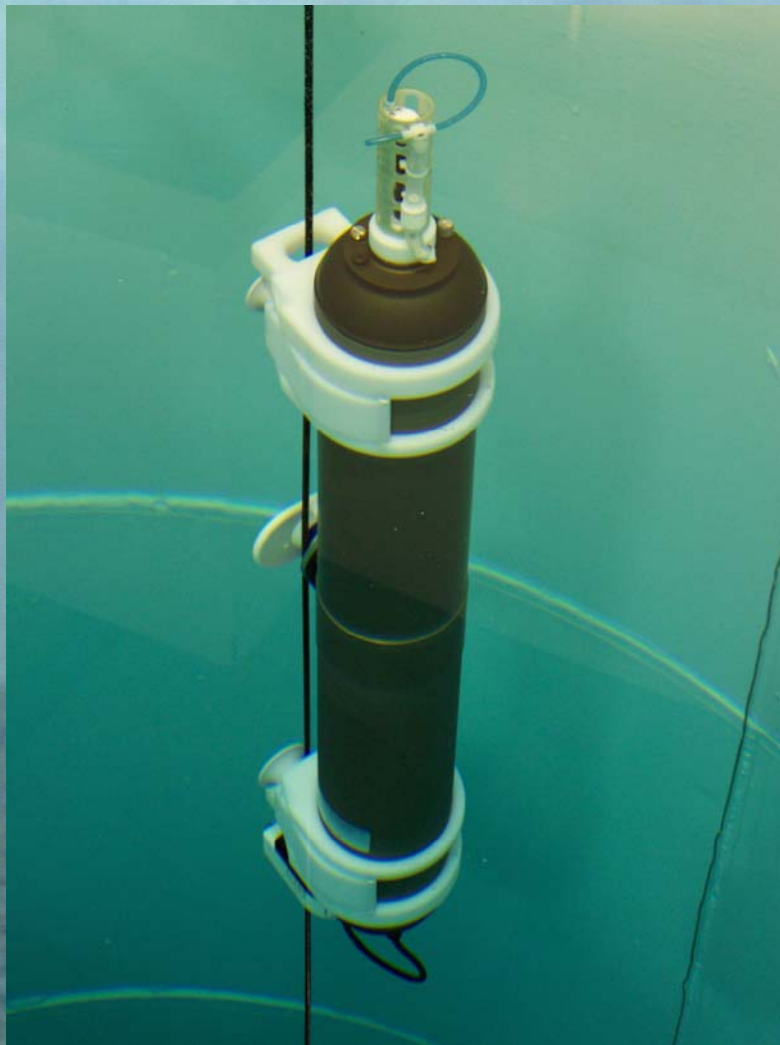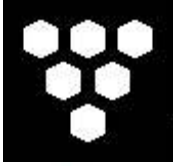# McLane ITP

User Manual

McLane Ice Tethered Profiler (ITP)

SHIPPED FROM:
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- **Fax: 508-495-3333**
- **Phone: 508-495-4000**
- **Internet: http://www.mclanelabs.com**

ITP User Manual Revision History:

October 2007	Rev A

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Chapter 1
Ice Tethered Profiler (ITP)

This manual describes assembling, maintaining, and deploying the Ice Tethered Profiler (ITP), an autonomous time-series instrument that vertically profiles the water column and collects *in situ* data at known locations. Review this manual before using the ITP for the first time.
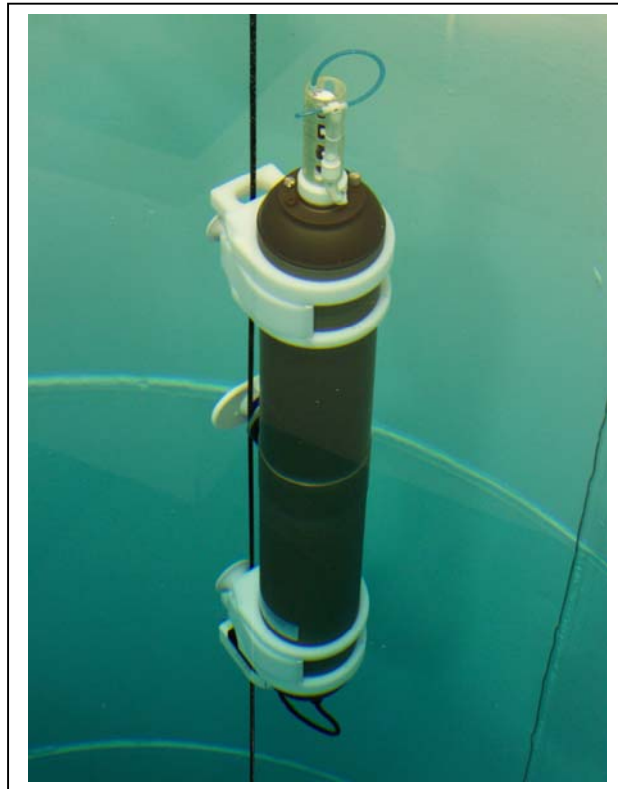
Figure 1-1: ITP with a Sea-Bird 41CP CTD

ITP Overview

The ITP can be deployed as a stand-alone profiler or used as an integral component of the Woods Hole Oceanographic (WHOI) Ice Tethered Profiling System when combined with a surface electronics package. The ITP technology is licensed from WHOI. When used with a surface controller, the ITP returns daily (near real-time) high-vertical resolution measurements of ocean temperature and salinity.

The ITP anodized aluminum housing is designed to be a buoyant hull similar to the ARGO float. A drive train moves the ITP along a mooring cable continuously collecting data according to an operator-programmed schedule to a maximum depth of 1,000 meters. Depending

on profiling settings and installed sensors, the ITP has sufficient battery life for a multi-year deployment.

Sensors

Currently, the ITP is fitted with a SeaBird 41CP CTD with or without Integrated Dissolved Oxygen (IDO). The SeaBird Underwater Inductive Modem (SBE44) is optional and is used for transmitting data. The ITP can also be customized with other sensors.

ITP Line Drawing

The Line Drawing in Figure 1-2 and the Specifications List that follows illustrate ITP mechanical design and construction.

NOTE
The CTD is integrated with the ITP end cap. The end cap and CTD electronics must be returned as a unit for calibration or repair.

