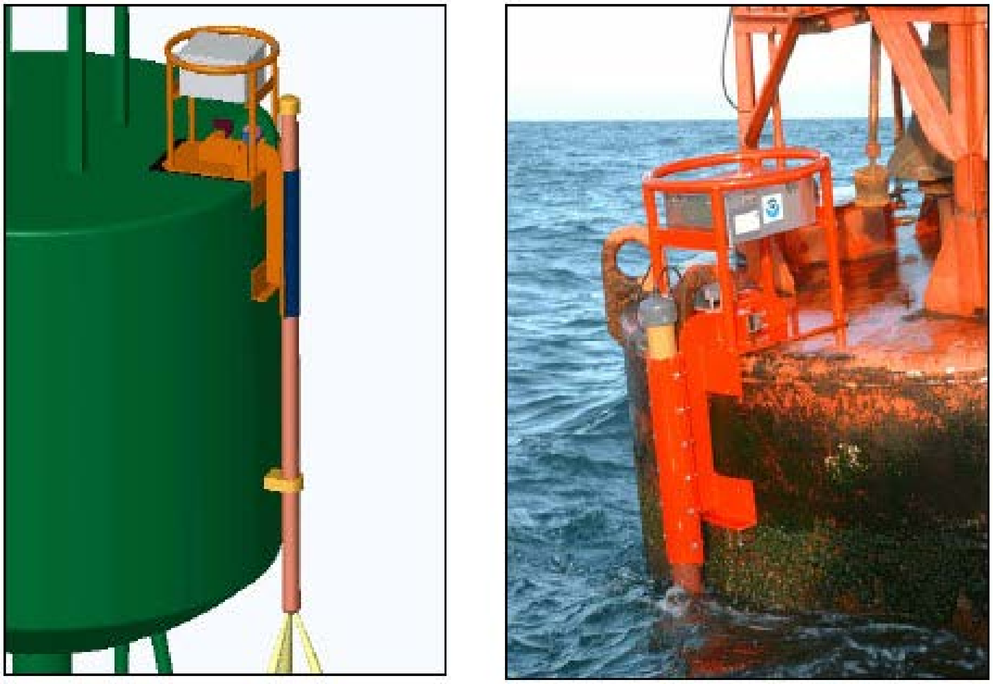


Figure 3. Diagram (l) and picture (r) showing the ATON ADCP system's Clamparatus that is used for attaching the downward-looking current profiler.

3.0 Detailed System Design

The following section contains design details for each of the iATON system's primary components: the enclosure, power system, the ADCP, and the data collection platform, as well as the assembled Clamparatus.

3.1 Enclosures

The iATON system utilizes two, water tight enclosures mounted to the Clamparatus. One enclosure contains the battery packs and the other contains all the components of the system's electronics. A Teledyne Oceanscience enclosure is used in the system, as shown in fig. 3(a). All the system's data collection platform (DCP) components are housed in a second, hinged stainless steel NEMA 4X enclosure manufactured by Hammond. The DCP's enclosure is shown in 3(b) and 3(c) (closed and opened).

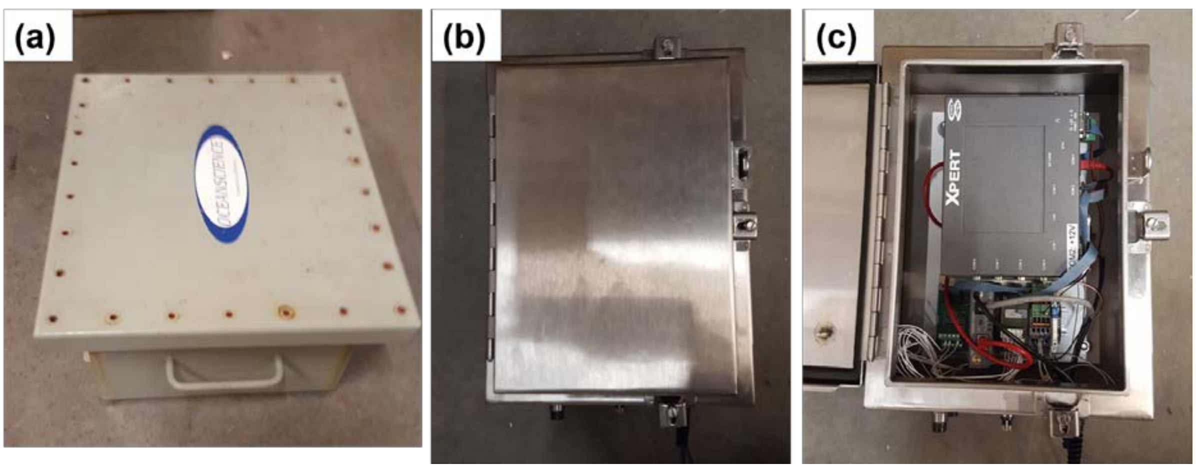
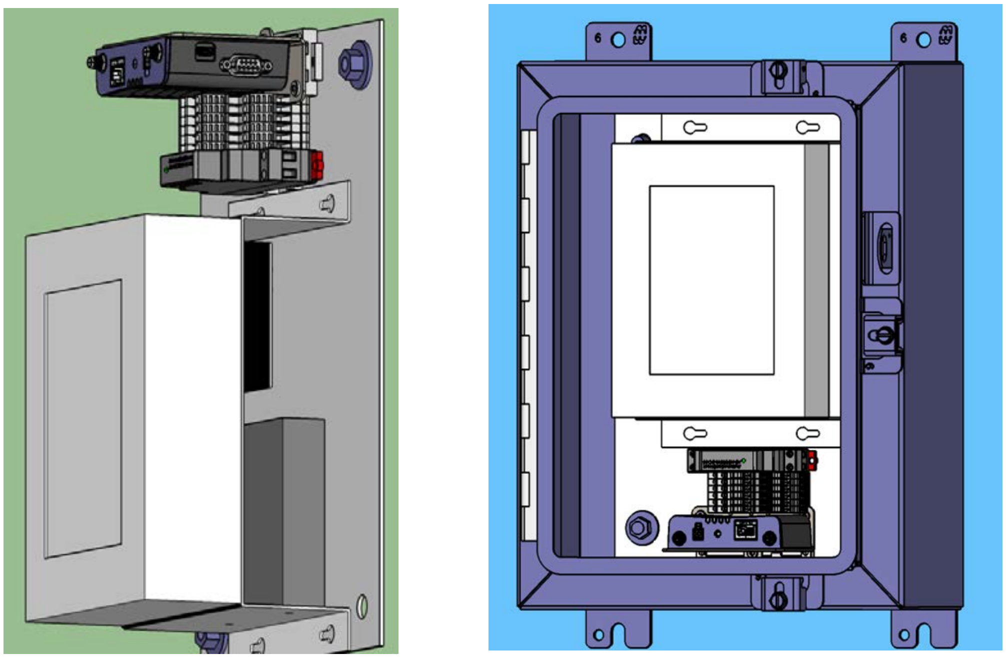


Figure 4. iATON Enclosures

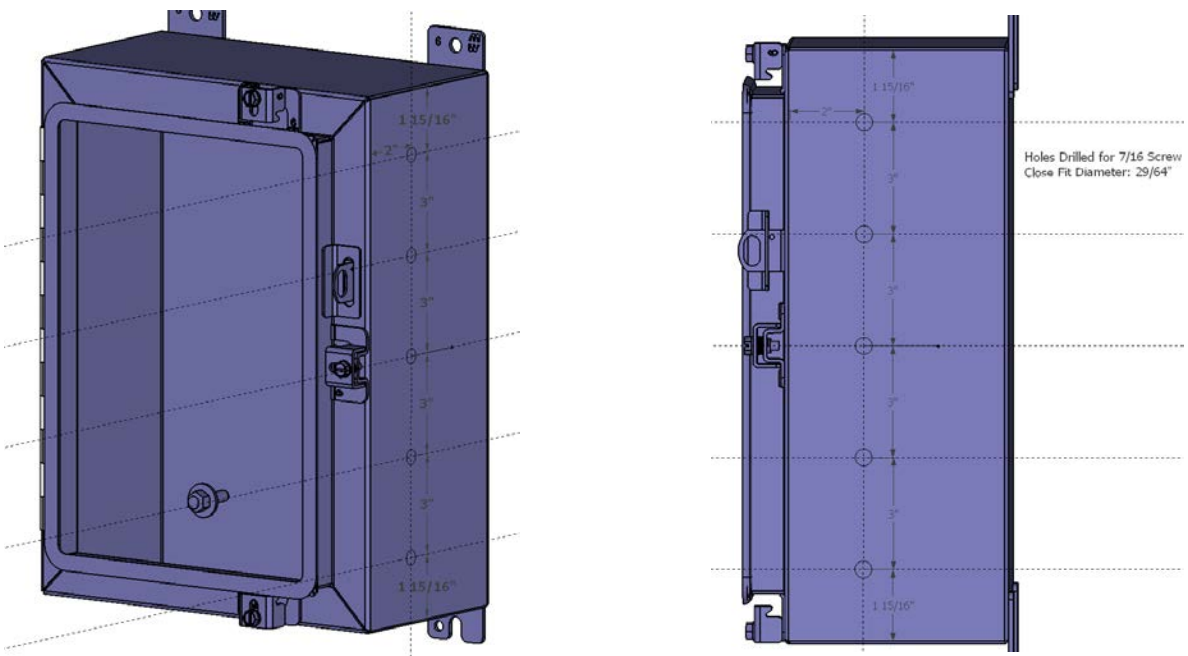
In the iATON's current design, a Hammond enclosure is mounted atop the legacy system's Clamparatus using two sections of Unistrut®, as described in section 3.5. Plans for future system developments include slight modifications to the Clamparatus to better accommodate the second enclosure, and possibly using a Hammond type enclosure for housing the batteries.

Figures 4 and 5 show several diagrams of the DCP enclosure, which is mounted atop the Clamparatus.



(a) **(b)**

Figure 5. iATON electronics enclosure



(a) **(b)**

Figure 6. iATON DCP enclosure modifications

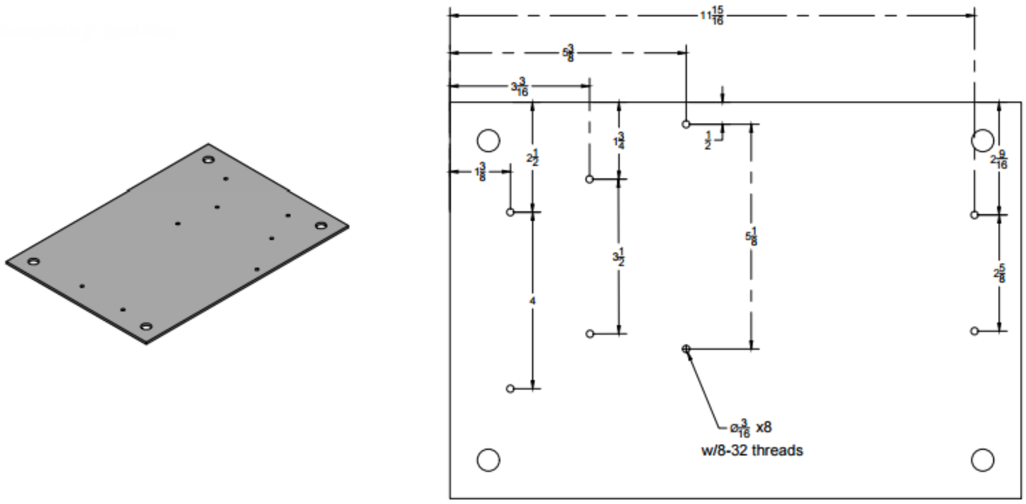


Figure 7: iATON Backing Board Holes

A more formalized drawing of Figure 6, meant for fabricators, is found in Appendix D. Each enclosure includes a 1/8” painted steel backing plate that has x4 holes for attaching to studs. Eight holes must be drilled and tapped in the backing board to attach the mounting bracket, Din-rail and other electronics. A custom bracket must be fabricated to elevate the DCP and give a second level for mounting electronics, to allow all components to mount securely in the enclosure.

Locktite® should be used on all 8-32 screws, which secure components to the backing board.

3.2 Cables, Connectors, and Wiring Diagrams

Connector/Feedthrough Guidelines per Teledyne Impulse Datasheet

- All mounting surfaces require a 32 finish.
- Lubricate mating surfaces with 3M Silicone Spray or equivalent. DO NOT grease! *Connectors must be lubricated on a regular basis.*
- Lubricate O-rings with Dow Corning #111 Valve Lubricant
- Avoid nicks and cuts around contacts, as these are the sealing surfaces.
- Elastomers can be seriously degraded if exposed to direct sunlight or high ozone levels for extended periods of time.
- Do not over tighten bulkhead nuts.
- Do not pull on cable to disconnect.
- Avoid sharp bends at cable entry to connector.

Figure 6 and table 1 provide a high-level diagram listing all cables and connectors used to interface the system's two enclosure boxes, two antennas, and the acoustic current profiling sensor. Only one connection is made between enclosure boxes 1 and 2 using the 2-pin, keyed Impulse cable.

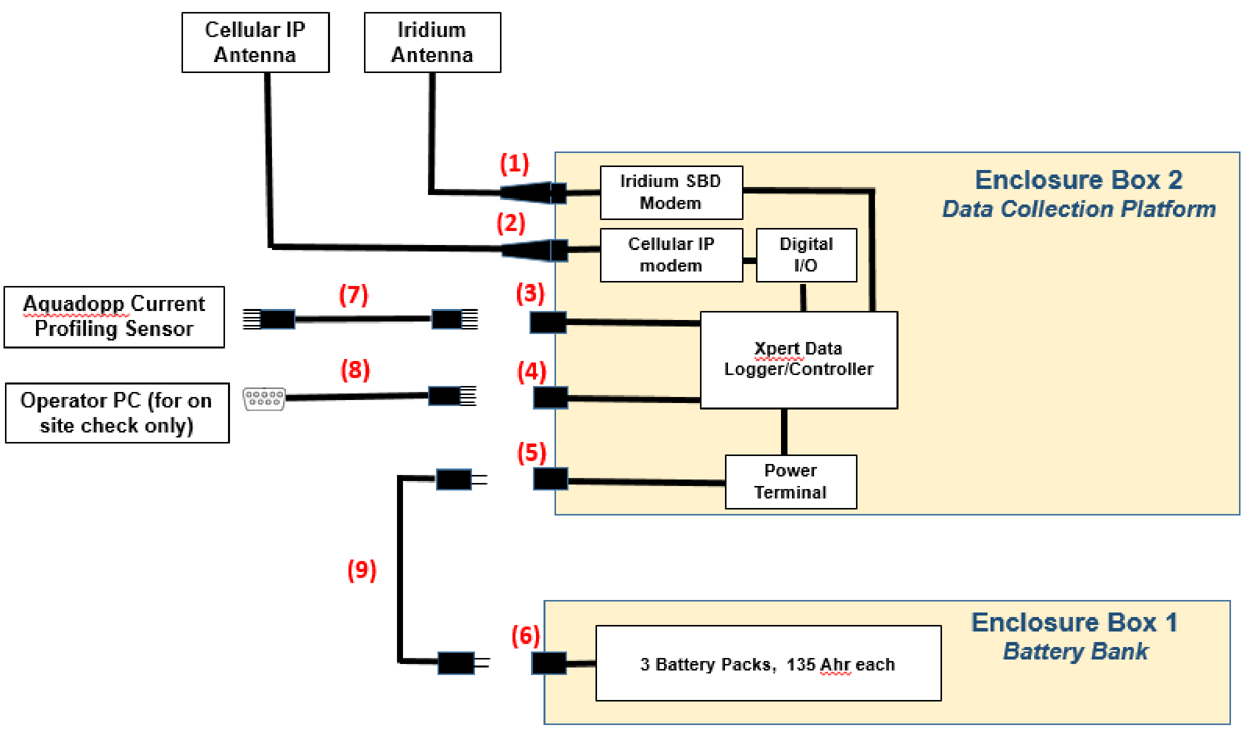


Figure 8. Diagram for the iATON system's external cables and connectors.

Table 1. Listing of connector and cable components numbered in fig. 6.

(1)	**Iridium antenna cable feed through**
(2)	**cellular antenna cable feed through**
(3)	**8 pin, female connector for Aquadopp cable to Xpert.**
(4)	**8 pin, female connector for operator PC cable to Xpert (for on site system check only)**
(5)	**2 pin, female connector, power in from battery enclosure**
(6)	**2 pin, female connector, power out from DCP enclosure**
(7)	**male-to-male 8 pin cable, Aquadopp sensor to (3) bulkhead connector**
(8)	**female 9 pin to male 8 pin cable, operator PC to (4) bulkhead connector**
(9)	**male-to-male 2 pin cable, power from battery enclosure to DCP enclosure**

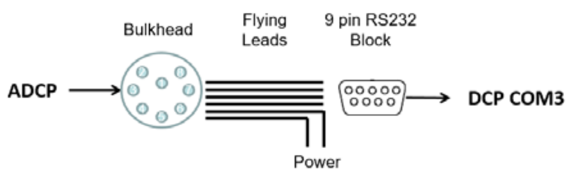
The following components are needed for the system's battery enclosure box:

- (3) alkaline battery packs – MN1300
- (1) Teledyne 2-Pin female, keyed bulkhead fittings for power (battery enclosure)

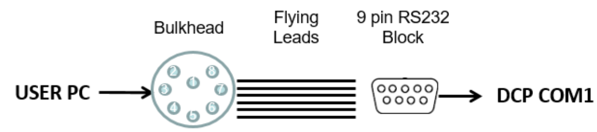
The following components are needed for the system's DCP enclosure box:

- (4) double-level plug-in terminal blocks - Automation Direct DN-EMXDV
- (2) RS232 breakout boards - DIN Rail Mountable
- (1) AirLink LS300 IP modem
- (1) LS300 DIN rail bracket
- (1) Sutron ISBD-1 Iridium SBD modem **with Department of Defense (DoD) Firmware**
- (1) Sutron digital I/O with screw terminals
- (1) Sutron XPert2 Dark (without display) data logger/controller
- (1) Teledyne 2-pin male, keyed bulkhead fittings for power (electronics enclosure)
- (2) Teledyne 8-pin female bulkhead fittings for user PC and ADCP

The enclosure boxes require the installation of four bulkhead connectors: one connector in the battery enclosure box and three connectors in the DCP enclosure box. Figure 7(a) details the pinout for the Nortek Aquadopp ADCP's connection to the RS232 breakout block, while 7(b) shows the pinouts for the DCP-PC connection.

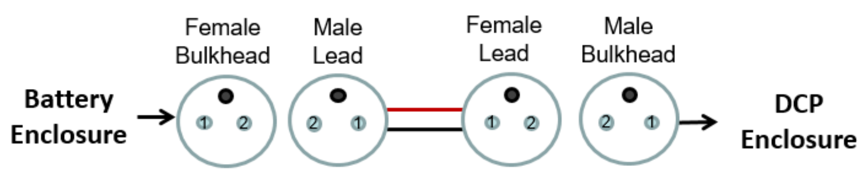


Bulkhead Cable Pin #	Function	RS232 block and power panel
1	Power -	V-
2	Power +	V+
3	Tx	2
4	Rx	3
5	232-GND	5
6	-	-
7	-	-
8	-	-



Bulkhead Cable Pin #	Function	RS232 block to and power panel
1	RTS	8
2	Not Used	-
3	GND	5
4	DSR	4
5	RX	3
6	TX	2
7	CTS	7
8	DTR	6
9	Not Used	-

Figure 9. Pinouts for ADCP and PC bulkhead connections



Power	Female Bulkhead Pin #	Male Lead Pin #	Female Lead Pin #	Male Bulkhead Pin #	Power
V+	1	1	1	1	V+
V-	2	2	2	2	V-

Figure 10. Pinouts for power bulkheads

In the latest version iATON system described here, a red **crossover Ethernet cable** is used to connect the LS300 IP modem to the XPert2 DCP's LAN port. To use the serial port on the LS300 modem, ask the Chesapeake Instrument Laboratory (CIL) to configure port forwarding.