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CTD

Cable Retainer

Guide Wheel

Drive Motor

Electronics

Lithium Battery Pack

Guide Wheel

Cable Retainer

Inductive Coil
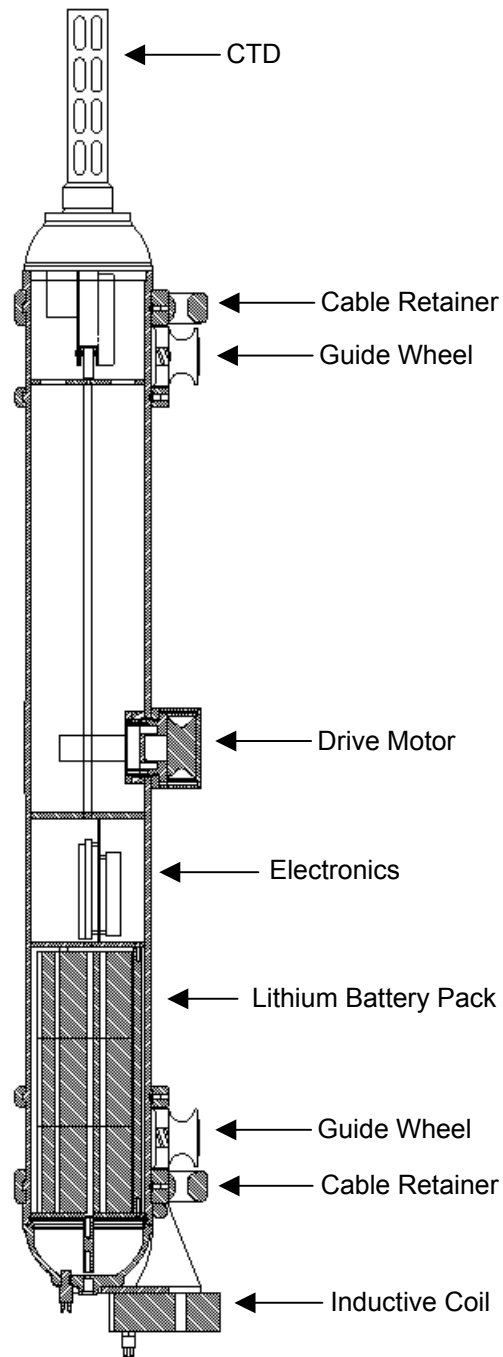
Figure 1-2: ITP Line Drawing

Specifications

Dimensions	171 cm (long) x 26 cm	Max Diameter (cm)
	67 in (long) x 10 in	
	(fits through an 11 inch ice hole)	
Weight	28 kg (61 lbs)	In air, w/Senso
	(neutrally buoyant)	In water
Depth Rating	1,000 meters	Max Depth
Temp Rating	–35°C	Min Temperature
Data Telemetry	SBE 44 UIM or IMM at 1200 bps	
Data Storage	Compact flash backup data storage	
Battery Endurance	240Ah or 360Ah lithium battery pack	
Profiling Speed	25cm/sec	
CTD Data Acquisition	~ 2 Hz (SBE 41CP)	
Power Requirement	120 mA	Profiling
	300 μA	Sleep
Pressure Housing	Anodized aluminum	
Drive Wheel	Urethane-coated titanium	
Guide Wheels	Ertalyte	

Electronics and Firmware

The ITP uses the same drive train, electronics and inductive modem technology as the McLane Moored Profiler (MMP). The ITP controller is a three board stack powered by a 240Ah or a 360Ah lithium battery pack. ITP firmware components are further described below.

Component	Description
Top Circuit Board	The top circuit board is a Persistor CF8Y2 with a 512MB compact flash card for data storage.
Middle Circuit Board	The middle circuit board is the Tattletale 8 Micro-Controller (TT8V2) that controls power and communications for the ITP.
Bottom Circuit Board	The bottom circuit board is the McLane ITP interface board. This board supports peripheral components such as the motor, CTD, power distribution, and independent watchdog circuit.
Communication Link	The communication link between the firmware and a PC is a standard, 3-wire, full duplex, RS-232 connection passing primarily ASCII text bytes. The 5-pin connector is also used for Underwater Inductive Modem (UIM) communications.

Drive Motor and Sensors

Component	Description
Drive Motor	The drive motor provides smooth steady ascent and descent at 25 cm/sec with a control interface of three DIO lines. One DIO line sets the motor direction (upward or downward profiling). The second line enables or disables the motor and sets the brake. The third DIO line is programmable (free wheel or profile). During free wheel, the motor is not driven by the battery and offers no resistance (other than friction) to external torque. The motor is automatically set to free wheel during launch to reduce slip related wear of the drive wheel.
Sensors	The primary ITP sensor is a Seabird 41CP Conductivity-Temperature-Depth Sensor (CTD) which is integrated into the ITP end cap and cannot be removed. One measurement each of conductivity, temperature, and depth is logged in each record. The TT8v2 communicates with sensors through a dedicated RS-232 serial port. When profiling is complete, logging stops and data is transferred to the flash card via inductive modem to the surface controller.

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Contacting McLane Research Laboratories

McLane Research Laboratories can be accessed via the Web at http://www.mclanelabs.com or reached by email at mclane@mclanelabs.com. The firmware also displays McLane contact information.

```
 McLane Research Laboratories, Inc.
 Falmouth Technology Park
 121 Bernard E. Saint Jean Drive
 East Falmouth, MA 02536, USA

 Tel:    (508) 495-4000
 Fax:    (508) 495-3333
 Email:  mclane@mclanelabs.com
 WWW:    http://www.mclanelabs.com

 Software version:  MMP-4_05.c
 Compiled:          Apr 20 2007 16:23:30
 Profiler S/N:      ML12345-01D
```

Additional Resources

A Preparation and Assembly video is included with the ITP. This instructional video shows the steps required for final ITP assembly, mooring line installation, and deployment.

McLane Research Laboratories also offers training at our facility where participants conduct trial deployments and work directly with members of the McLane engineering staff. Conducting trial deployments is a beneficial way to learn system operations before actual field investigations. For more information refer to http://www.mclanelabs.com.

Notes

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Chapter 2
Predeployment Assembly

Before deploying the ITP, steps are required to install and connect the battery, connect the electronics and seal the end caps. Procedures for completing these steps are in the sections that follow. This chapter provides steps for configuring the firmware and verifying settings for the Sea-Bird 41CP CTD end cap sensor. Additional notes about the 41CP CTD sensor are also included. More information is also available from Sea-Bird Electronics (www.seabird.com).

Figure 2-1: Assembled ITP

NOTE
Refer to the Puck and Par Sensors Appendix in this User Manual for additional assembly information if these sensors are installed on the ITP.

ITP Toolkit

The ITP comes with a toolkit that is useful for assembling, disassembling and servicing the profiler. The toolkit contains spare parts and tools including:

- Wrenches, screwdrivers, and ball-hex drivers sized for the required hardware.
- Spare pressure housing o-rings, nylon and stainless steel screws and bolts.
- Communications cable for serial port connection to a PC.
- CD containing documentation, Crosscut software, and programs for data processing.

- DVD containing an instructional video that demonstrates ITP predeployment assembly, mooring line installation and deployment.

Integrated CTD Sensor Endcap

IMPORTANT
The Sea-Bird 41CP CTD is integrated with the ITP end cap and cannot be removed. Consult Sea-Bird before disassembling any of the CTD electrical or mechanical components

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Installing the Battery into the Battery Holder

Connecting and disconnecting the main battery switches the ITP on and off. Before connecting to the electronics, install the battery pack into the battery holder by completing the following steps:

1. Remove the plastic insulator and lead ballast plates from the battery holder.

2. Place the battery between the three battery tie rods, over the plastic spacer.

3. Orient the battery wires to fit into the cutout in the electronics mount plate.

Figure 2-2: Battery Installed in Battery Holder
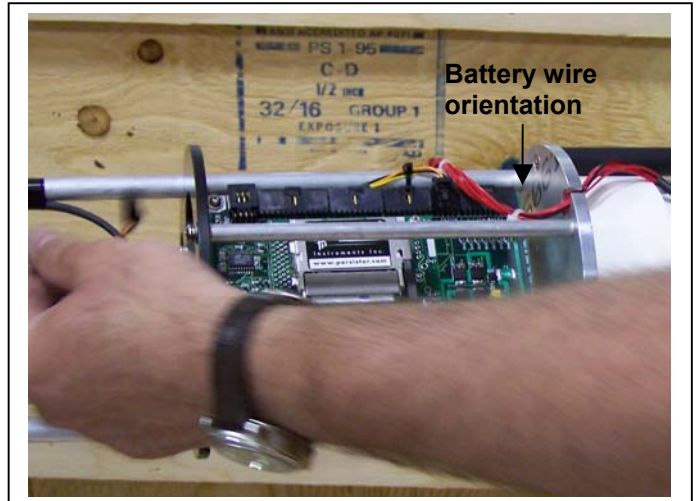
Figure 2-3: Orient Battery Wires

4. Place the plastic insulator on the battery and install the lead ballast plate.

Figure 2-4: Plastic Insulator

Figure 2-5: Lead Ballast Plates

5. Secure the bottom battery plate with screws.
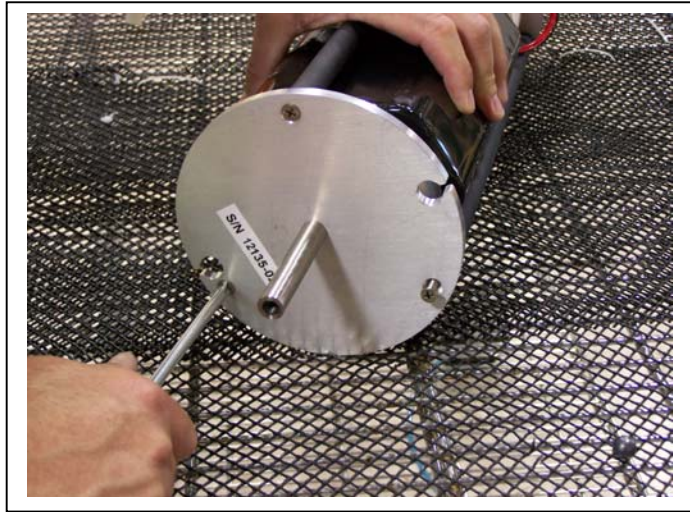
Figure 2-6: Securing the Battery Holder Bottom Plate

Connecting to the Electronics

Due to the ITP design, the battery, UIM/COM, drive motor and CTD cables must be connected to the electronics as the chassis is installed into the controller housing.

Connecting the Battery and Putting the Firmware to Sleep

The battery must be connected and the ITP firmware placed in sleep mode before the electronics is inserted into the ITP. Connect the battery by completing the following steps:

1. Boot the PC and start Crosscut.

2. Plug the COM cable into the connector on the bottom end of the chassis.

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3. Plug the main battery connector into a BATTERY port on the controller board.
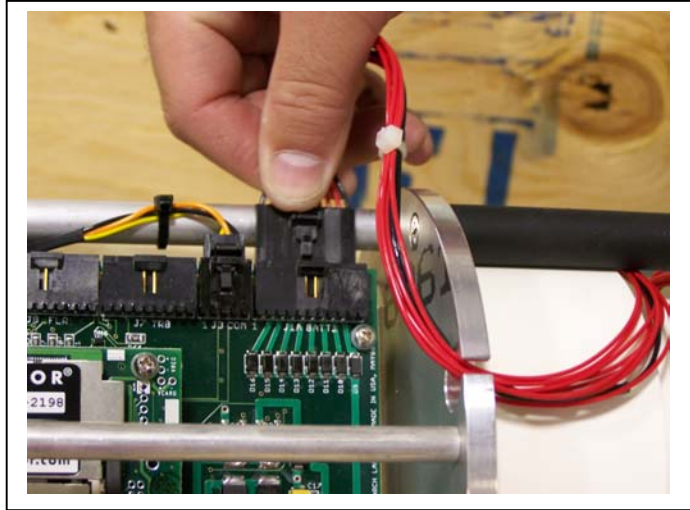
Figure 2-7: Connecting the Battery

4. Follow the instructions on the Crosscut screen to put the ITP to sleep, and then disconnect the COM cable.

Installing the CTD and Top End Cap

After the battery is connected, the electronics chassis and battery holder must be installed into the controller housing. The drive motor is also connected while sliding the electronics into the controller housing. To install the electronics chassis and connect the motor, complete the following steps:

1. Confirm that the desiccant packet is in place to absorb moisture near the plastic spacer, just below the battery and battery holder rods.
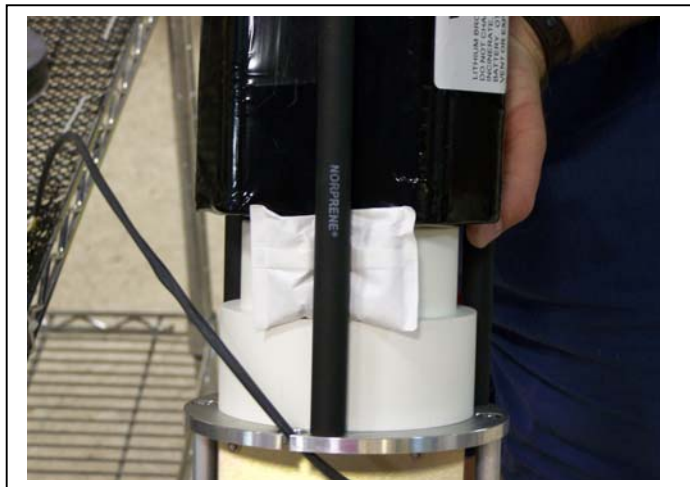
Figure 2-8: Desiccant Packet

2. Position the connecting rods on opposite sides of the drive motor and when the wires are within reach, plug the 2-pin drive motor connector into the main circuit board.
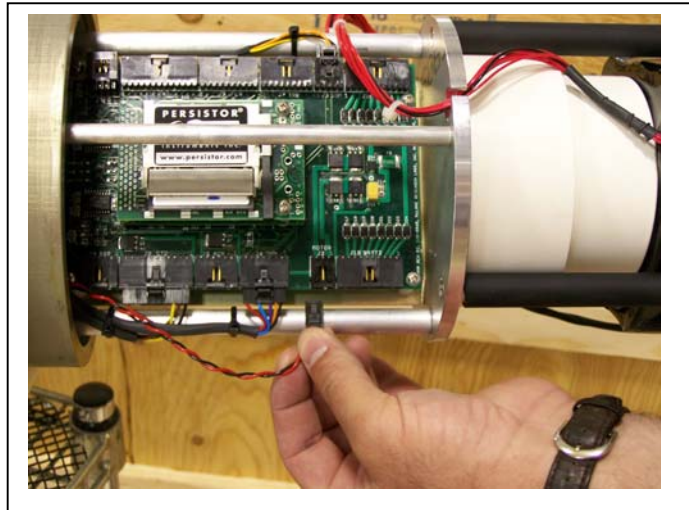
Figure 2-9: Connect 2-Pin Drive Motor