Long pieces of shrink tubing are used mitigate cable management concerns because many of the wires are white and of the same length/diameter.

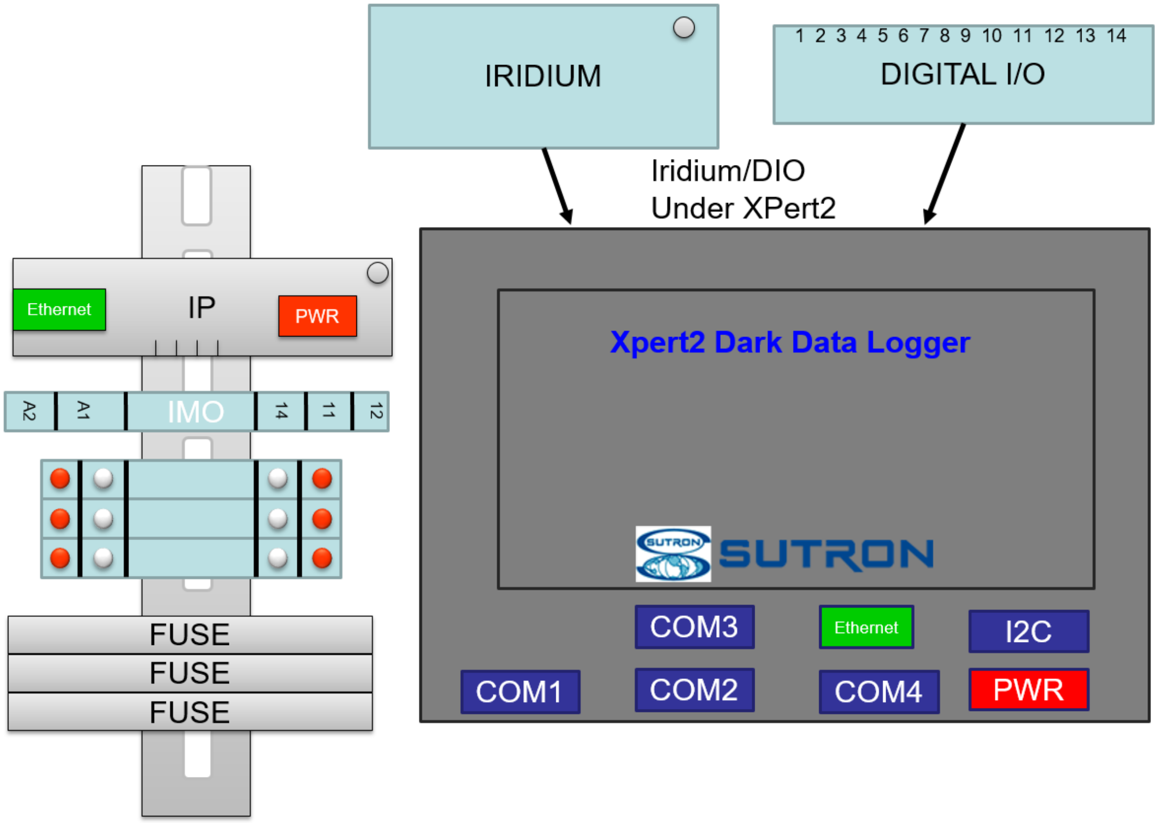
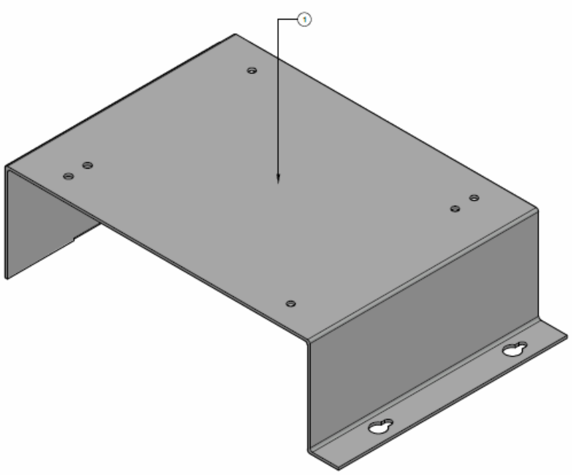


Figure 11. iATON box component layout



For detailed drawing and specifications of the DCP mounting bracket shown below, refer to Appendix E.

Figure 12: DCP Mounting Bracket

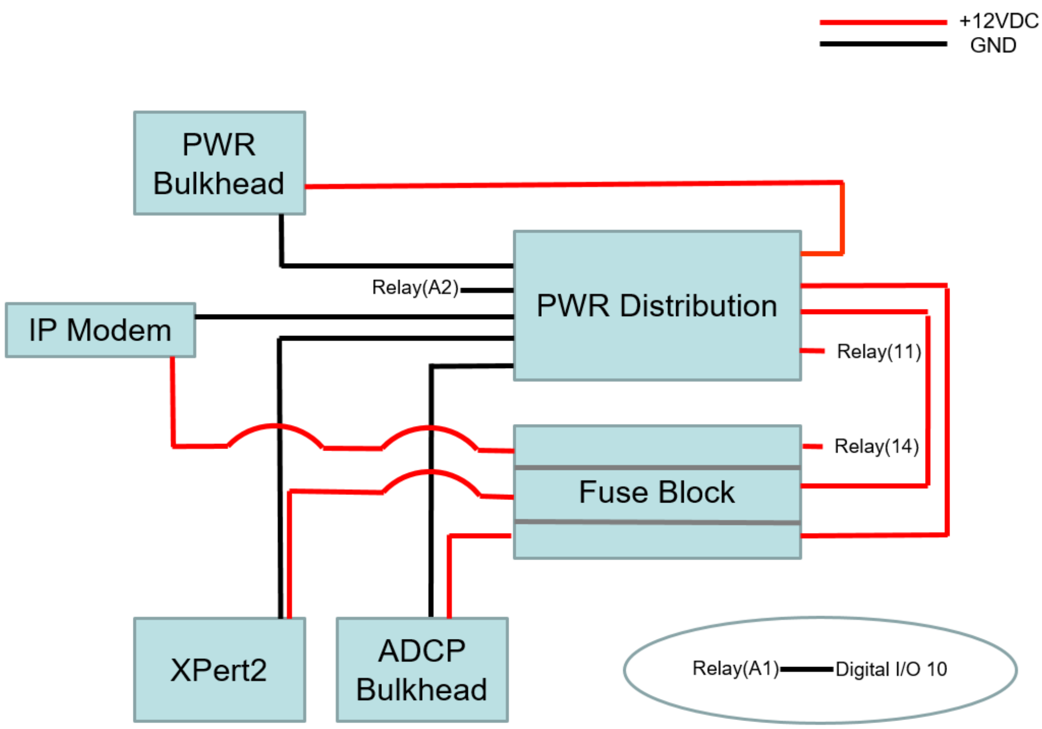


Figure 13. iATON wiring - bulkheads, fuses, and modem

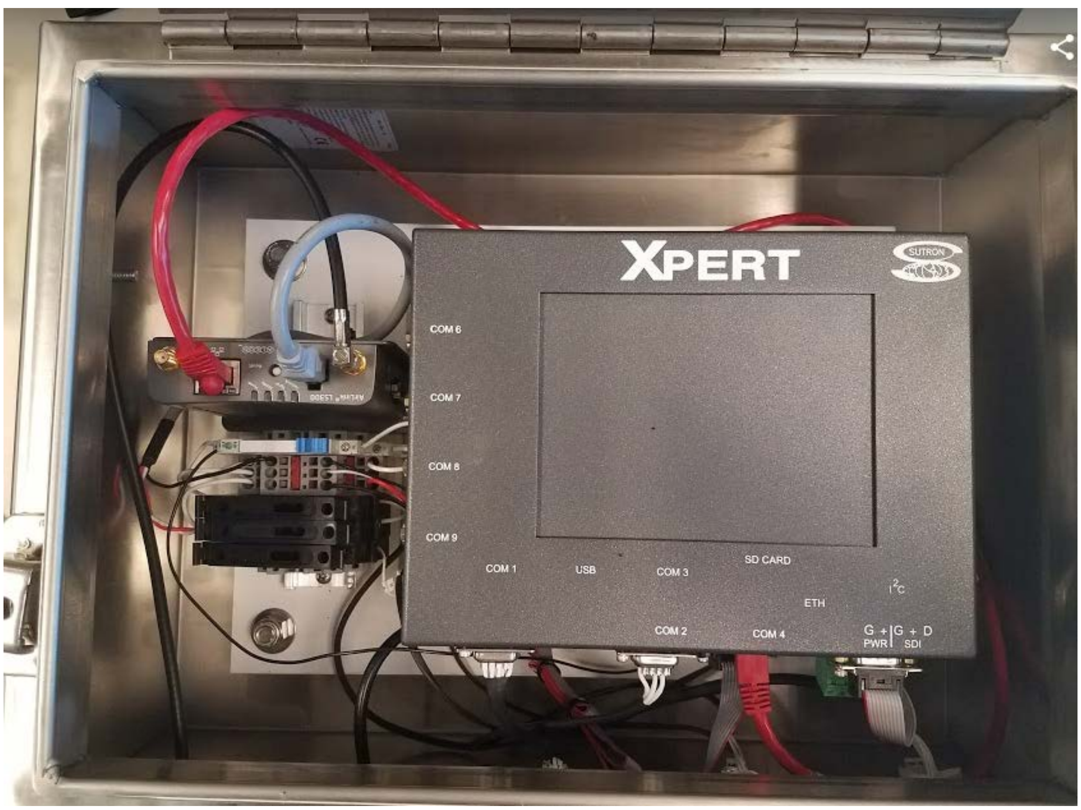


Figure 14. iATON electronics enclosure configuration and wiring EXAMPLE

3.3 Acoustic Current Profiler Configuration

When configuring the current profiler for use with the data logger, you must use the Nortek AquaPro software for generating *.pcf configuration files, detailed in the *Nortek Systems Integrator Manual* (appendix C). Take note that the save location for the *.dep deployment file must not have a period '.' in the filename.

Once you have successfully generated the *.pcf file, move it to the Flash Disk or SD Card on the Xpert2 data logger. This configuration file will be referenced when adding the Nortek SLL block to the logger's graphical setup.

Once AquaPro is started, the main screen below will appear. From the top menu bar, select ***Communication→ Serial Port.***

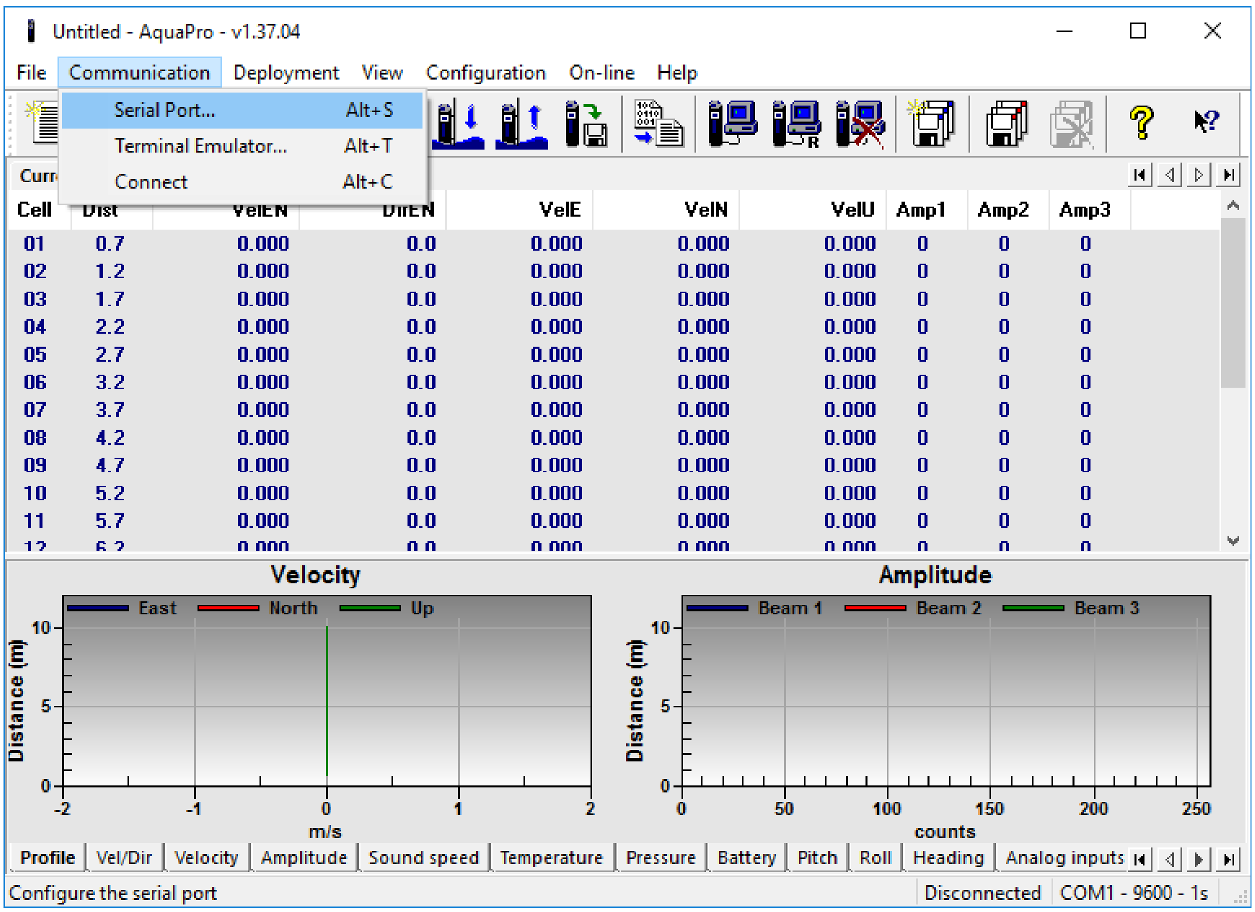


Figure 15. Nortek AquaPro main GUI screen

For successful communication between the XPert2 and the Aquadopp profiler, configure the serial port as shown in fig. 13.

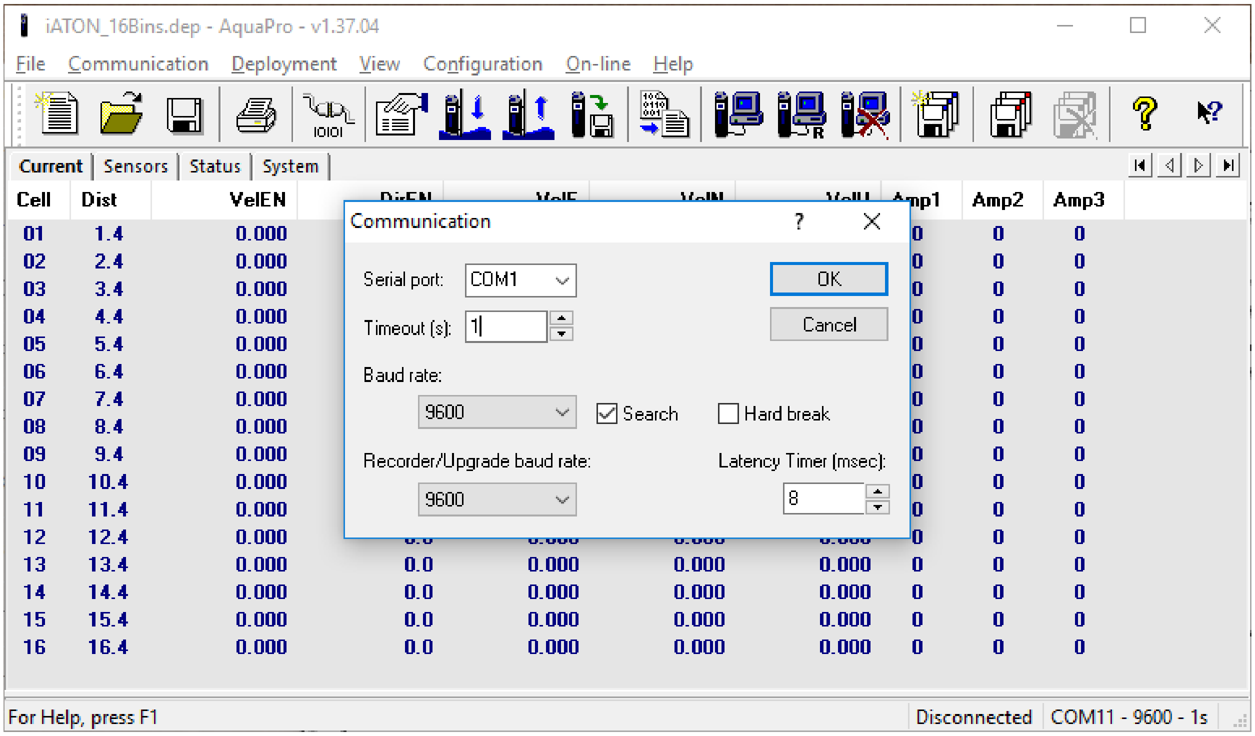


Figure 16. AquaPro Serial Port Communication Settings

After configuring the serial port and baud rate settings for communication with the Aquadopp profiler, it is necessary to configure a deployment file based on settings specific for each deployment. The NOAA CO-OPS' CIL in Chesapeake, Va. will be able to assist with determining such parameters, but for demonstration purposes, standard settings for 16 1-meter bins with a 5-minute sample on 6-minute intervals is shown in fig. 13.

From the main screen, select ***Deployment* → *Planning* → *Use Existing*** a planning window will appear with settings for configuring the instrument (fig. 14).

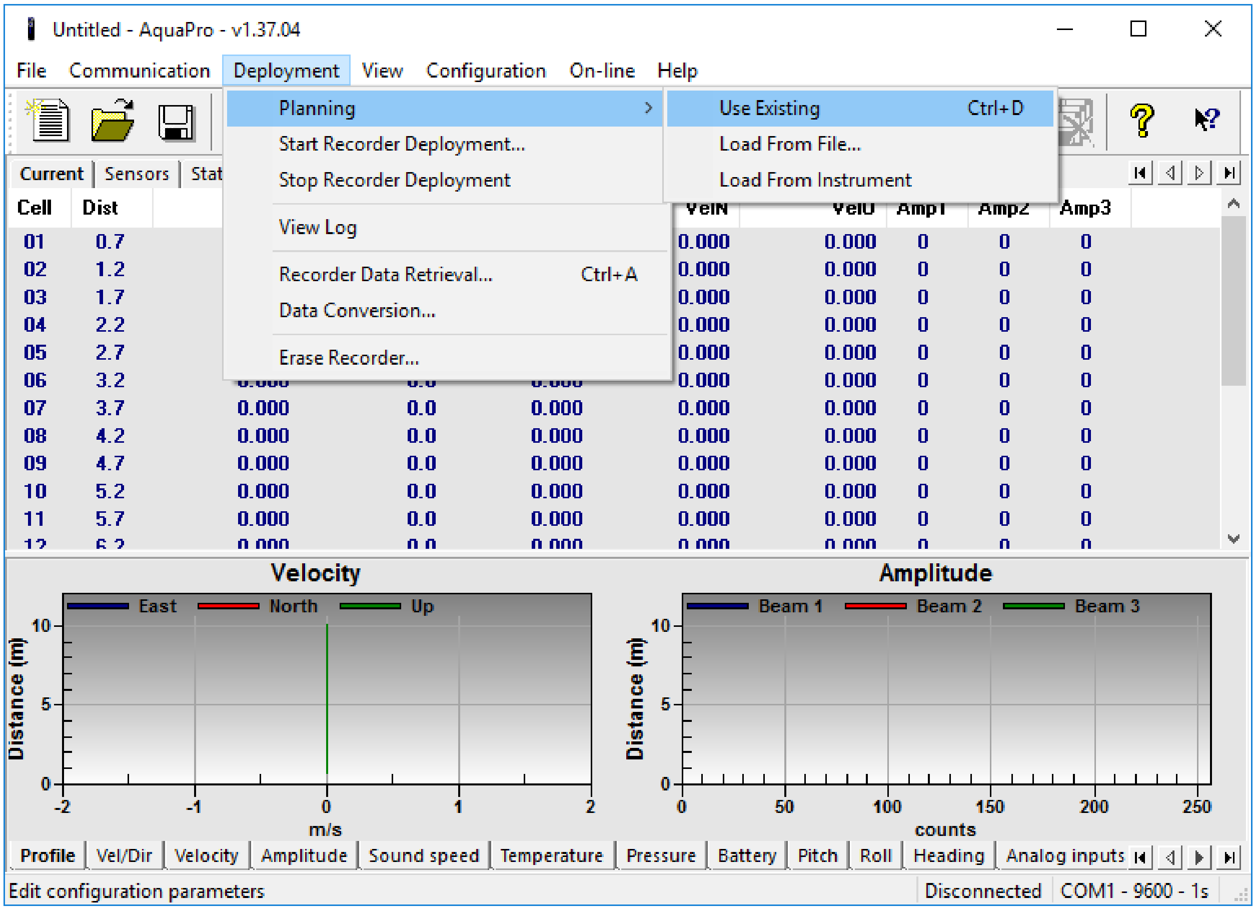


Figure 17. Nortek AquaPro - open deployment configuration

Check the box to **Use Advanced Settings** before continuing configuration (fig. 15).

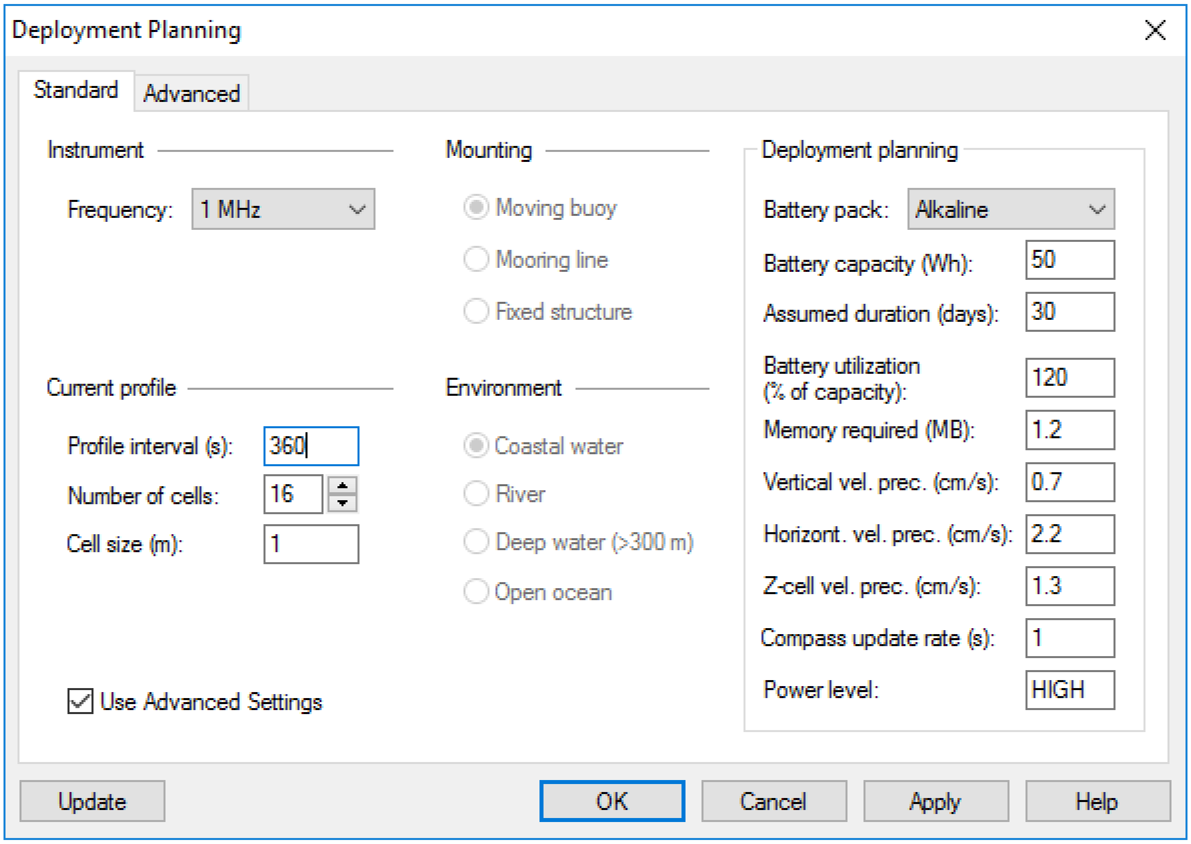


Figure 18. Nortek AquaPro - deployment planning standard settings

The deployment planning window has two tabs, ***Standard*** and ***Advanced****;* set and/or select parameters as shown in fig.16, with one exception: on the ***Standard*** window, the ***Number of cells*** setting will vary depending on the water depth at each deployment site. The 16 is the maximum depth bins allowed for generating a 6-minute Iridium SBD message due to message size constraints. The exact number of cells, set for water depth, will be determined at the time of a site reconnaissance. For now, 16 is the default setting.

Standard Settings		
Instrument	Frequency	1 MHz
Current Profile	Profile interval (s)	360
	Number of cells	16
	Cell size (m)	1

After configuring the settings in the **Standard** tab, click the **Advanced** tab to update settings as shown in fig. 16 and then click **OK**. Also, verify that the checkbox for **Output power** is checked in the **Analog inputs** section.

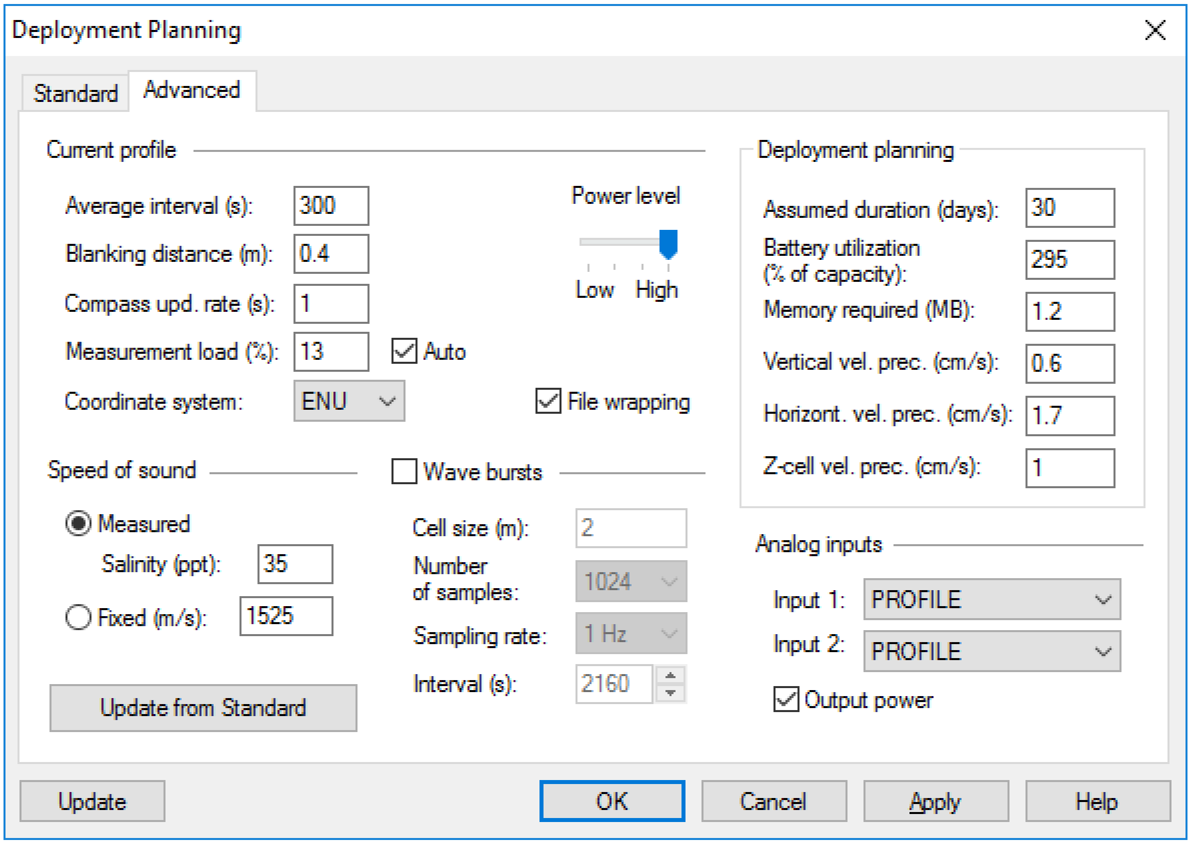


Figure 19. Nortek AquaPro - **Deployment Planning Advanced** tab

Advanced Settings		
Current Profile	Average interval (s):	300
	Blanking Distance(m):	0.4
	Compass upd. Rate(s):	360
	Measurement load (%):	13 (Auto checked)
	Coordinate System:	ENU
	File Wrapping:	CHECK
Speed of Sounds	Measured Salinity (ppt):	35
Analog Inputs	Input 1:	PROFILE
	Input 2:	PROFILE
	Output power:	CHECK

To save the *.pcf profiler configuration file, you must start a recorder deployment as shown in fig. 20.

Verify that your computer's clock is correct and configured to UTC time before starting the deployment. The time is updated again from the DCP and this step is a precaution to align with legacy configurations.

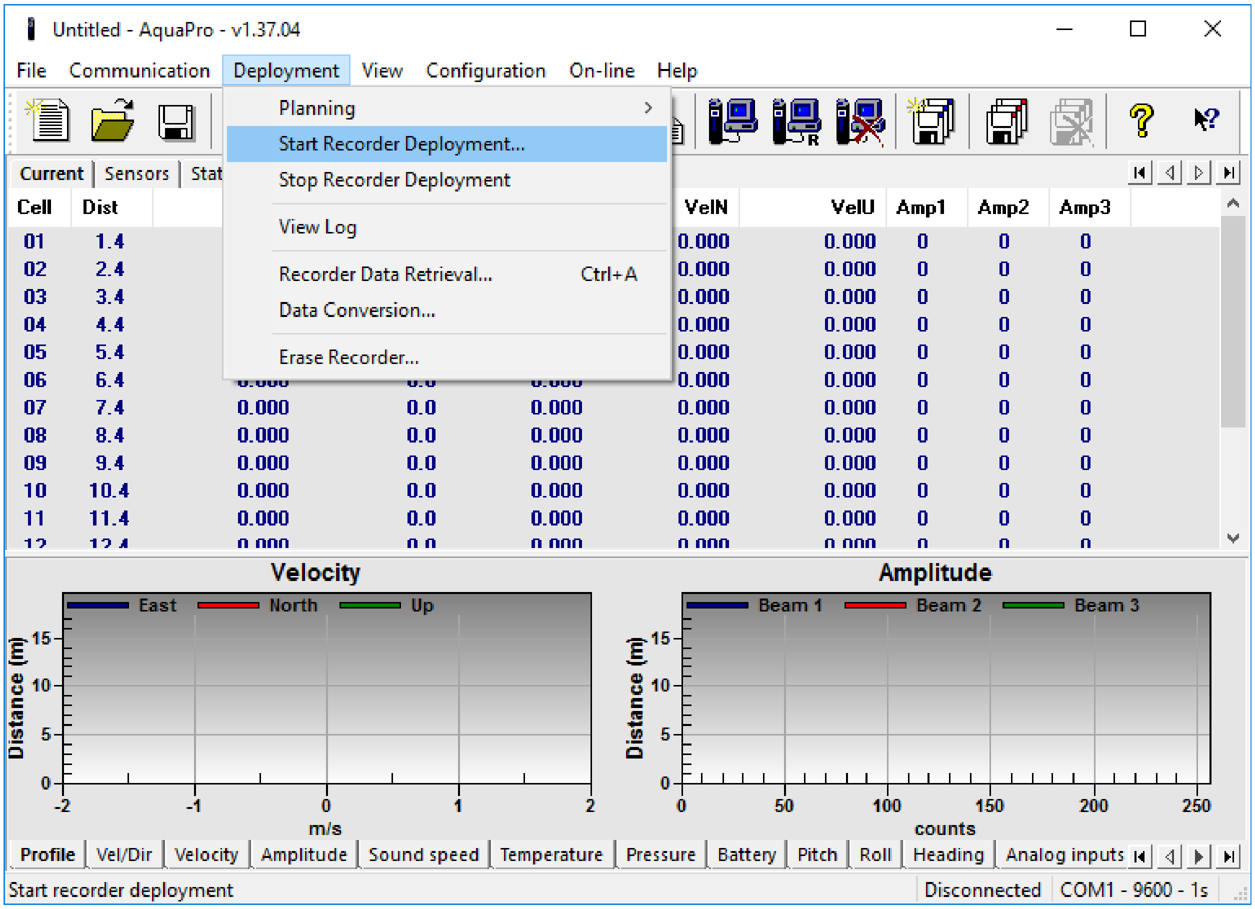


Figure 20. Nortek AquaPro – **Start Recorder Deployment**

The **Deployment** window will appear once you select the **Start Recorder Deployment** menu item. Select the **Start Now!** button so that the deployment will use the computer's clock, and then select **Enable serial output** (fig. 18).

It is common practice to choose a 6-character name that will correspond to either the number of profile bins or the station name that has been set up through CO-OPS' Oceanographic Division (OD). Add comments if necessary up to 80 characters and then select **OK**.

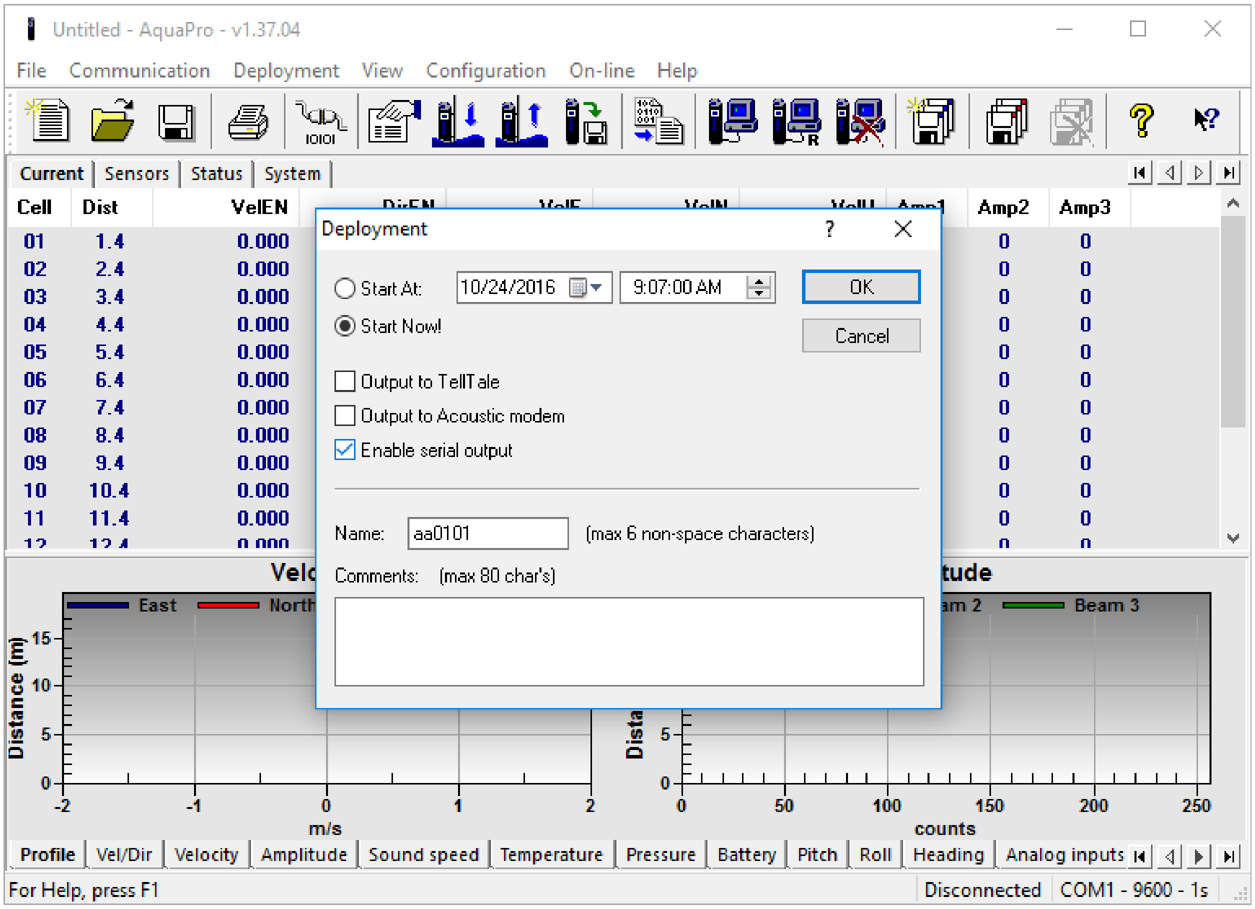


Figure 21. Nortek AquaPro – Deployment Settings

After you click the OK button, the software will ask if you wish to save the configuration to file. Select **Yes** and a '**Save As**' dialog will appear (fig. 19). Save the *.dep file with a filename that corresponds to the station name selected by CO-OPS' OD (fig. 20).