Figure 2-10: Slide in Electronics Chassis

Figure 2-11: Secure Retaining Ring

3. Slide the electronics all the way into the housing and secure the retaining ring.

4. Thread the CTD cable through the top connecting plate and secure with two ¼-20 socket cap screws.
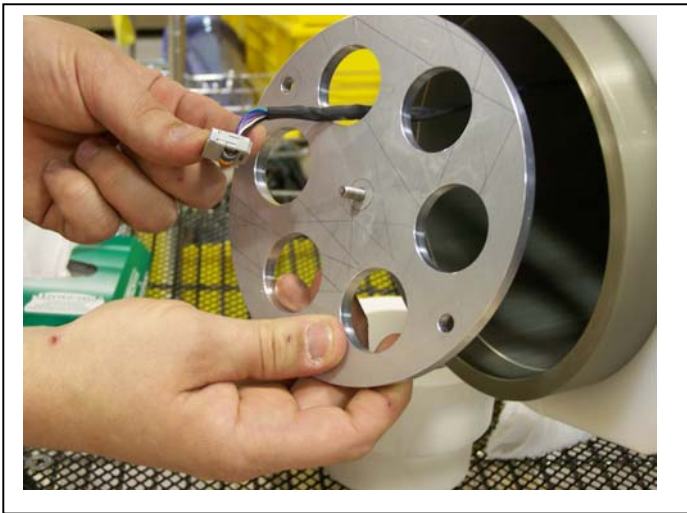
Figure 2-12: Thread CTD Cable

Figure 2-13: Secure Top Connecting Plate

5. Check the seal on the CTD cap.
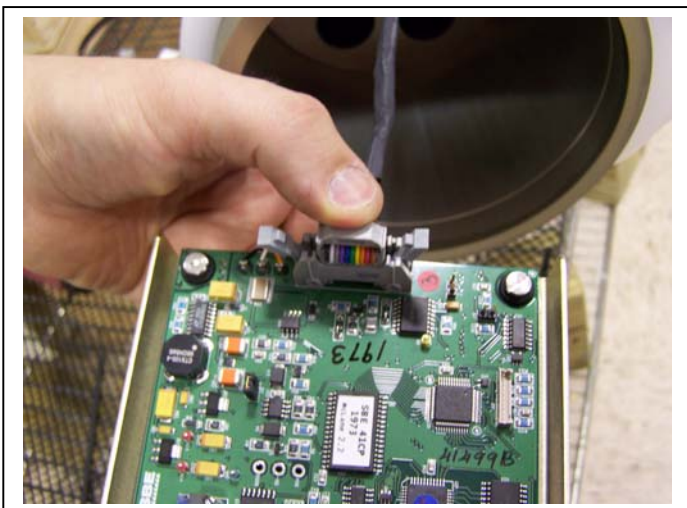
Figure 2-14: Connect CTD Cable
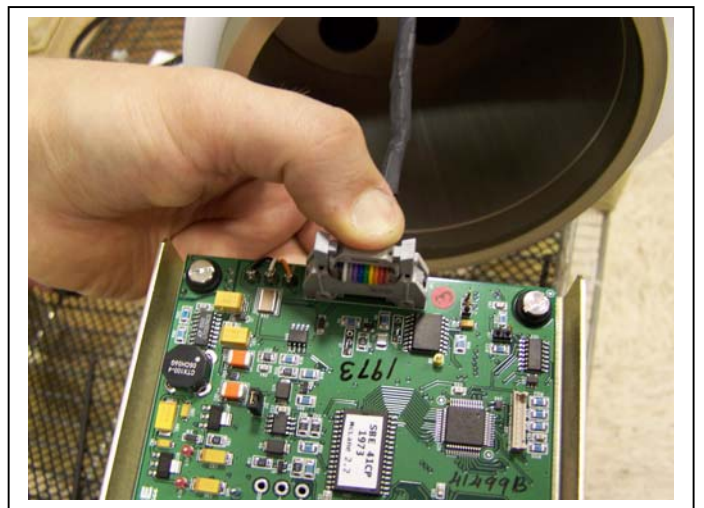
6. Press the CTD cable onto the connector on the CTD circuit board (the side clips will 'close').

7. Slide the CTD electronics into the controller housing.

Figure 2-15: Slide in CTD Electronics   Figure 2-16: Tighten Cap into Stud

8. Center the end cap in the housing opening, and use a 3/16" long hex driver to secure the cap onto the stud in the center of the connecting plate.

9. Install both top end cap plugs.

Figure 2-17: Install Both Top Plugs

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Installing the UIM and Bottom End Cap

1. Inspect and reseat the o-ring if necessary and plug in the Underwater Inductive Modem (UIM)/COM connector.

Figure 2-18: Inspect and Reseat O-Ring
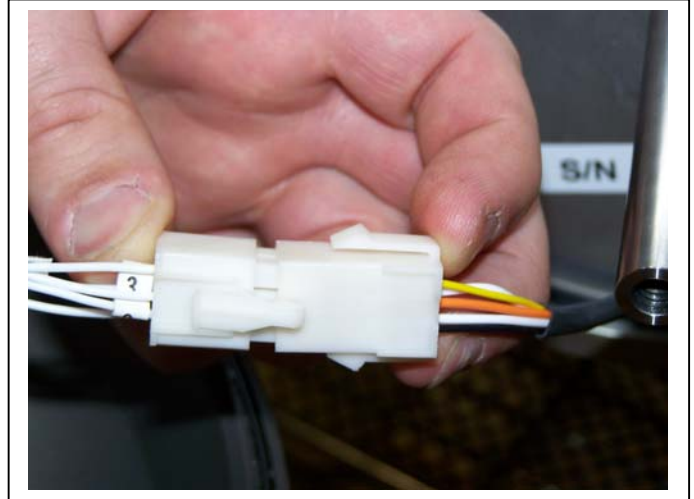
Figure 2-19: Plug in UIM/COM Connector

2. Coil the UIM/COM connector cable inside of the end cap.

3. Position the Inductive Modem in line with the cable guides.

Figure 2-20: Coil UIM/COM Wiring Harness

Figure 2-21: Position Inductive Modem

4. Apply a small amount of anti-seize lubricant to 5/16" socket cap screw.

5. Using a ¼" hex driver, tighten the socket cap screw to center the end caps and compress the top and bottom o-ring seals.

Figure 2-22: Apply Anti Seize Lubricant

Figure 2-23: Tighten Socket Cap Screw

6. If installed, attach the UIM cable from the UIM/COM connector to the coil. Otherwise, install a dummy plug on the connector.

7. Install the bottom end cap plug.

Figure 2-24: Connect UIM Cable

Figure 2-25: Install Bottom Plug

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<table>
<tr><td>IMPORTANT</td></tr>
</table>

Confirm the the bottom plug and both top plugs are installed before deploying the ITP.

Deploying without the plugs in place will flood the ITP housing and damage the electronics.