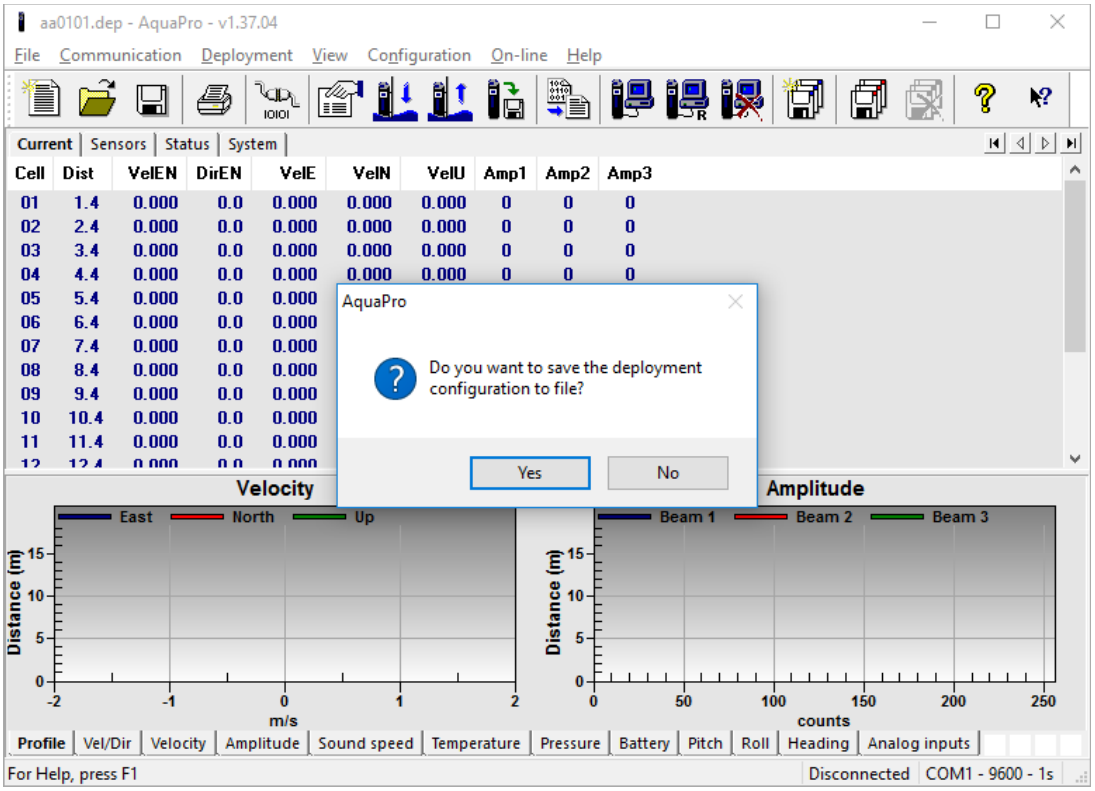


Figure 22. Nortek AquaPro – Save Deployment Configuration to File

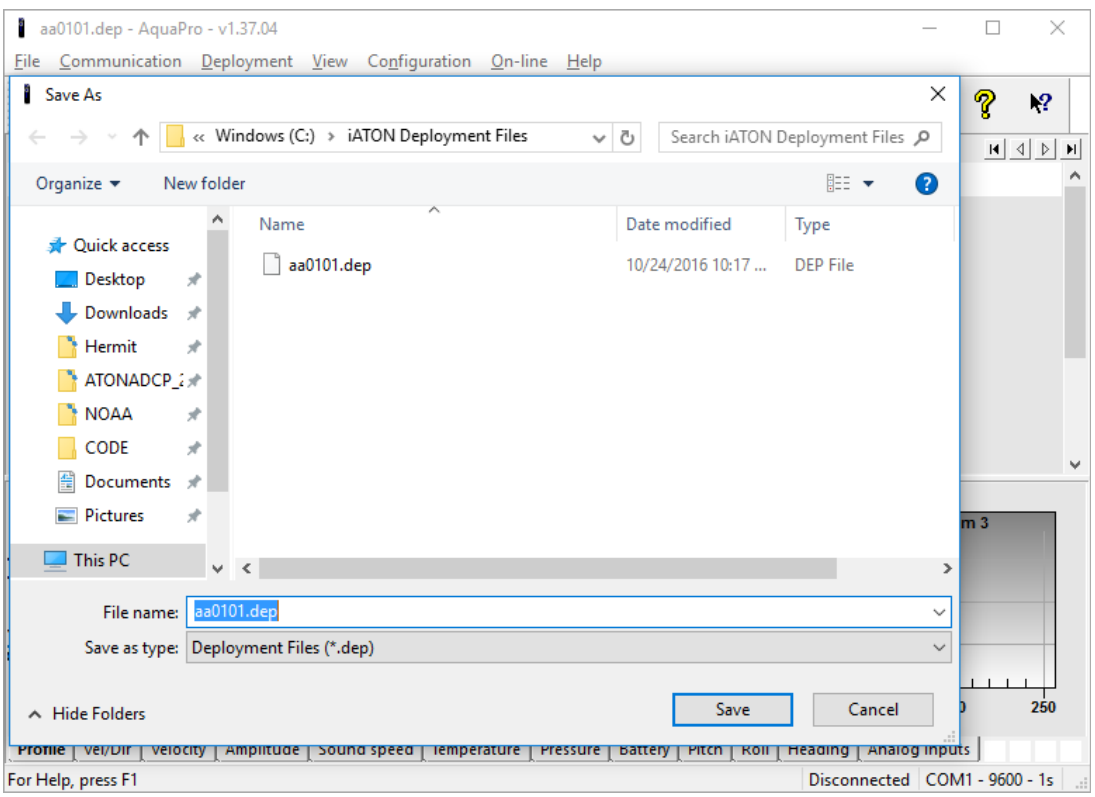


Figure 23. Nortek AquaPro – **Save As** Dialog Box

> **Note from Nortek SLL Manual**: At the time of this writing, it was found you must make sure no "." character is in the path to the saved file when saving the deployment file, or the pcf file will not be created (for example, save to "C:\Temp", but **do not save to** "C:\Users**myname.workgroup**\documents"). See the Nortek integrators manual for more information on using the -cu option.

The software may respond that the instrument is collecting data and ask if you wish to stop the data collection. Verify that the PC time is set to UTC time (fig. 23). Select **Yes** to start a new deployment (fig. 21) and then select the check box to **Set clock to PC time** (fig. 22), then click **OK** to verify instrument clock (fig. 23).

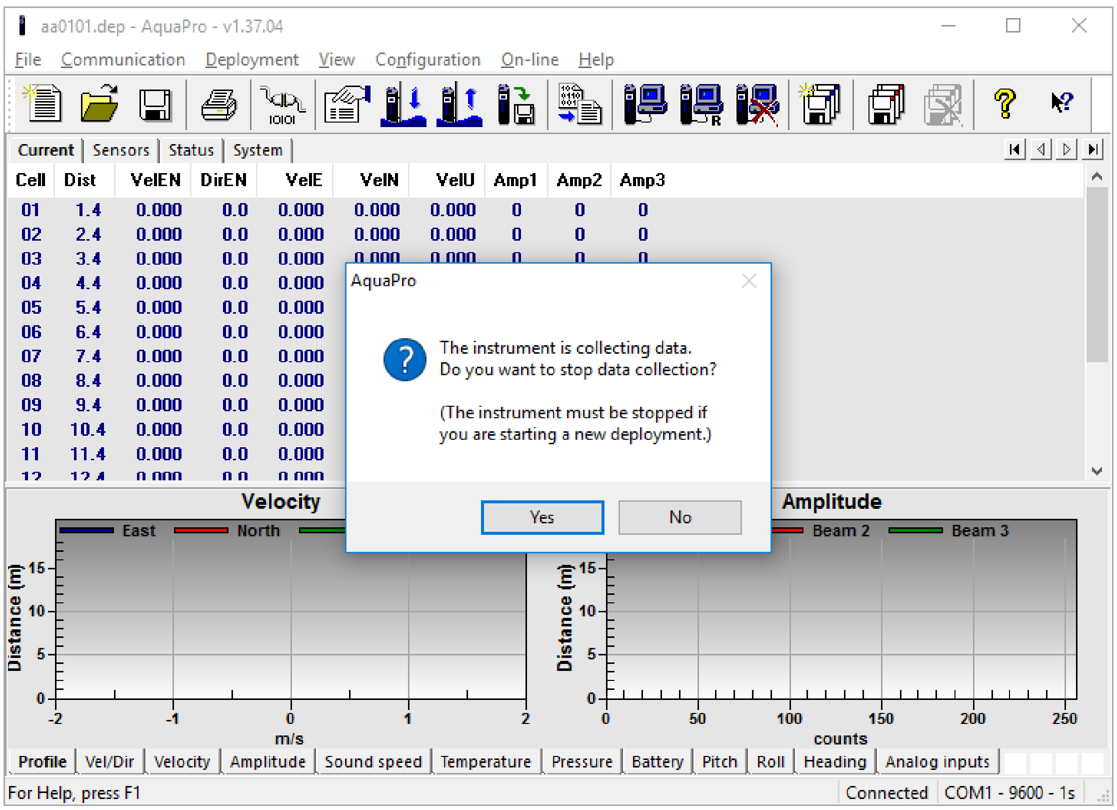


Figure 24. Nortek AquaPro - Starting New Deployment

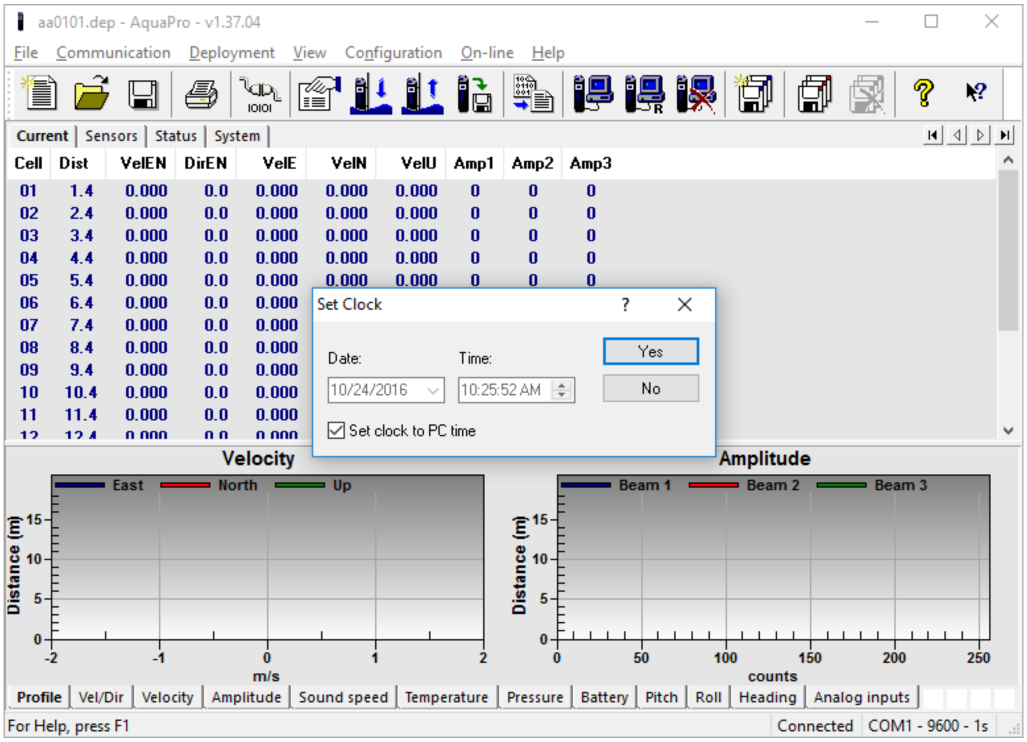


Figure 25. Nortek AquaPro - set instrument to PC time (UTC)

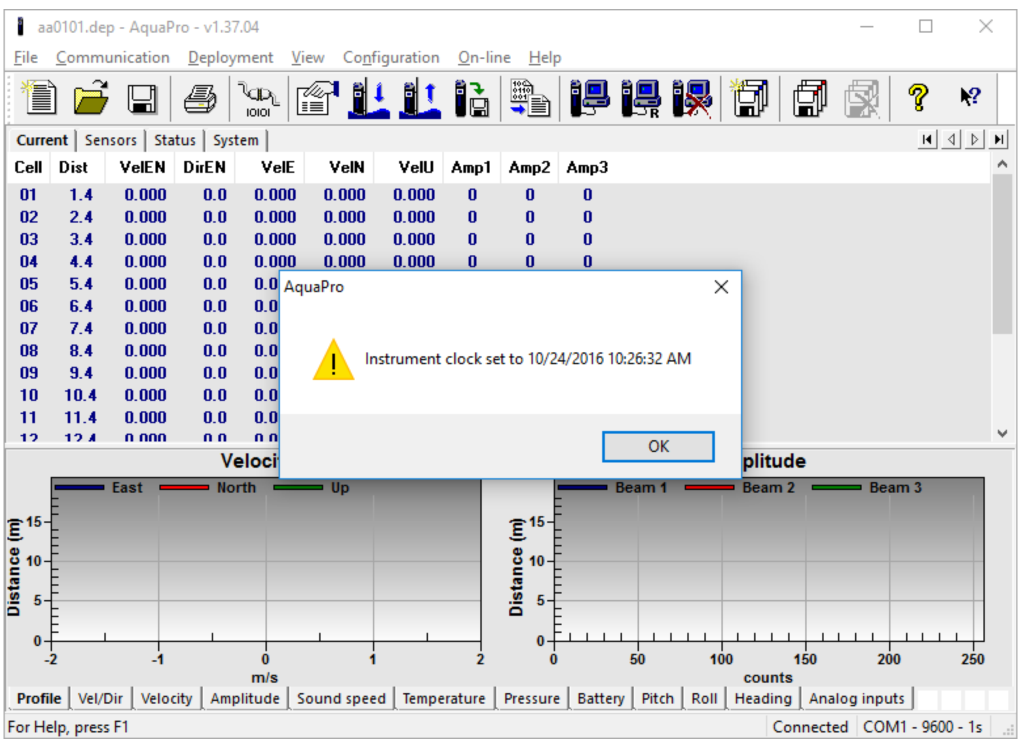


Figure 26. Nortek AquaPro - verify instrument clock

Now that the instrument clock has been set to UTC time, a dialog will appear if the instrument is connected to power through an AC-DC adapter instead of running on internal batteries. Select **Yes** to continue with the deployment (fig. 24) and save the binary configuration file.

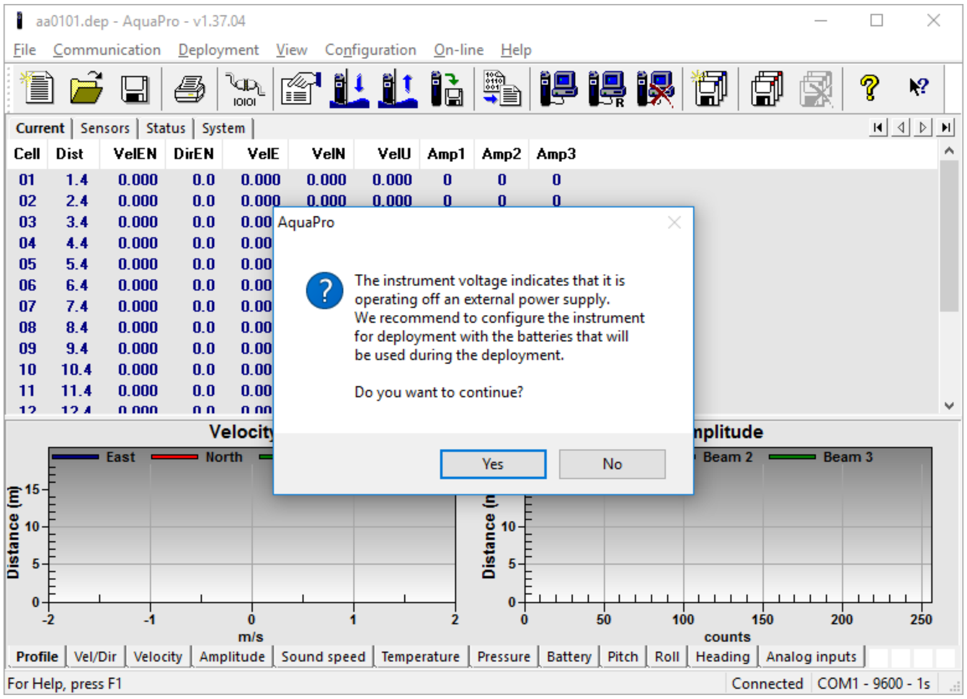


Figure 27. Nortek AquaPro - Operating on External Power

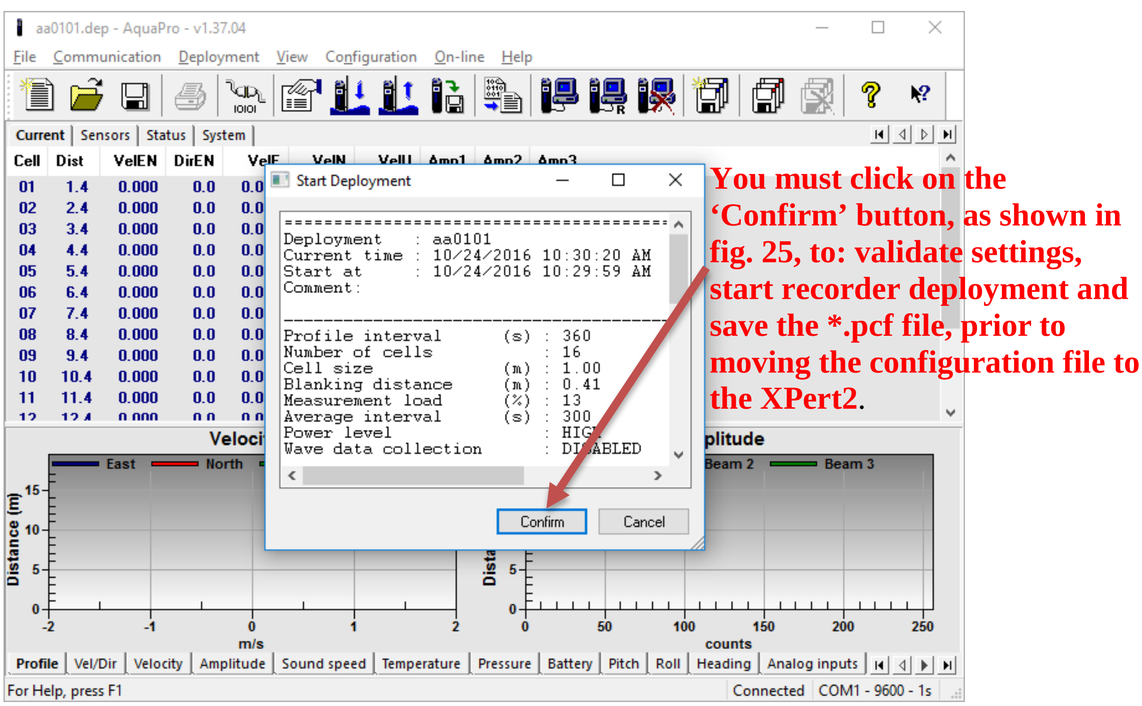


Figure 28. Nortek AquaPro – confirming deployment

3.4 Pressure Sensor Offset

It is important to note that the sensor is not calibrated at the factory to compensate for atmospheric pressure and thus the values track this pressure. This procedure is taken from the Nortek Service Manual Section 1.2.2 and is elaborated on further in that document.

1) Submerge Instrument in 0.50m of water.
2) Click *Online > Set Pressure Offset*
3) Enter 0.50 in the box
4) Click *Start*

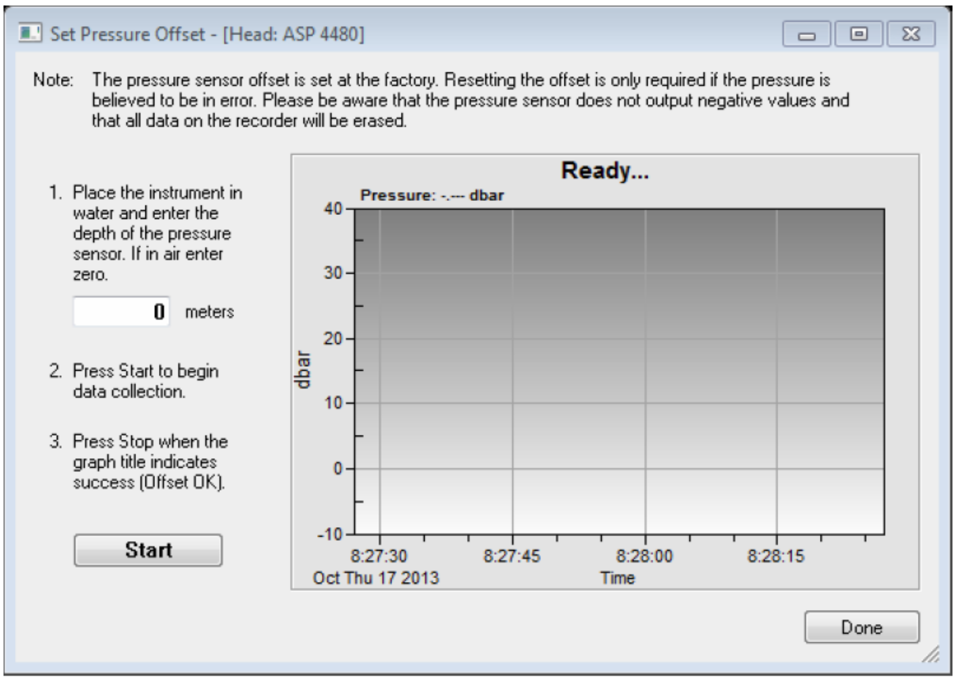


Figure 29: Set Pressure Offset Pt. 1

5) After 1 Minute Click *Stop*
6) Validate the data and Click *Done*

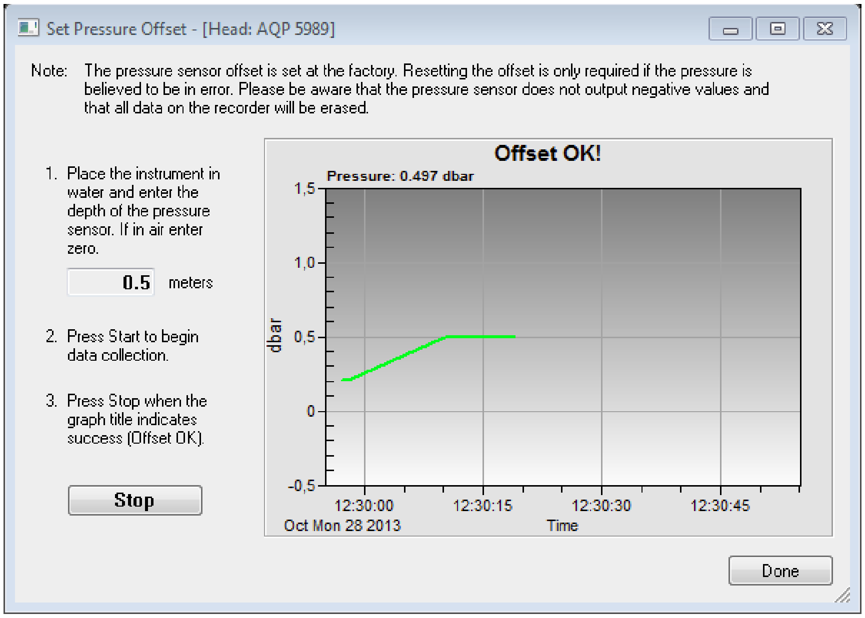


Figure 30: Set Pressure Offset Pt. 2

3.5 Data Collection Platform Configuration

This section describes details of primary components of the iATON's DCP, the Iridium Short Burst Data (SBD) modem, which is the primary source of real-time data telemetry; the cellular IP modem, which is for two-way communications and remote trouble-shooting; and the XPert2 Dark data logger.

3.5.1 Sutron Iridium SBD Satellite Transceiver

Figure 26 shows the Iridium SBD modem employed be the system, the Sutron ISDB-1-O.

Figure 31. Sutron Iridium SBD Modem

http://www.sutron.com/product/iridium-short-burst-data-sbd-transceiver/

When procuring Sutron Iridium SBD modems, you must include DoD-approved firmware with the unit. Also, five IP addresses of CO-OPS' data ingestion servers must be specified to the Iridium vendor, as endpoints for data after arriving at the Iridium gateway. For an iATON system to be integrated into CO-OPS PORTS real-time data stream, the SBD modem should be configured to send data to the IP addresses listed in table 2.

Table 2. CO-OPS' data server IP addresses

IP Address	Ingestion Device
72.215.148.73	Chesapeake LRGS1
72.215.148.72	Chesapeake LRGS2
161.55.90.16	Seattle LRGS1
161.55.90.17	Seattle LRGS2
140.90.78.212	Silver Spring Server ("TidePool")

NOTE: Do not transmit full ensembles of data using commercial service because the cost quickly becomes prohibitive, as the data is billed per byte.

3.5.2 Cellular IP Modem and Relay

As of 09/20/2016, the cellular IP modem utilized in the iATON system is the Sierra Wireless AirLink LS300 with Verizon wireless service. CO-OPS uses a DC relay to turn the cellular modem on/off so that the LAN port on the Sutron XPert2 becomes available through the static IP. The modem is installed in the iATON system using a DIN rail mounting bracket (fig. 30).

Figure 32. IP Modem - LS300 and mounting bracket

Contact the CIL for further instruction on setting up the IP modem for connectivity.

CAUTION:

- Failure to configure the relay/modem properly will cause a dramatic decrease in battery life of the system.
- Modifications were made to IP modem security settings which limit accessibility to the NOAA-COOPS' internal subnet. This limits fraudulent login attempts on the device from remote systems.

Figure 33. Sutron Digital I/O Module

http://www.sutron.com/product/xpert-digital-io-module-8-channels/

The Digital I/O module (fig. 31) is connected to the XPert2 via the I^2C port and controls the IMO relay shown in fig. 32.

Figure 34. 12 VDC IMO relay and holder

3.5.3 Data Logger/Controller Hardware Changes

To use the Iridium SBD Modem with the Sutron XPert2, it is advised that you open the XPert2 and change the jumper settings to output 0 VDC on all COM Ports except for COM4 (J1000) which is set to +12 VDC. Make sure not to select SW 12VDC as that voltage is software controlled.

Jumper location images in fig. 35 are taken from the Sutron XPert2 Manual. The jumper settings in the figure below are NOT the recommended setup for the iATON application and are only an example.

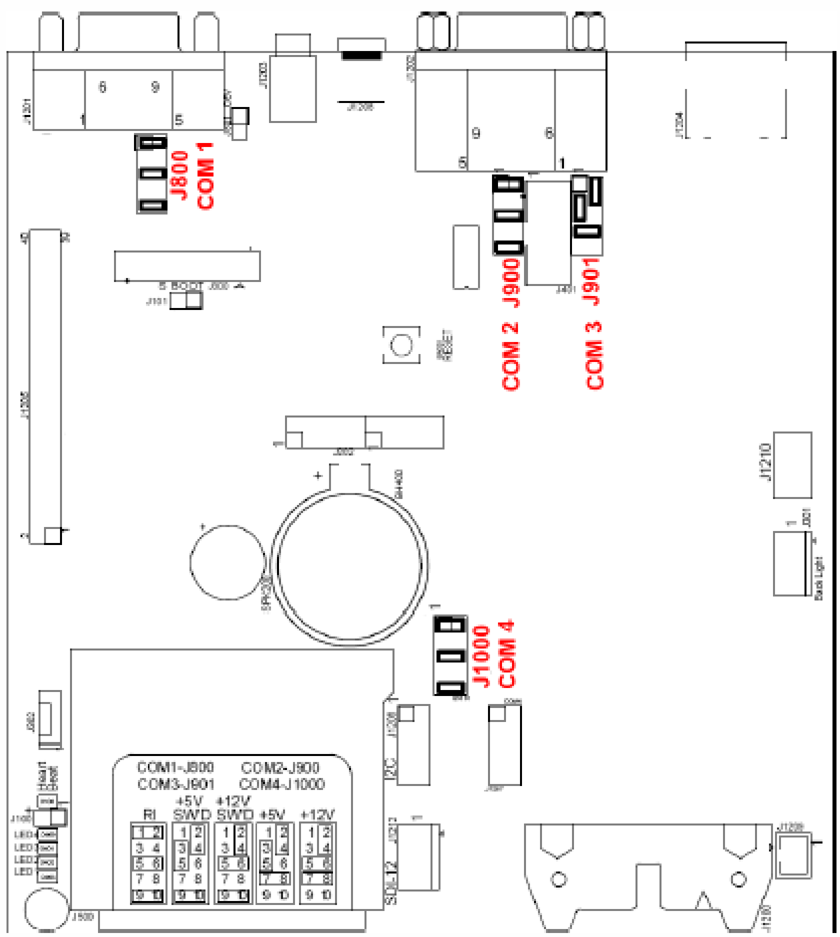


Figure 35: COM 1-4 Jumper Locations EXAMPLE

3.5.3 Data Logger/Controller Software Setups

At the time this version of the design document was written, the following XPert2 operating system and additional software tools are required of the latest version iATON system:

- *Operating System Version*: v3.22.0.5
- *Additional SLLs*: Iridium.SLL, Nortek.SLL
- *BASIC Software*: IMO Relay.bas, atonfmt.bas

The custom BASIC software is found in the Appendices. For further information, contact the CIL Team Lead for details.

The diagram in fig. 33 and table 3 provide an overview of how each DCP component is connected/interfaced to the system’s XPert2 logger/controller.

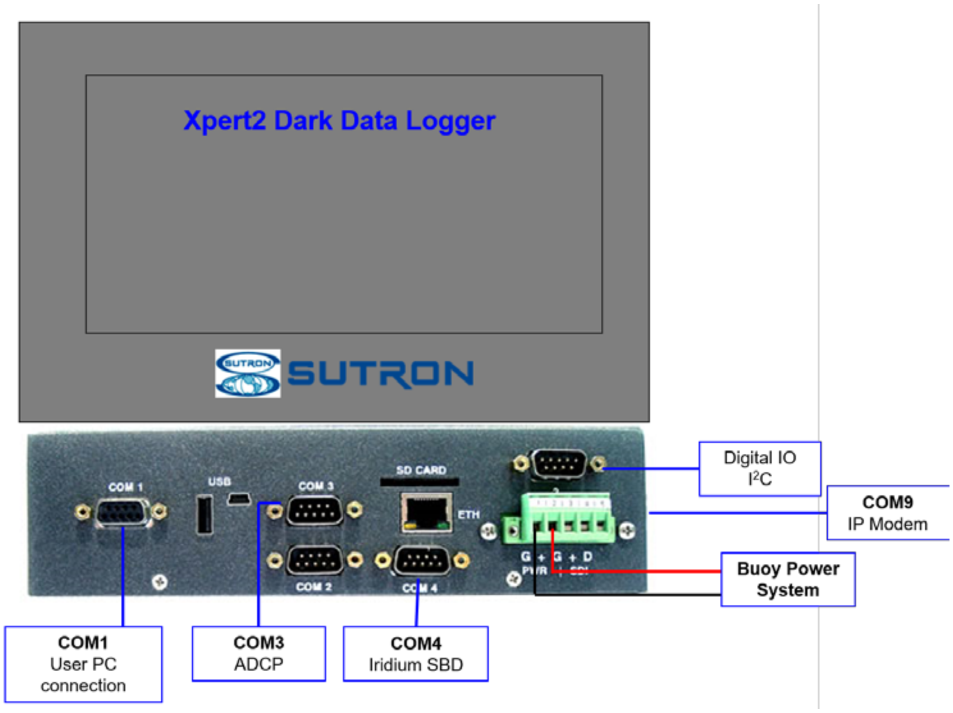


Figure 36. XPert2 COM Ports – External Configuration

Table 3. Xpert2 COM port configuration

System Component	Xpert2 Data Logger COM Port #	External Bulkhead I/O
User PC interface to Xpert2 logger	COM1	Bulkhead
Iridium SBD	COM4 *12 Volts on pin 9*	Feedthrough
IP Modem	COM9	Feedthrough
ADCP	COM3	Bulkhead
Digital I/O	I[2]C	N/A

The following screenshots step through the setup of the Xpert2's Sutron setup file (SSF) to allow for recording and transmission of a Nortek Aquadopp ADCP. Encoding is per standard NOAA-COOPS ADCP formatting schema, developed and maintained by Phil Libraro, for transmission via geostationary operational environmental satellite (GOES) to make the decoding process easier for COOPS' Information System's Division (ISD). The GOES-formatted SatLink buffer is then utilized to encode an Iridium SBD message.

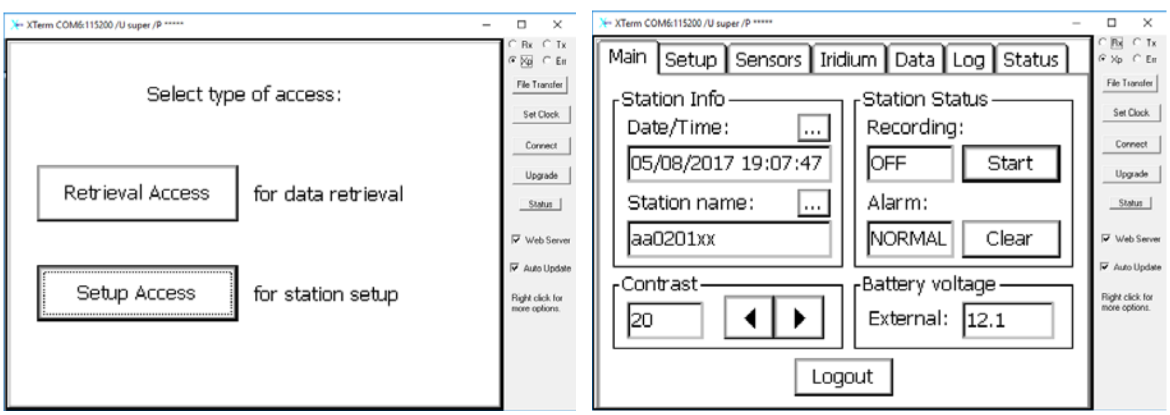


Figure 37. Graphical setup

The iATON system is configured using the XTerm - **Setup** access login shown in fig. 34. After logging into the station, verify that Recording is **OFF** before attempting to modify the software configuration.

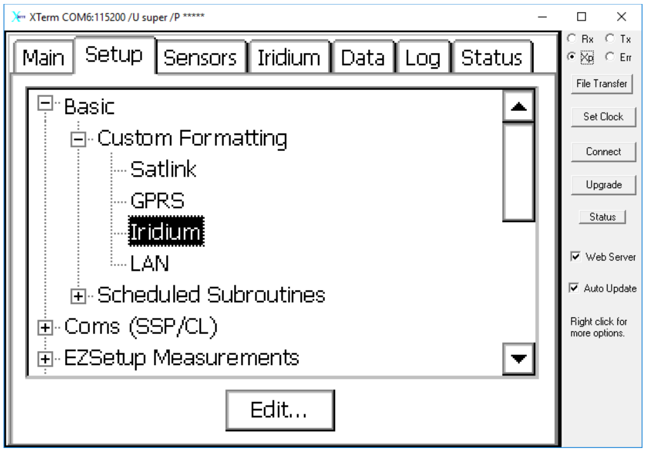


Figure 38. Graphical Setup - Iridium formatter

One of the first changes necessary to the XPert2 configuration is the BASIC Custom Formatting routine, which is shown in Appendix A. You may access this menu by expanding BASIC-Custom Formatting-Iridium in the **Setup** tab of the Sutron XPert's graphical interface.

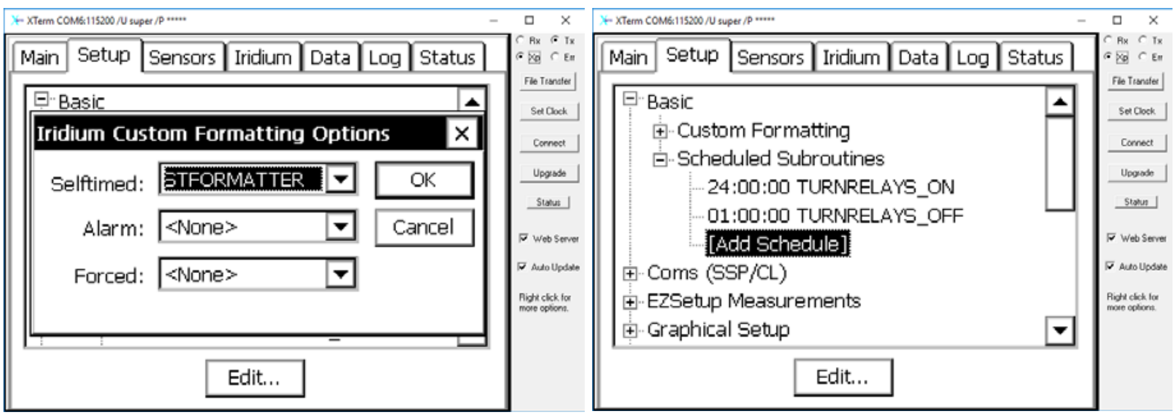


Figure 39. Graphical Setup - Iridium formatter

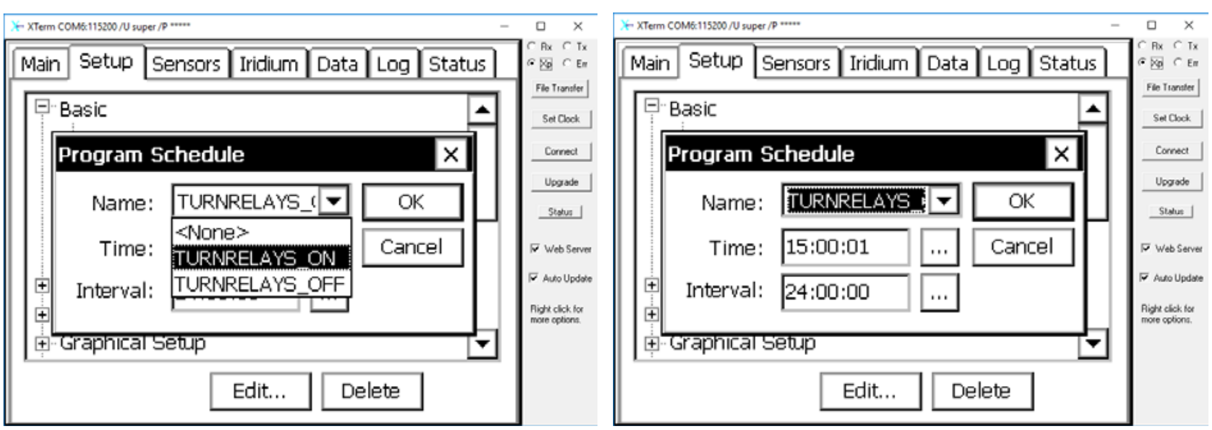


Figure 40. Graphical Setup - Relay BASIC Schedule Relay ON.

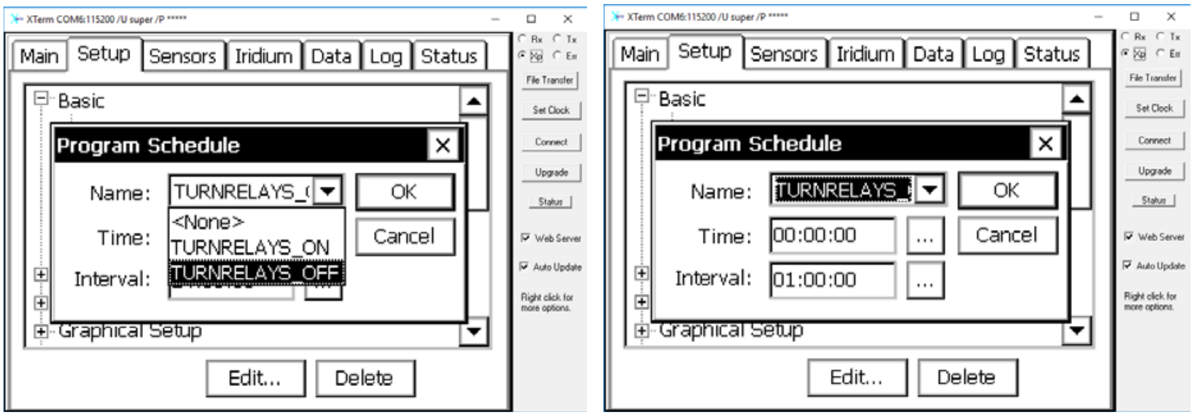


Figure 41. Graphical Setup - Relay BASIC Schedule Relay OFF.

For configurations utilizing an IP Modem for remote troubleshooting connectivity, add Scheduled BASIC programs to turn the IMO relay on/off. CO-OPS schedules the relay to turn off once every hour and to turn on once every 24 hours at 15:00:00 GMT. This adds a degree of confidence that the IP modem will not be left in an ON state, which would dramatically decrease the battery life of the iATON system.