Configuring the Firmware to Use a Sea-Bird CTD

The System Configuration menu specifies which sensors are enabled. To enable a Sea-Bird 41CP, complete the following steps:

1. From the Main Menu type 'c' and enter the password 'configure'.

2. Select <2> for the 41CP CTD and then select 'Y' to enable the sensor.

3. Select [X] to exit and save the entry.

```
c   Password:  configure

 Synchronizing system configuration files . . . done.


              ┌─────────────────────────────────────┐
              │         System Configuration         │
              └─────────────────────────────────────┘

      System Parameters:
        <E> Nominal Endurance        240 Ah
        <I> Inductive Telemetry      Enabled
        <T> Acoustic Transponder     Disabled
        <C> Inductive Charger Modem  Disabled
        <F> File Deletion            Enabled, size= 60

      Sensor Suite:
        <1> FSI EM        CTD        Disabled
        <2> SeaBird 41CP  CTD        Enabled
        <3> SeaBird 52MP  CTD        Disabled
        <4> FSI 2D        ACM        Disabled
        <5> Nobska MAVS   ACM        Disabled
        <6> SeaPoint      Fluorometer Disabled   (Chlorophyll à)
        <7> Wetlabs       Fluorometer Disabled
        <8> SeaPoint      Turbidity   Disabled   (IR)
        <9> Aanderaa Optode          Disabled
```

Figure 2-26: System Configuration Menu with Sensor Selections

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Verifying 41CP CTD Settings

Settings for the 41CP CTD can be verified from the Bench Test menu in the firmware. To display and verify settings, complete the following steps:

1. From the Bench Test option on the Main Menu, select <1> CTD Communications. The system shows the following display and prompt (S>).

```
SBE 41CP McLane V 1.0
S>
```

Figure 2-27: 41CP CTD Settings

2. Type 'ds' at the prompt to display and verify the CTD settings as shown in Figure D-4.

```
S>ds
SBE 41CP McLane V 1.0  SERIAL NO. 1001

stop profile when pressure is less than = -100.0 decibars

automatic bin averaging when p < -100.0 disabled

number of samples = 0

number of bins = 0

top bin interval = 10

top bin size = 10

top bin max = 100

middle bin interval = 50

middle bin size = 50

middle bin max = 1000

bottom bin interval = 100

bottom bin size = 100

do not include two transition bins
S>
```

Figure 2-28: Verifying 41CP CTD Settings

3. At the next S>prompt, type [CTRL]-[C] to power off the CTD.

4. Type <CR> to return to the Bench Test Menu.

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Additional 41CP CTD Notes

This section provides some additional notes about using the 41CP CTD.

<table>
<tr><td>NOTE</td></tr>
<tr><td>For more in-depth information, refer to the Sea-Bird Electronics website (www.seabird.com) or contact Sea-Bird.</td></tr>
</table>

- Remove the three protective caps (the red plastic cap covers the water intake port and two translucent caps cover the T-shaped water outlet) before operating the CTD in water. The caps protect the cell from contamination by airborne particulates that could coat the cell walls and change sensor calibration.

- The red cap is attached to a TC Duct which ensures that the water sensed by the temperature sensor is the same water that passes through the cell. The effect optimizes the coordination of the T and C measurements so that salinity and density can be correctly determined.

- Test the CTD sensors with a closed loop of tubing connecting the intake and exhaust ports.

- Sensor orientation is important. The 41CP is deployed with the sensor pointing upward to ensure that the U-shaped water path can fill with water.

Flush the cell before and after deployment with a dilute solution of Triton X-100 (approximately 1 part Triton to 50 parts deionized water) to help keep the cell clean and facilitate wetting of the conductivity cell electrodes.

Attaching to the Mooring Wire

To attach to the mooring wire the cable retainers must be removed and the protective caps taken off of the CTD. If using the UIM, the front of the inductive coil must be also removed.

NOTE
Refer to the ITP instructional DVD (included with the toolkit) for a guided overview of attaching to the mooring wire.

IMPORTANT
The inductive modem (IM) core is free to rotate for self-alignment, and is therefore slightly loose. Handle this movable part carefully to ensure that it remains in the body.
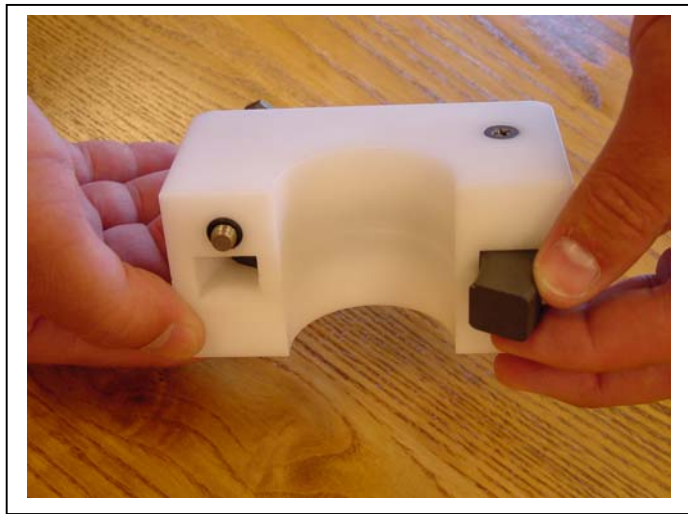
Figure 2-29: Inductive Modem Core

Each cable retainer contains four socket cap screws that can be removed using a 5/16" hex driver. The front of the inductive coil can be removed using a 3/8" nut driver. Once the cable retainers (and front of the inductive coil) are removed, thread the mooring cable through the two guide wheels and the drive wheel. Reattach the cable retainers (and the front of the inductive coil).

IMPORTANT
The minimum mooring tension for the ITP is 113kg (250lb).

Notes

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Chapter 3
ITP User Interface

This chapter describes the firmware menus, commands and screens in MMP 4.X firmware versions. The ITP shares the same firmware as the McLane Moored Profiler (MMP), however, fewer menus and screens are needed to program the ITP. Before programming a deployment, it is helpful to understand these concepts:

- Power Up Sequence

- Re-booting the System

- System Prompts and Key Combinations

- Using the File Capture Utility

IMPORTANT
The 4.X firmware operates only on the Rev D board. The message in Figure 3-1 is displayed during firmware initialization if the firmware is installed on an incompatible electronics board.

```
 ****************************************************************
 WARNING: This software is intended to run on a Rev-D MMP board!
 Your current configuration indicates you are using a Rev-C board.

 If you are not using a Rev-D board this firmware will not operate
 properly!
 If you are using a Rev-D board please configure the board revision!
 ****************************************************************
```

Figure 3-1: Electronics Board Configuration Error Message

Power Up Sequence

When the main lithium battery pack is connected to the BATTERY 1 or BATTERY 2 connector on the motherboard, the micro-controller automatically loads the firmware into the TT8v2 RAM. Several steps occur during the power up sequence.

1. Initialization:
   - The firmware initializes the TT8V2 and the CF8V2 and confirms that the controller and compact flash card are functioning. If no flash card is detected, flash card operations are disabled.
   - Initialization begins a 30 second countdown.

- Type [CTRL]-[C] to gain control of the firmware. If the countdown is uninterrupted, the Unattended Reset, Autonomous Operation (URAO) attempts to restart the deployment (for more details see "Watchdog Reset Test Example" in this chapter).

2. Activating the Watchdog circuit:

   - The watchdog circuit is activated. A warning displays if a problem is detected. Typing 'w' or 'W' at the Main Menu manually triggers watchdog activation.