It is possible to **Start** and **Stop** recording on the DCP and turn the IP Modem on and off by issuing MTMs (mobile terminated messages) to the field application. Rebooting the DCP is also possible through MTM data commands and the process is described here. These commands' functionality has been verified, and although there is potential for other commands, it is recommended that no other commands be tested during field deployments at this time.

Step 1. Open a new file in **Notepad.**

Step 2. Enter the desired command in the text editor.

Step 3. Save the file with a '.sbd' file extension, e.g., 'systatcmd.sbd'.

Step 4. Attach the '.sbd' file and email to '**data@sbd.iridium.com**' if the modem is provisioned on a Commercial Iridium Gateway and '**data@sbd.pac.disa.mil**' if the modem is configured for use on the DoD's Iridium Gateway:

a. Put the corresponding *IMEI Number* in the subject line
b. Leave the body of the message blank
c. Attach SBD file to email

Confirmation that the message is queued at the gateway will be sent in a return email. The software is configured to listen for MTM periodically; thus, it may not recognize the instruction as soon as it is sent. Every hour during transmission or during a mailbox check, the ISU (Iridium Subscriber Unit) will connect to the gateway and deliver any MTM that is queued there (table 4).

Configure the XPert's COM ports for use with the Nortek Aquadopp, direct Serial connection to a PC and COM6 (or other) for use with the Cellular IP modem. The setup described here is currently standard for CO-OPS' stations, but other configurations are possible. Contact CIL for more information if a nonstandard configuration is required.

Table 4. Iridium SBD MTM commands

Supported Operation	Command
Start Recording	!RECORDING ON
Stop Recording	!RECORDING OFF
Turn IP Modem On	!set IOEnable -1
Turn IP Modem Off	!set IOEnable 0
Reboot	REBOOT?

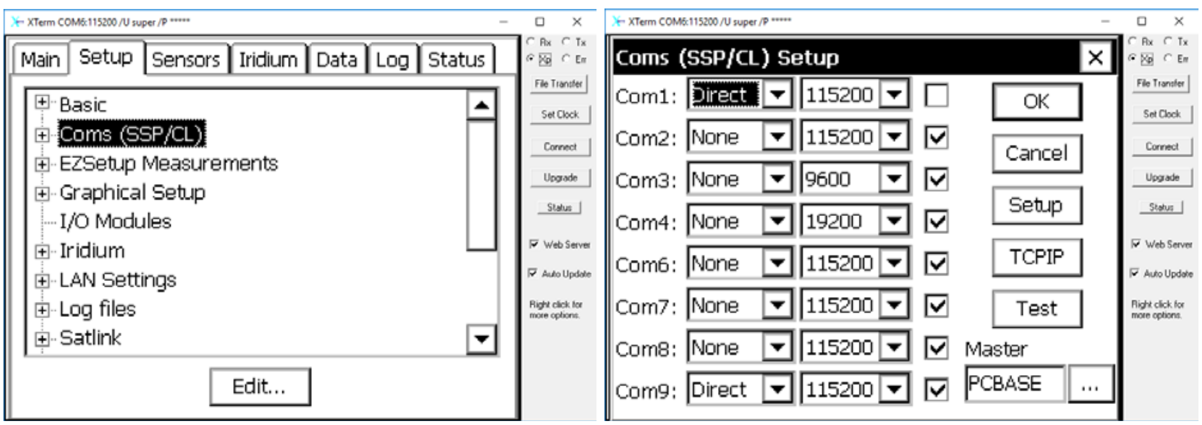


Figure 42. Graphical setup - COM port configuration

CO-OPS has configured iATON for 6-minute average measurements and data telemetry. If setting up a system, it is necessary to use the graphical setup's **Edit** function where it is possible to add the Nortek measurement block as shown in fig. 40.

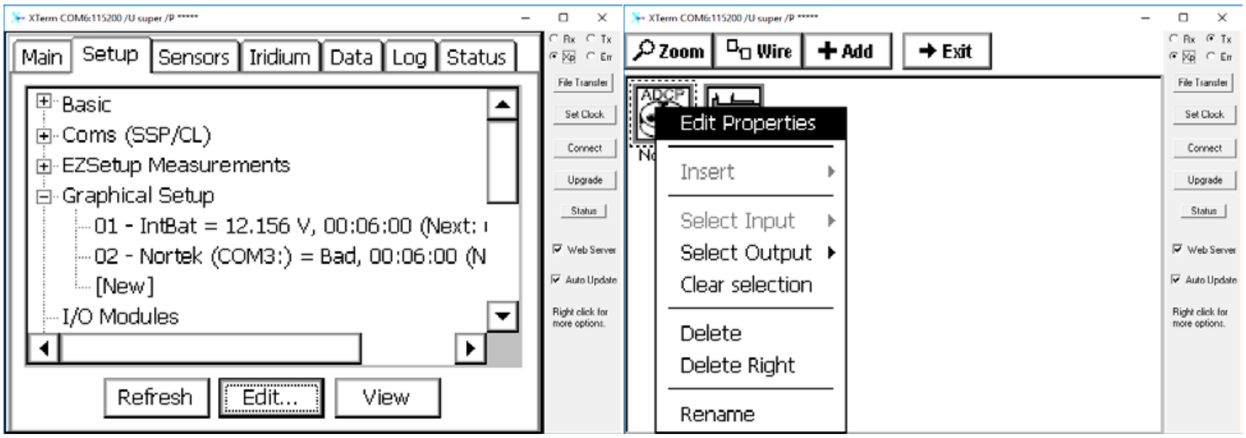


Figure 43. Graphical setup - Nortek SLL properties

Although the Nortek block's title is **AWAC Properties**, the software will work using Nortek's Aquadopp profiler. Add the Nortek block and connect a Measure block to and of the Outputs of the Nortek block as shown in fig. 40. Then use the Edit menu and then click on the Init... button to access initialization parameters, which must be configured properly by CIL (fig. 41).

After opening the Nortek block, click on the **Data** tab to access the **Data Capture Properties**. Configure as shown in fig. 42 and click **OK**. There is nothing to configure in the 'Outputs…' section.

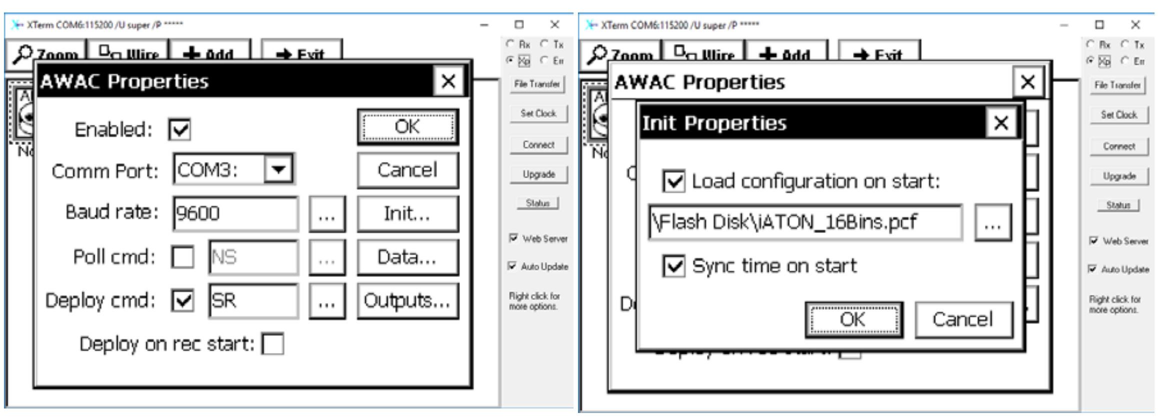


Figure 44. Graphical Setup - AWAC Properties – Init…

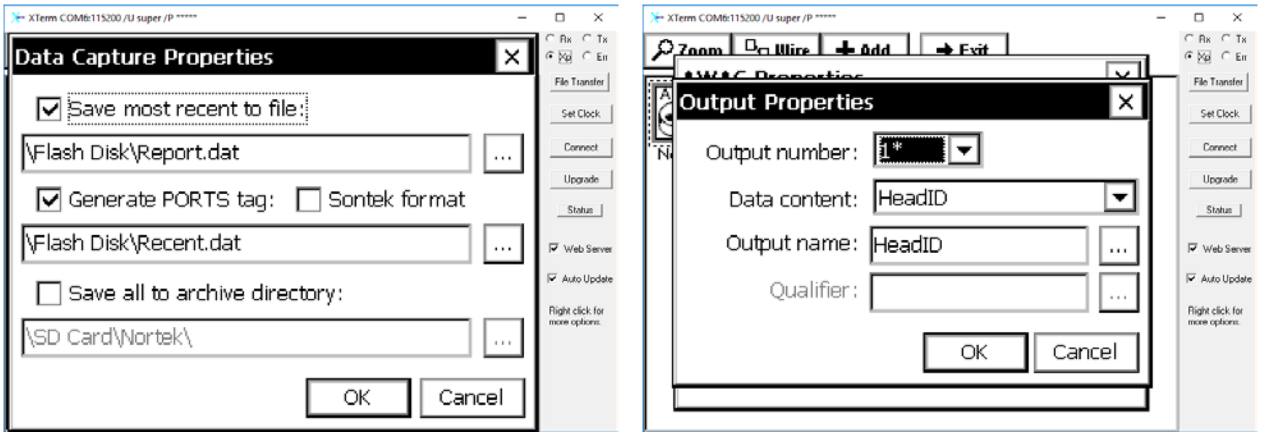


Figure 45. Graphical setup - Nortek SLL data capture/output

Add a **Measure** block to any of the Nortek block's output and set the measure *Interval* to 00:06:00 with a 00:05:58 *Time* offset (fig. 43). This allows 2 seconds for the software to configure the deployment and sets the time of first ping to the top of the 6-minute mark. If the measurement interval configuration is different than is suggested, additional configuration may be necessary from ISD and OD at CO-OPS.

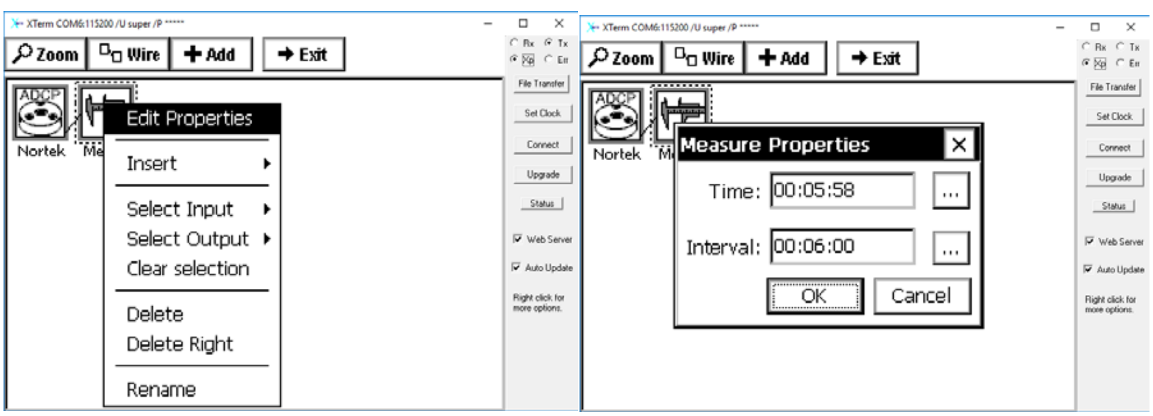


Figure 46. Graphical setup - Nortek SLL measure block properties

If using the IP modem's LAN connectivity option (recommended), you must set the **LAN** configuration to Auto in the XPert2's **LAN Settings** (fig. 44). This allows the onboard DHCP server to assign an internal IP address to the DCP and allow for seamless connectivity using the

XTerm software, which is available as a bundled app in the OS distribution for use with the XPert/9210 product line.

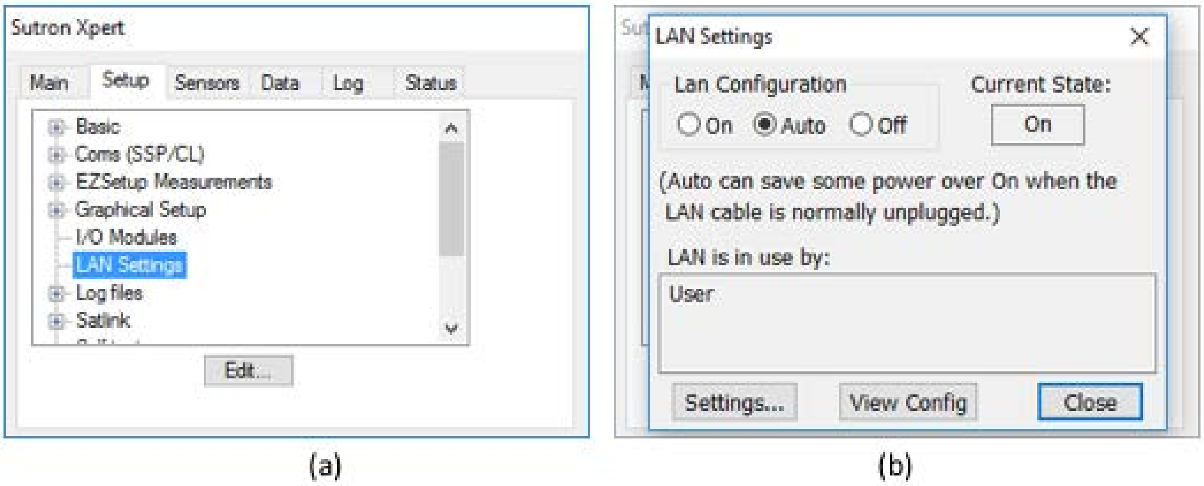


Figure 47. XPert2 LAN Settings

Because the iATON system is a modified telemetry method of the original ATON ADCP system, COOPS has chosen to maintain the same encoding schema as used in all other configurations. This allows for a better continuity of software among all ATON ADCP systems. The iATON's **Self-Timed Properties** are set up for 6-minute GOES transmissions (fig. 45); however, the SatLink's **Initialize SatLink** checkbox is left unchecked (fig. 46b). This will build a GOES message in the DCP's internal buffer, which is then accessed, using the custom Iridium STFormatter, packaged in an SBD message and transmitted via Iridium.

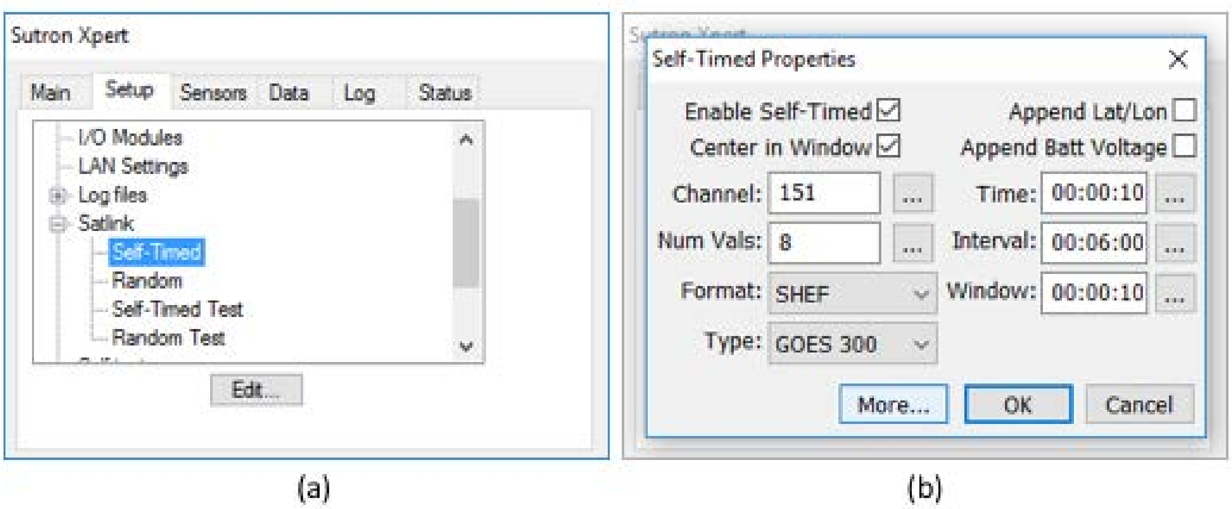
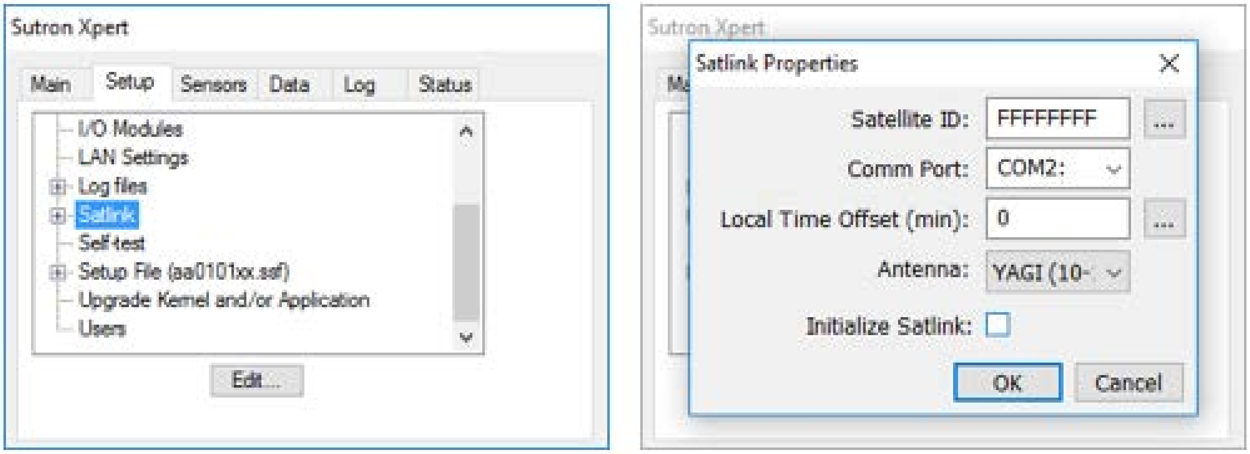


Figure 48. XPert2 Self-Timed Settings



(a) (b)

Figure 49. SatLink Settings

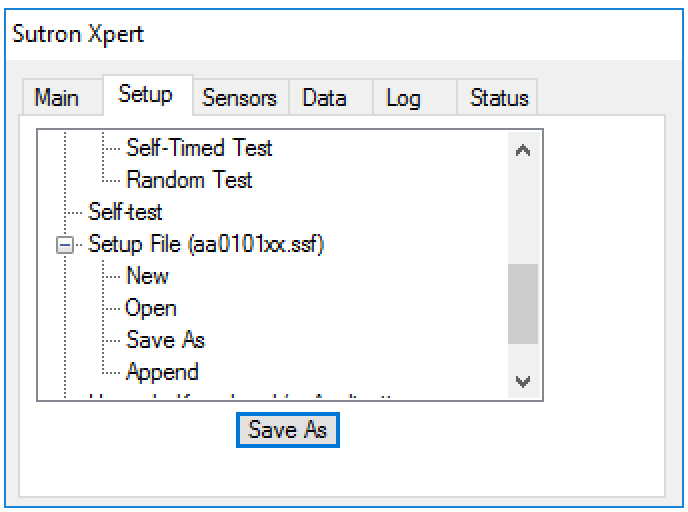


Figure 50. XPert2 Save Setup File

When the deployment is started, the XPert will load the iATON_16bin.pcf file to the instrument and configure the deployment to begin at the next 6-minute mark. After the 5-minute sample, the data is saved.

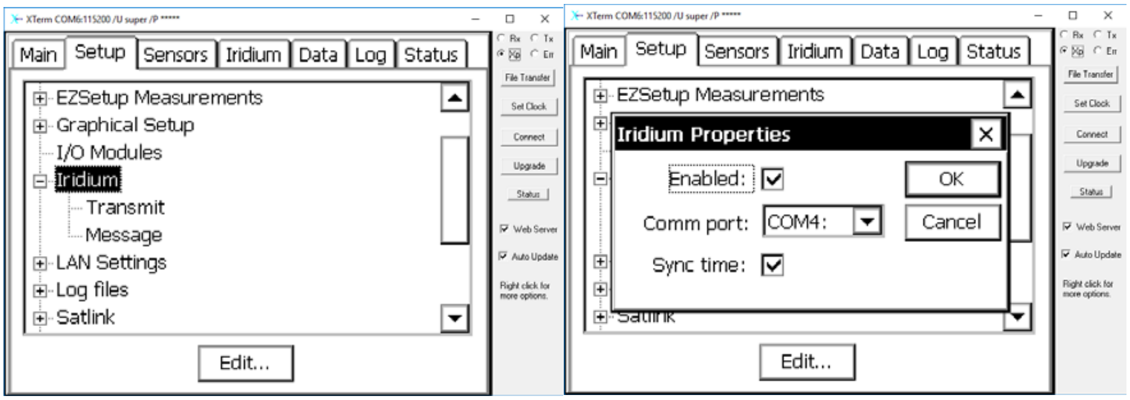


Figure 51: Enable Iridium Tx

Enable time synchronizing and specify the COM Port for the Iridium modem (fig. 48). Also, set the Iridium modem to transmit every 6 minutes.

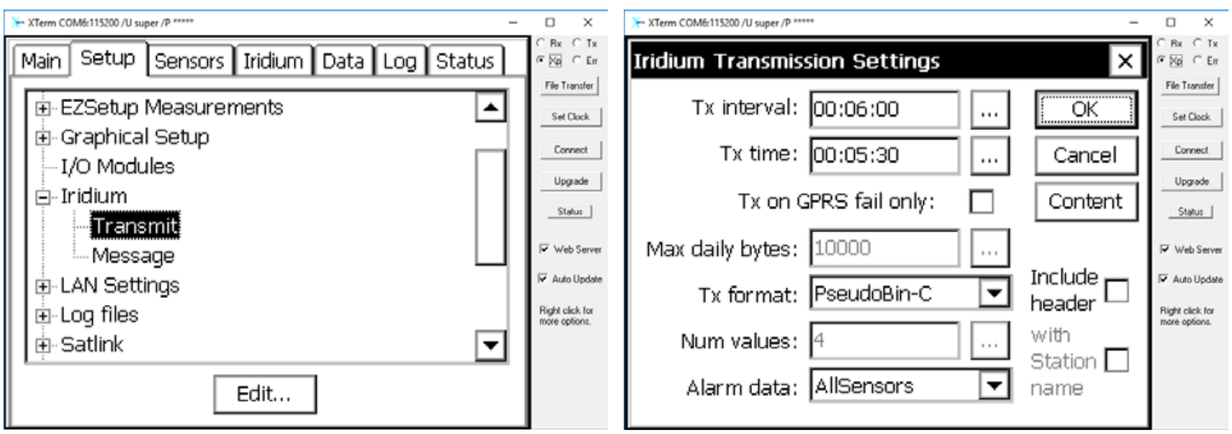


Figure 52: Iridium Transmit Settings

3.5 Assembled Clamparatus and Antenna Mounts

The Clamparatus, manufactured by Teledyne Oceanscience, serves as a nonintrusive measurement platform, which clamps to a lifting eye on the USCG ATON buoys. Custom antenna-mounting blocks are required for easily attaching the IP and Iridium antenna to the top ring of the ATON buoy.

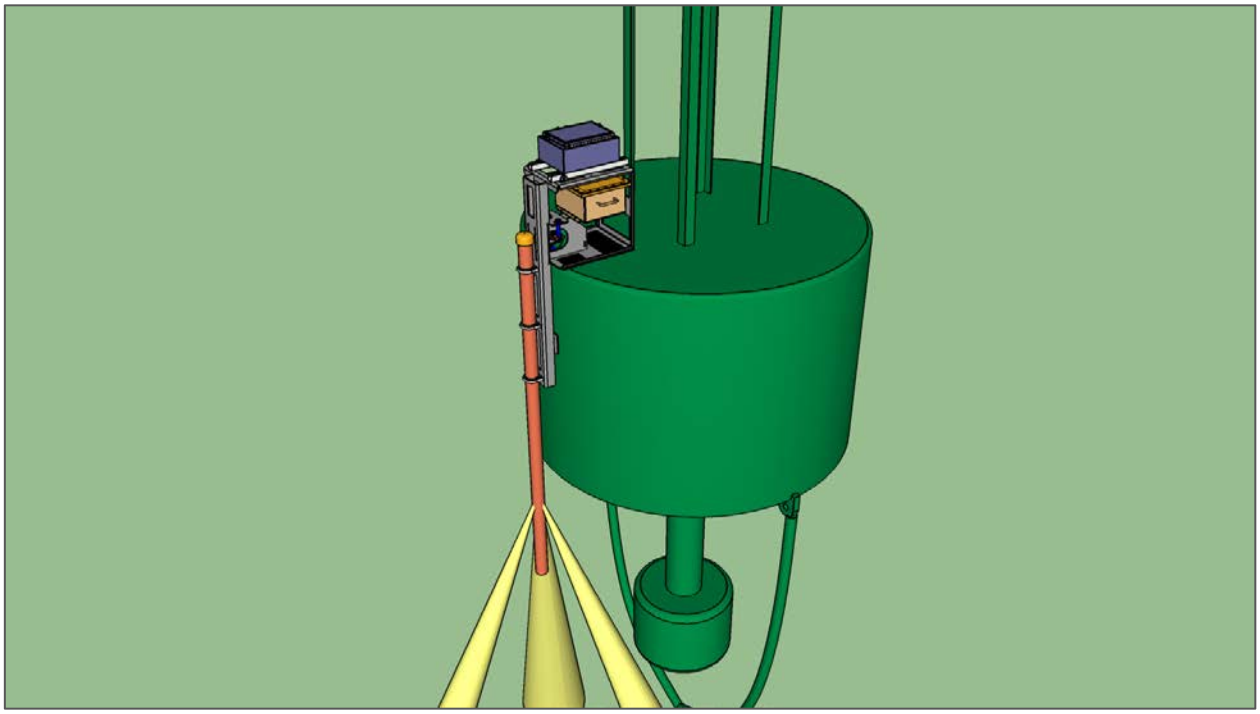


Figure 53. ATON, iATON System and Clamparatus

http://www.oceanscience.com/Products/Clamparatus/Home.aspx

Figure 54: Installed iATON System

Figure 55: Mounting Antennas

4.0 Data Throughput Verification Test Procedure

After an iATON system is assembled per specifications described above, a data throughput verification test will be completed in the laboratory, prior to field deployment. This will involve CIL personnel working with both the Engineering Division's Configuration and Operational Engineering Team (COET) and the Oceanography Division's Data Monitoring and Analysis Team (DMAT).

Station Configuration in CO-OPS Database

The first step in data throughput testing involves configuring a test station in CO-OPS database through PORTS Powerbuilder. The following metadata from the iATON system needs to be sent in an e-mail to COET (nos.coops.oetteam@noaa.gov) with a cc to DMAT (nos.co-ops.dmat@noaa.gov):

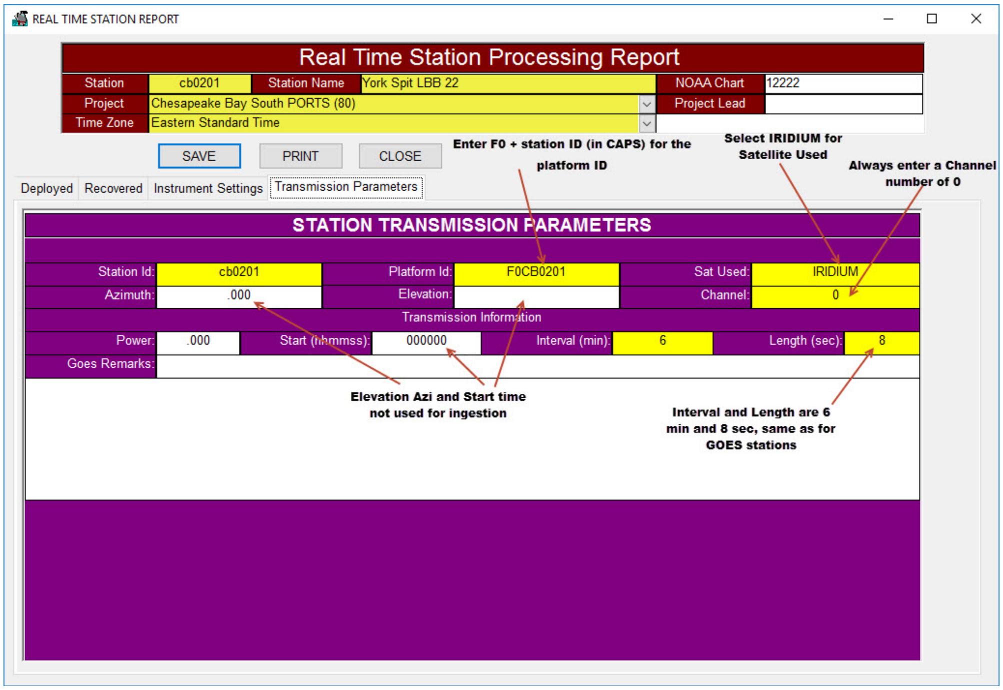
- sensor manufacturer
- sensor type
- sensor serial number(s) – (AQD:#### Serial)
- acoustic center frequency
- profiler settings
  - bin size
  - number of bins
  - blanking distance
  - center to bin 1 distance
    - (Bin Size + Blanking Distance = 1.4m for Nortek Aquadopp)
  - measurement coordinate system (ENU)
- sensor depth
- station location (latitude/longitude)
- approximate flood/ebb directions (for new installs)
- approximate water depth (for new installs)
- communication settings
  - Iridium SBD modem IMEI
  - IP address (with specification DO NOT POLL)

When configuring a station for initial throughput testing a designated test station ID should be used, not the actual PORTS station ID. Designated test ID's are **aa0101** and **aa0201** (if these ID's are actively being used for testing, **aa0301** can be established. A new deployment should be entered in PORTS Powerbuilder using one of these ID's (a recovery time may be necessary for the previous deployment).

The system's station ID must be changed to the deployment station ID on the system's Xpert logger after throughput verification testing completed, just prior to field deployment.

Entering metadata should follow normal procedures for a real-time station. The Transmission Parameters information is a little different for Iridium stations when compared to GOES stations.

- Platform ID should be F0) followed by the station ID in CAPS (e.g. *F0CB0201*). Note it is F followed by a zero).
- Iridium should be selected for the satellite.
- Channel should always be entered as zero.
- Interval and length are the same as for GOES (6 min, 8 sec)
- Elevation, Azimuth and Start time fields are not used.



The DAS control file for the station should be configured using the Tectia application. This file should be configured the same as any new real-time currents station. If an existing test station ID is being used, the following DAS control files may need to be modified based on the metadata sent to COET:

- /ports/aaports/tables/locat/*aaXXXX*
- /ports/aaports/tables/instr/*instrument_ ID*

Once these files are added or modified on the DAS, they are copied over to the Data Ingestion Server (DIS) automatically.

Setting up System for Throughput Testing in the Lab

1. Put assembled system without the Clamparatus sensor tube attached, on a test stand cart.
2. Mount antenna temporarily to the Clamparatus.
3. Take system outside so antennae have a clear view of the sky.
4. Secure the enclosure cover to protect from rain
5. Sensor must be oriented straight up and down, with the transducers facing downward, to pass QA/QC during data throughput testing.
    a. This is best accomplished with the sensor not installed in the Clamparatus tube
    b. Preferably the sensor is sitting in a 5 gallon bucket of water
6. IMPORTANT – hook up external power source to the power bulkhead on electronics enclosure
    a. DO NOT USE the battery bank that will be used for field deployment.
    b. It is suggested to use a 2-pin female bulkhead with flying leads (MCBH-2-FS (SS)) to fabricate a test cable.
7. Connect computer to the DCP through the PC-DCP bulkhead
8. Change station ID on DCP to test ID, provided by COET
9. Start recording on DCP (details in Field Installation Guide) and Verify the following:
    a. Sensor recording data to DCP
    b. Satellite formatting updates every 6 minutes
    c. IP Modem turns on/off as scheduled
    d. DCP login capable through IP
    e. Iridium SBD message capabilities
10. E-mail DMAT & COET to validate throughput testing acceptance

Work with DMAT to Verify Data Throughput

If the station is configured properly on the DAS and in the database, data should begin to populate in the database automatically. Decoded data along with PUFFF files can be retrieved from the Data Ingestion Server by DMAT and decoded Iridium data can also be retrieved using DCSToolkit. Ingested data can be viewed on C-MIST.

Both header (pitch, roll, heading, temperature, pressure) and profile data should be checked in C-MIST for reasonable values to ensure that data are being encoded and decoded properly. Ingestion should run for a period of a few days to ensure that there are no intermittent data issues, which sometimes occur with currents data transmissions over satellite.

5.0 References

1. Bosley, K.T.; J. Dussault, C. McGrath, M. Bushnell; M. Evans; G. French; K. Earwaker. 2005. Oceans System Test and Evaluation Program Test, Evaluation, and Implementation of Current Measurement Systems on Aids-To-Navigation. NOAA Technical Report NOS CO-OPS 043, http://www.tidesandcurrents.noaa.gov/publications/technical_report_43.pdf

2. Bosley, K.T.; C. McGrath, T. Graff, J. Stepnowski. 2006. Enhancements to the NOAA current measurement system on US Coast Guard navigation buoys. OCEANS 2006, DOI: 10.1109/OCEANS.2006.306996, pp. 1-3. Boston, MA: MTS/IEEE.

3. Krug, W., Heitsenrether, R., Hensley, Project Plan for Development and Test of Enhanced PORTS® ATON ADCP Real-Time Current Measurement System, November 2014 – September 2015, OSTEP Project Plan, November 2014, http://intranet.nos-tcn.noaa.gov/media/wikidocs/OSTEP/New_ATON_ADCP/ATONADCP_ProjectPlan_v6.pdf

4. Heitsenrether, R., W. Krug, W. Hensley, M. Bushnell, System Requirements for the Enhanced PORTS® ATON ADCP Real-Time Current Measurement System, December 2014. http://intranet.nos-tcn.noaa.gov/media/wikidocs/OSTEP/New_ATON_ADCP/ATON_ADCP_Requirements_v3.pdf

5. OSTEP Preliminary Design Review Presentation (April 2015): http://intranet.nos-tcn.noaa.gov/media/wikidocs/OSTEP/New_ATON_ADCP/PrelimDesignSummary_v4.pdf

6. OSTEP Critical Design Review Presentation (July 2015): http://intranet.nos-tcn.noaa.gov/media/wikidocs/OSTEP/New_ATON_ADCP/DetailedDesignSummary_v2

7. Nortek System Integrator Manual. Last Accessed 09/20/2016. http://www.nortek-as.com/lib/manuals/system-integrator-manual.

Appendix A. iATON Message Formatter ‘atonfmt.bas’

```
'----- ADCP Message Formatter ---------------------------------------------
'           Author: Phil Libraro
'           Date: Unknown - Last Used in iATON 09/20/2016
'           This basic code is the self-timed formatter for Nortek ADCP'S
'           In this case, we capture RECENT.DAT and store to a working output.dat.
'           The GOES message is stored in SAT.Dat. That way, the user can define a
'           special log in name and password and retrieve the message that way.
'
'           The function SELFTIMED_STFormatter handles the message capture.  Most of this
'           routine is straight from the XPert2 BASIC manual.
'
'---------------------------------------------------------------------------
'
Public FUNCTION SELFTIMED_STFormatter
  'Note here that Selftime_STFormatter is the current message built by the C code
  F1 = FREEFILE
  strDatFileName = "\Flash Disk\RECENT.DAT"
  F2 = FREEFILE
  OPEN "Output.Dat" FOR OUTPUT AS F2
  DATASTR = ""
  OPEN strDatFileName FOR INPUT AS F1
  result = ReadB(F1, DATASTR, 1000)
  N = WriteB(F2,DATASTR,result) 'TRANSFER RECENT.DAT TO WORKING FILE
  CLOSE F1
  CLOSE F2
  F3 = FREEFILE
  OPEN "Output.Dat" FOR INPUT AS F2
  OPEN "SAT.Dat" FOR OUTPUT AS F3
  TStr = ""
  PRINT F3, "CA";SYSTAT(0);     'PRINT STATION ID
'12 01 2011 16 26 51 00000000 00110001  11.8 1486.8 132.5  -5.4   0.5   2.022  10.18      0 14868
  LINE INPUT F2, TStr   'read in HEADER line
  PRINT F3, "-";BIN6(VAL(MID(TStr,
1,2)),2);Bin6(VAL(Mid(TStr,4,2)),2);Bin6(VAL(Mid(TStr,7,4)),2);Bin6(VAL(Mid(TStr,12,2)),2);Bin6(VAL(Mid(
TStr,15,2)),2);Bin6(VAL(Mid(TStr,18,2)),2);
  PRINT F3, Bin6(VAL(MID(TStr,21,8)),3);Bin6(VAL(MID(TStr,30,8)),3);
  PRINT F3,
Bin6(VAL(MID(TStr,38,6))*10,2);Bin6(VAL(MID(TStr,44,7))*10,3);Bin6(VAL(MID(TStr,51,6))*10,2);Bin6(VA
L(MID(TStr,57,6))*10,2);Bin6(VAL(MID(TStr,63,6))*10,2);
  PRINT F3,
BIN6(VAL(MID(TStr,69,8))*1000,2);BIN6(VAL(MID(TStr,77,7))*100,2);BIN6(VAL(MID(TStr,84,6)),3);Bin6(V
AL(Mid(TStr,90,6)),3);
'  -0.129  -0.068  -0.004 140.0 139.0 139.0
  Do While Not Eof(F2) 'read in all bin lines
 TStr = ""
   LINE INPUT F2, TStr   'read in profile line
 If Len(TStr) > 2 then
           PRINT F3,"+";
           PRINT F3, BIN6(VAL(MID(TStr,1,8))*1000,3);
           PRINT F3, BIN6(VAL(MID(TStr,9,8))*1000,3);
           PRINT F3, BIN6(VAL(MID(TStr,17,8))*1000,3);
           PRINT F3,
BIN6(VAL(MID(TStr,26,3)),2);BIN6(VAL(MID(TStr,32,3)),2);BIN6(VAL(MID(TStr,38,3)),2);
```

```
 End if
  End Loop
  CLOSE F2
  CLOSE F3
  OPEN "SAT.Dat" FOR INPUT AS F3
  result = ReadB(F3, DATASTR, 2000)
  CLOSE F3
  Selftimed_STFormatter = DATASTR
END FUNCTION
```