3. Sizing the flash card:

   - The storage capacity of the flash card and the number of data files that can be accommodated are displayed.

4. Setting the real time clock (RTC):

   - Set the real time clock (RTC) by entering the date and time (MM:DD:YY:MM:SS) and pressing Enter. The watchdog clock (WDC) is automatically synchronized to the RTC.

5. Displaying profiling history:

   - Motor hours and estimated meters traveled (stored in EEPROM) are displayed during the power-up sequence.

6. Loading deployment definition parameters:

   - Current deployment definition parameters are loaded from the EEPROM. The deployment parameters are recorded in the EEPROM and on the flash card whenever a deployment begins. The stored parameters are also used by the URAO utility to restart a deployment.

7. Recovering stored deployment definition parameters:

   - Recovery of the stored parameters completes the power-up sequence.

A typical power up sequence is shown in Figure 3-2.

```
MMP-4_04


McLane Moored Profiler operator interface.

The MMP operating system is initialized
and running.

Type <CTRL>-<C> within 30 seconds to
assert operator control and complete
system initialization.


30 seconds
29 seconds
28 seconds
27 seconds
26 seconds

Independent system watchdog successfully initialized.
Watchdog alarm IRQ has been activated.

Sizing flash card (~2 seconds / 100 Mbytes) . . . done.

521.347 Mbyte flash card installed
520.454 Mbyte currently free

File system can accommodate  4080 data files


Clock reads 01/01/1970 00:00:08
Change time & date (Yes/No) [N] ? y

Enter date as MM DD YY HH MM SS
Enter year 2001 as 1, 01, 101, or 2001

Enter correct time [01/01/1970 00:00:13] ? 03/21/07 09:45:00

Clock reads 03/21/2007 09:45:00
Change time & date (Yes/No) [N] ? n

Setting watchdog clock . . . done.

Profiling history:
  Total motor hours:                      59.31 hours
  Total meters traveled:                 125944 meters
```

Step ❶ System initialization countdown

Step ❷ Watchdog activation

Step ❸ Flash card sizing

Step ❹ Setting RTC

[ENTER] sets RTC

System syncs WDC

Step ❺ Profiling history

Figure 3-2: Power Up Sequence

Re-Booting the System

The power-up sequence does not repeat unless the firmware is re-booted. Execute a "cold" re-boot by disconnecting the power and then reconnecting it after 5 to 10 seconds to allow capacitors to fully discharge. Execute a "warm" re-boot, which will not reset the RTC, by exiting the firmware to the TT8v2 monitor (TOM8) and then manually re-starting the program.

Prompts and Key Combinations

The following information describes prompts and frequently used key combinations:

- Upper and lower case alphabetic characters are used for most prompts, however, the password prompt to exit to the monitor is case sensitive.

- Select the default choice for many prompts by pressing [ENTER]. If a default is available, the value is displayed at the end of the prompt in square brackets.

- Prompts for numerical values accept only numbers that fall within a displayed range. When an out of range or otherwise unacceptable entry is made the operator is re-prompted.

- Prompts for alphanumeric input accept only characters from the displayed list. Unrecognized characters cause an operator re-prompt.

- [CTRL]-[C] terminates the current operation and returns to the Main Menu.

- [CTRL]-[C] terminates a deployment after the profiler is recovered. The firmware completes any critical steps, such as terminal data storage operations, and returns to the Main Menu.

- [CTRL]-[C] wakes from low power sleep.

Using the File Capture Utility

Use the file capture utility within the communications program to log interactions with the firmware. A complete record of the deployment programming steps can be invaluable during data analysis or troubleshooting.

Powering Down the Firmware

To power off the firmware, complete the following steps:

1. From the Main Menu select 'Sleep'.
2. Disconnect the main lithium battery pack.

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<table>
<tr><td style="background-color:yellow">IMPORTANT</td></tr>
<tr><td>Do not disconnect power to stop a deployment. Powering down during deployment may corrupt open data files.</td></tr>
</table>

The Main Menu - Operating the Firmware

The MMP Main Menu displays after firmware initialization. This menu controls all firmware operations. This section of the manual describes the menus and options. To select an option, type a key and press [ENTER].

<table>
<tr><td style="background-color:lightgreen">NOTE</td></tr>
<tr><td>The ITP shares the same version 4.x firmware as the McLane Moored Profiler (MMP).</td></tr>
</table>

```
                McLane Research Laboratories, USA
                     McLane Moored Profiler
               Version: MMP-4_05  S/N: ML00000-00D

              ┌────────────────────────────────────┐
              │             Main Menu               │
              └────────────────────────────────────┘

                    Wed May  2 15:02:15 2007


         <1> Set Time        <5> Bench Test
         <2> Diagnostics     <6> Deploy Profiler
         <3> Flash Card Ops  <7> Offload Deployment Data
         <4> Sleep           <8> Contacting McLane
         <C> Configure

           Selection  ?
```

Figure 3-3: Main Menu (firmware version 4.05)

<table>
<tr><td style="background-color:lightgreen">NOTE</td></tr>
<tr><td>Typing 'O' at the Main Menu displays a hidden option to view Profiling history. This information also displays when <6> Deploy Profiler is selected. Profiling history is listed as motor hours and meters traveled.</td></tr>
</table>

```
Profiling history:
      Total motor hours:                    59.31 hours
      Total meters traveled:              125944 meters
```

Figure 3-4: See Profiling History from Main Menu

<1> Set Time

This option sets the real time clock (RTC). The watchdog clock (WDC) is automatically synchronized to the RTC. Range is 1970 to 2038. Valid separators are colon (:), space, or slash (/)

IMPORTANT

Set the RTC during the power-up sequence. When the profiler is powered on, the clock defaults to January 1,1970, 00:00:00. Set the clock to any date and time in the allowed range and the count will continue from the new value.

Type '1'
[ENTER]

Type date, time
[ENTER] sets
RTC

WDC
synchronized

```
         Selection  ? 1

Clock reads 11/01/2006 11:53:44

Enter date as MM DD YY HH MM SS
Enter year 2001 as 1, 01, 101, or 2001

Enter correct time [11/01/2006 11:53:45] ? 11/2/2006 11:53:44

Clock reads 11/02/2006 11:53:44
Change time & date (Yes/No) [N] ? n

Setting watchdog clock . . . done.
```

Figure 3-5: Set Time

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<2> Diagnostics

Diagnostics is a scrolling display of status information including the RTC, WDC, battery voltage and motor current (mA). The nominal voltage of the lithium battery pack is 10.8 V. A new battery generates approximately 11.6 V but drops to the nominal value after some use and stabilizes for most of the usable battery life.

A sample Diagnostics display is shown in Figure 3-6. Typing 'X', 'x', or [CTRL]-[C] exits from Diagnostics and returns to the Main Menu. The display can be toggled on and off without leaving Diagnostics by pressing any other key.

```
             Selection  ? 2
 Press any key to pause/continue display, <X> to exit.

 RTC: 11/02/2006 11:53:59   WDC: 11/02/2006 11:53:58   10.8 Vb      0 mA
 RTC: 11/02/2006 11:54:00   WDC: 11/02/2006 11:53:59   10.8 Vb      1 mA
 RTC: 11/02/2006 11:54:01   WDC: 11/02/2006 11:54:00   10.8 Vb      1 mA
```

Figure 3-6: Diagnostics

The battery voltage provides information about the battery. A reading above 11 V indicates a new battery. After the initial high readings, the battery voltage will remain near 10.8 V until ~90% of the available energy in the battery has been used. Battery voltage near 10.8 V and motor current values near 0mA indicate proper functioning of the sensing circuits on the motherboard, functioning of the analog-to-digital converter chip on the TT8v2, and operation of the SPI bus.