Appendix B. IP Modem Relay Control Software

```
'-----------------------------------------------------------------------
' Filename: IMO Relay Enable.bas
' Purpose: Set up a COMS Tag to turn a digital IO
'           on or off remotely via the command line or
'           Iridium MTM.
'
'           To test MTM capability, send sbd message with the following:
'
'           !set IOEnable 1
'
'-----------------------------------------------------------------------
'Digital I/O Vars
Static iOut         = 5         'Edit this number to match the I/O point of the IP Modem Relay
Static iOut2   = 6 'Edit this number to match the I/O point of Wi-Fi Dongle Relay
Static iSleep1 = 3600 'Keeps I/O point set for 1 hour when MTM Turns it on.
Static iSleep2 = 60   'Keeps I/O point set for 1 Minutes on Schedule
Static iModule = 1              'Only change this if you are using I/O module 2 on an XPert
Static IOon         = -1
Static IOoff   = 0
' Coms Tag Vars
Declare Tag IOEnable(1)
Last_IOEnable = Digital(iModule,iOut)
Public Function Get_IOEnable(Value)
  If Value = 1 Then Get_IOEnable = Last_IOEnable
End Function
Public Sub Set_IOEnable(Value, Data)
  If Value = 1 Then
           Last_IOEnable = Data
           Digital iModule , iOut , Data
           Digital iModule , iOut2, Data
           StatusMsg "Trying to set DIOs to: "&Data
  End If
End Sub
Public Sub Eval_IOEnable
  Last_IOEnable = Digital(iModule , iOut)
End Sub
Public Sub Start_IOEnable
  REM called when recording is started
  Call Eval_IOEnable
End Sub
Public Sub Stop_IOEnable
  REM called when recording is stopped
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' THESE ROUTINES MUST BE USED IN UNISON. DO NOT FORGET TO TURN I/O OFF
''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
Public Sub SCHED_TURNRELAYS_ON
' Turn Relay's ON
           Digital iModule , iOut  , IOon
           Digital iModule , iOut2 , IOon
```

```
    StatusMsg "Scheduled Attempt: Turn IOs ON"
End Sub
Public Sub SCHED_TURNRELAYS_OFF
' Turn Relay OFF
    Digital iModule , iOut  , IOoff
    Digital iModule , iOut2 , IOoff
    StatusMsg "Scheduled Attempt: Turn IOs OFF"
End Sub
```

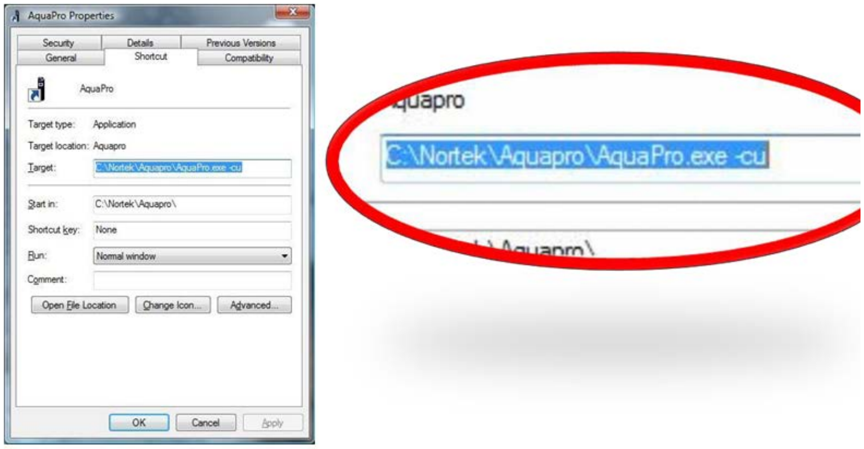
Appendix C. Nortek System Integrator Manual (Dec 2014)

Section 4.1 - Omitting Steps 5-8

Always use the Nortek software accompanying your Nortek instrument when making deployment files. This will save you from a lot of unneeded efforts! When you have generated the file, you may save it. However, this will not generate a file in binary format suitable for direct download to your controller.

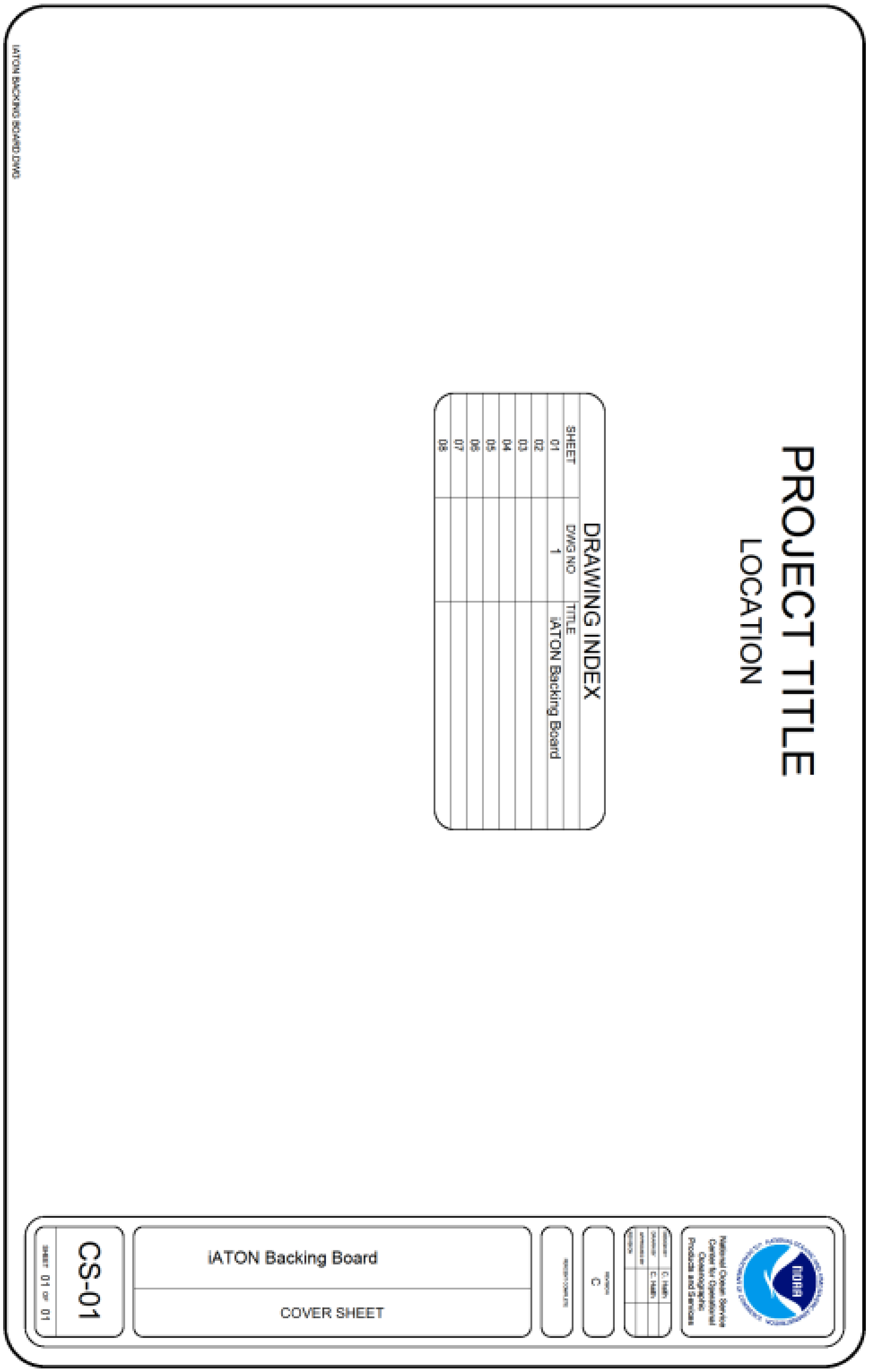
To generate deployment files in binary format do as follows:

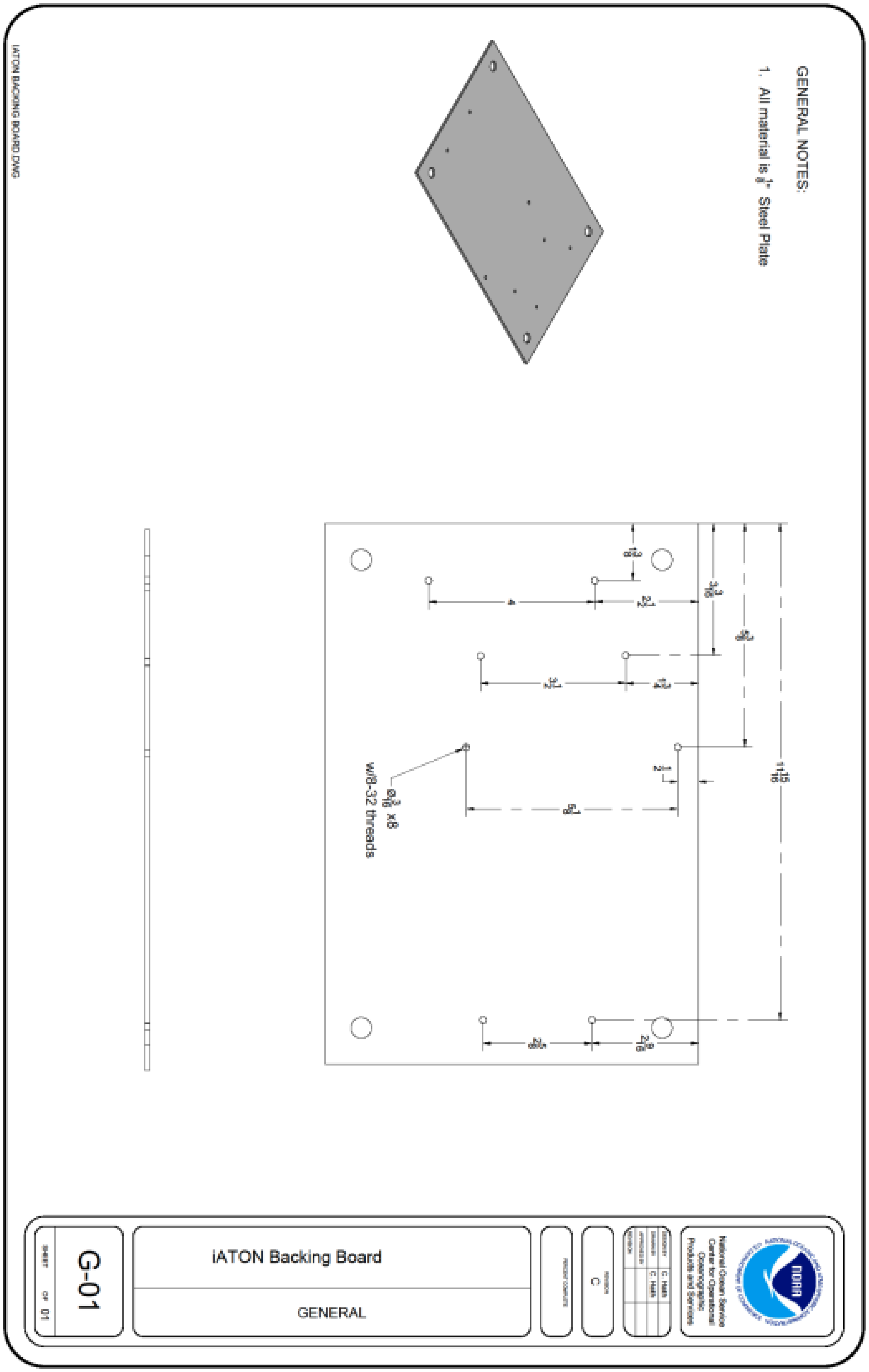
1. Generate a new shortcut to the Nortek software. Right click on the AquaPro (in this example) icon
2. Append the characters -cu in the target line as shown below (using AquaPro as example).



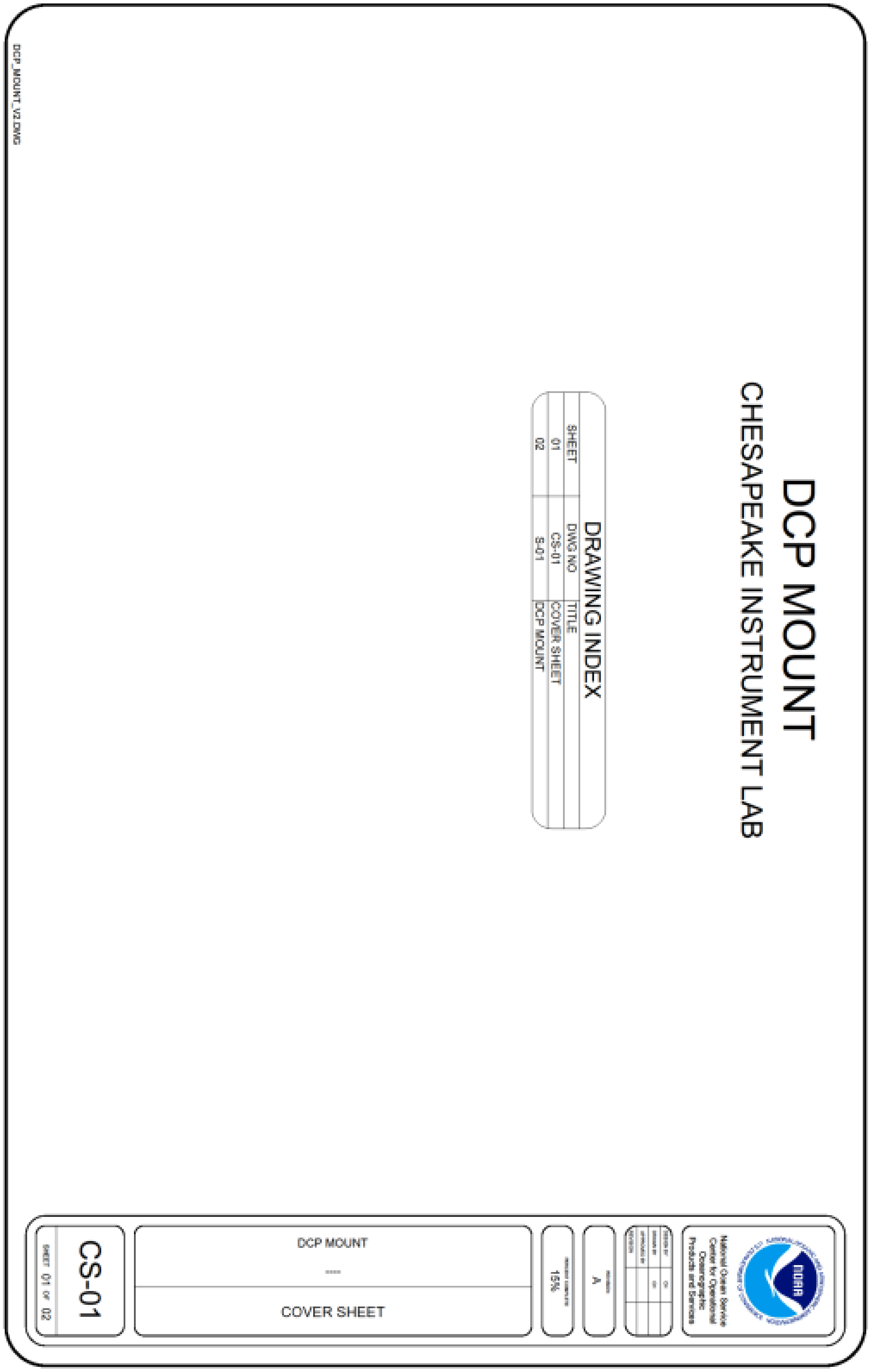
3. Start the Nortek software using the new shortcut.
4. When you now save the deployment file, this will generate two files – the regular file and a file in binary format with the file extension .pcf. This file is the one to download with your controller.

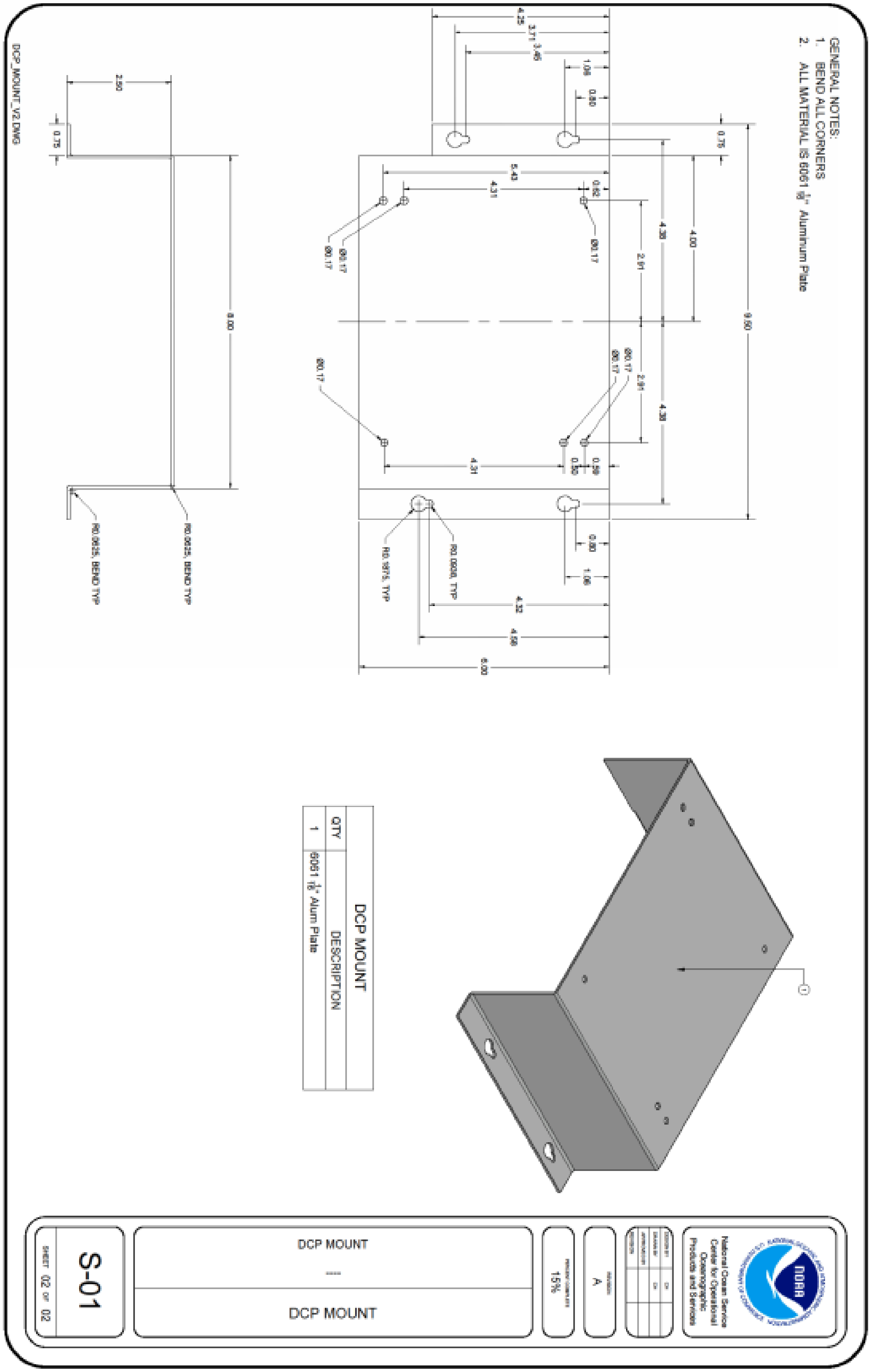
Appendix D. iATON Backing Board Design




GENERAL NOTES:
1. All material is 1/8" Steel Plate
w/8-32 threads
iATON Backing Board
GENERAL
G-01
National Ocean Service
Center for Operational
Oceanographic
Products and Services
C. Hatch
C
IATON BACKING BOARD.DWG

Appendix E. DCP Mounting Bracket Design




GENERAL NOTES:
1. BEND ALL CORNERS
2. ALL MATERIAL IS 6061 1/8" Aluminum Plate
DCP MOUNT
QTY
DESCRIPTION
1
6061 1/8" Alum Plate
DCP MOUNT
DCP MOUNT
National Ocean Service
Center for Operational Oceanographic Products and Services
S-01
SHEET 02 OF 02
DCP_MOUNT_V2.DWG