The steady advance of both clocks indicates that they are working. It is unnecessary to precisely synchronize the clocks (a one second offset is typical). An accurate and advancing WDC also indicates that the TT8v2 SPI bus, a critical communications link used by the 68332 CPU to communicate with the watchdog and other devices, is functioning.

IMPORTANT
A reading below 10.0 V indicates that at least 90% of the lithium battery capacity is used and the battery should be replaced before deployment. A battery voltage below 7.5 V indicates all available battery energy is used.

Low battery output voltage triggers operator warning messages. If battery output of the lithium battery is below 10.0 V, a caution message displays during the exit from Diagnostics suggesting battery replacement before deployment.

```
Battery voltage is abnormally low.  Check/replace
main battery pack before deploying system.


Press any key to continue.
```

Figure 3-7: Low Battery Voltage

If the output of the lithium battery is below 7.5 V, a warning message and a single status line displays. Diagnostics automatically terminates and returns to the Main Menu.

```
Main battery is extremely low and should be replaced
before running diagnostics.

RTC: 01/28/2006 16:35:46   WDC: 01/28/2006 16:35:46    6.8 Vb      0 mA


Battery voltage is abnormally low.  Check/replace
main battery pack before deploying system.

Press any key to continue.
```

Figure 3-8: Replace Battery

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<3> Flash Card Ops

Flash Card Ops accesses the files on the flash card through a DOS-like interface called PicoDOS.

```
┌─────────────────────────────────────────────────────────────────────┐
│                      ┌──────────────────────────────┐                 │
│                      │      Flash Card Operations    │                 │
│                      └──────────────────────────────┘                 │
│                                                                       │
│           <1> Flash card size/free                                    │
│           <2> List flash card files                                   │
│           <3> Hex dump profile count                                  │
│           <4> Delete all files                                        │
│           <5> Exchange flash cards                                    │
│           <6> Format flash card                                       │
│           <7> Command line interface                                  │
│           <M> Main Menu                                               │
│                                                                       │
│             Selection  ?                                              │
│                                                                       │
│                                                                       │
└─────────────────────────────────────────────────────────────────────┘
```
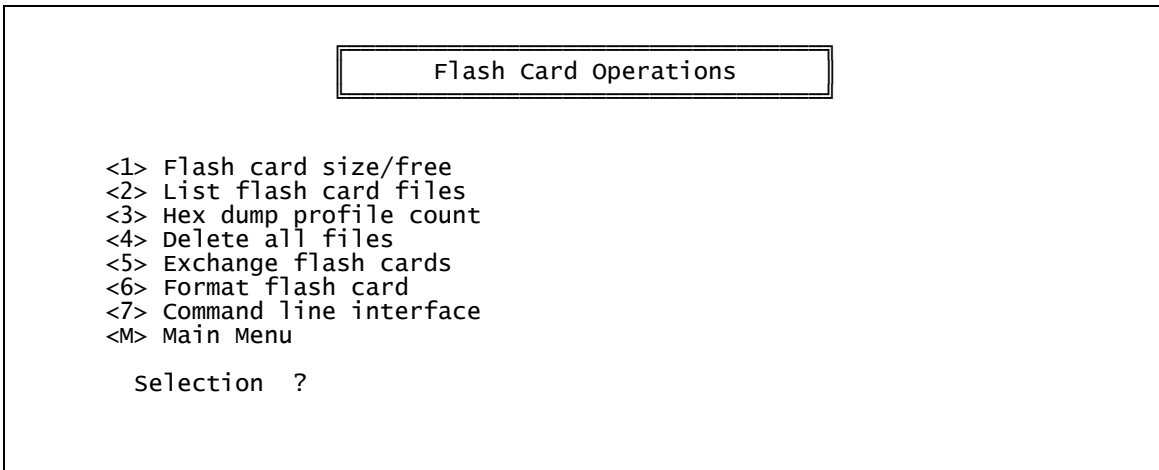
Figure 3-9: Flash Card Operations Menu

IMPORTANT
Use the Flash Card Operations menu carefully. Files can be deleted including the firmware.

Option <1> Flash Card Size/Free

This option measures the total capacity and remaining free space on the flash card and calculates the number of files that can be stored. The firmware reserves space for 16 data files. This number is subtracted from the flash card to obtain the file system accommodation number.

```
      Selection  ? 1

Sizing flash card (~2 seconds / 100 Mbytes) . . . done.

439.329 Mbyte flash card installed
438.698 Mbyte currently free

File system can accommodate  4080 data files


Press any key to continue.
```

Figure 3-10: Sizing Flash Card

NOTE

The DOS file system limits the number of files that can be stored in the flash card root directory to 4096. The 'Profiles per file set' option increases the number of profiles that can be conducted by allowing the storage of multiple profiles as a single data file.

Option <2> List Flash Card Files

This option lists the flash card directory contents. The flash card should contain MMP-N_NN.RUN (the firmware) and AUTOEXEC.BAT, the batch file that calls the firmware when power is applied to the firmware. Additional files in the example that follows are the deployment definition parameters (DEPLOY.DAT), the current profile count (PROFILES.DAT), the log of interrupt requests and other exceptions (IRQ_XCPT.LOG), and the last profile number that completely transmitted via inductive modem (LASTSENT.DAT). These are binary files processed by the on-board offload utility or the high-speed binary data processor. Other files that might be present are the engineering and CTD files from a deployment.

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```
         Selection  ? 2

Directory of A:
AUTOEXEC.BAT               9 11-02-06 11:45
MMP-4_01.RUN         429,894 08-11-06 14:55
DEPLOY.DAT               158 06-28-06 14:54
PROFILES.DAT               4 07-05-06 17:52
IRQ_XCPT.LOG           1,032 07-05-06 17:02
LASTSENT.DAT               4 06-28-06 14:54
E0000000.DAT             976 06-28-06 15:34
C0000000.DAT           3,330 06-28-06 15:33
A0000000.DAT          10,034 06-28-06 15:33
E0000001.DAT             752 06-28-06 15:49
C0000001.DAT           3,253 06-28-06 15:48
A0000001.DAT           9,782 06-28-06 15:48
E0000002.DAT             780 06-28-06 15:55
C0000002.DAT           3,275 06-28-06 15:54
A0000002.DAT           9,854 06-28-06 15:54
E0000003.DAT             752 06-28-06 16:04
```

Figure 3-11: List Flash Card Files

Option <3> Hex Dump Profile Count

This option displays the profile count in hexadecimal notation. In the example below, the profile count is $019F_{hex}$ (414_{dec}), indicating that 415 profiles, numbered 0 through 414, have been conducted and are stored on the flash card.

```
 Selection  ? 3

 LOCATION   CONTENTS
 00000000   0000 0019F

 Press any key to continue.
```

Figure 3-12: Profile Count

Option <4> Delete All Files

This option works like the 'del *.*' (delete all) command in DOS. If the firmware and/or the AUTOEXEC.BAT file are deleted, the profiler cannot be deployed until the files are restored.

```
 This utility will delete all files on the flash
 card, INCLUDING THE SYSTEM CONTROL CODE if it is present.

 Do you wish to continue (Yes/No) [N] ?
```

Figure 3-13: File Deletion Utility

Option <5> Exchange Flash Cards

This option allows a "hot swap" to remove or install a flash card with the firmware powered on. When the swap is complete, the firmware checks for a card, and runs the card capacity routine, or locks out all flash card operations (except flash card exchange) if no card is detected.

Exchange card after ellipsis displays. System pauses. Press [ENTER] _twice_ when card exchange is complete.

```
This utility permits a flash card exchange
 without disconnecting the battery.  Hit any
 key TWICE after the exchange.  The utility
 is reasonably robust, however, if the system
 crashes, simply follow the instructions or          ,
 disconnect the battery, wait 10 seconds, and
 reconnect the battery.                              .

Ready for card change (CS2), hit any key to continue
 ... Card Installed

 Sizing flash card (~2 seconds / 100 Mbytes) . . . done.

 439.329 Mbyte flash card installed
 439.124 Mbyte currently free

 File system can accommodate  4089 data files
 Deployment can include up to 1362 profiles
```

Figure 3-14: Flash Card Hot Swap Utility

Option <6> Format Flash Card

This option formats the flash card. This utility can be used to insure that new cards are compatible with PicoDOS. To do this, boot the profiler with a flash card containing the firmware and AUTOEXEC.BAT. Run the card exchange option and insert the card to be formatted. Run format and then remount the flash card using hot swap a second time.

IMPORTANT
Do not use any Microsoft Windows operating system to format a flash card.

As with the delete option, if the firmware and/or the AUTOEXEC.BAT file are deleted, the profiler cannot be deployed. The files must be restored from the archival backups or CD-ROM.

```
This utility ensures flash card compatibility,
however, running format will erase all files
currently stored on the card, INCLUDING THE
SYSTEM CONTROL CODE if it is present.

Do you wish to continue (Yes/No) [N] ?
```

Figure 3-15: Format Flash Card

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<u>Option<7> Command Line Interface</u>

This option provides a command line for full access to PicoDOS. Before using this option, make a copy of the firmware and AUTOEXEC.BAT.

<table>
<tr><td>**IMPORTANT**</td></tr>
<tr><td>Knowledge of the TT8v2 and PicoDOS are essential to use this option. Incorrectly using the command line interface can corrupt or delete data and program files or alter the firmware and compromise proper operation. As a precaution, backup the firmware and AUTOEXEC.BAT.</td></tr>
</table>

```
          Selection  ? 7

=====  PicoDOS Intrinsic Commands  (plus .RUN and .BAT Files)
=====
COPY        source dest           DATE        (prompts)
DEL         filename              DIR         [file |
wildcards]
ERASE       filename              FORMAT      [/Q][/E][/F]
OPT         [ON|OFF][/P]          TYPE        filename
REN         oldname newname       VER         (PiCoDOS
version)
G           or GO[address]        LO          [ofs][;Bx[+]]
[;G]
MD          [address]             MM          [address]
XS          [/Q][/X][/C]file      XR
[/Q][/X][/C][file]
YS          [/Q][/G]file[,file...] YR         [/Q][/G]
BAUD        [newrate] [/Q]        SAVE        file[start][end]
DUMP        file[start[,end]]     CAPTURE     file[delim] [/N]
BOOT        [PICO][TOM8]          CCC         (card change)
RESET       (hard reset)          TOM8        (exit to TOM8)

 CAUTION:  Some of these commands can erase,
           halt, damage, or hide the system
           program resident in flash memory.

<?>-<ENTER> for list of commands
<CTRL>-<C> to exit

Enter command >>
```

Note the CAUTION → (points to CAUTION block)

'?' redisplays the cmd list → (points to <?>-<ENTER> line)

Returns to Flash Card Ops menu → (points to <CTRL>-<C> line)

Figure 3-16: Command Line Interface

<4> Sleep

The Sleep interface option puts the TT8v2 in Low Power Sleep (LPS) mode to conserve battery power. The TT8v2 is a small fraction of the total battery load (typically <1%, during a profile), however, the TT8v2 remains powered between profiles, and those periods can be long

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enough for the cumulative effect of a small drain (a few milliamps), to be a significant factor in the energy budget of a deployment.

The firmware enters LPS whenever more than 20 minutes elapse without operator input. Prior to LPS the current time displays. During LPS, the firmware wakes every 20 minutes to check status, display the time, and returns to LPS. To wake the firmware from LPS press [CTRL]-[C] three times.

2 keystrokes begins wake-up

[CTRL]-[C] completes wake-up

```
<07/06/2006 15:58:51> Sleeping . . .

  Enter <CTRL-C> now to wake up?
```
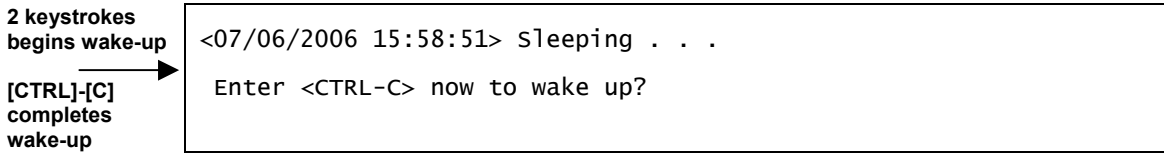
Figure 3-17: Low Power Sleep

<5> Bench Test

Bench Test selections are grouped into 'Sensor Utilities', 'System Evaluation' and 'System Options Tests'.

```
                    ┌─────────────────────────────┐
                    │         Bench Tests         │
                    └─────────────────────────────┘
                       Mon Jan 22 16:46:55 2007


Sensor Utilities:
    <1> CTD Communication        <4> CTD Temperature Record
    <2> CTD Pressure             <5> ACM Communication
    <3> CTD Average Pressure    <6> FSI ACM Tilt and Compass

 System Evaluation:
   <7> Motor Operation          <9> Independent Watchdog
   <8> Brake on.   Change?

 System Options Tests:
   <I> Inductive Telemetry      <F> Chl à Fluorometer
   <P> Acoustic Transponder     <C> CDOM Fluorometer
   <E> Battery Endurance        <T> IR Turbidity
   <S> SIM/UIM Transactions     <U> Power UIM
   <A> Inductive Charger Modem
```

Figure 3-18: Bench Tests Menu

Sensor Utilities

Sensor Utilities assess the operability and performance of the sensors. The CTD bench tests utilities are used for the ITP and are explained in the section that follows.

Option <1> CTD Communication

This is a "pass-through" communications channel to the CTD (the Bench Test echoes the keyboard commands). The screens shown next refer to the Sea-Bird 41CP CTD.

NOTE

For more about the 41CP CTD see the "Sea-Bird 41CP CTD Sensor" appendix in this User Manual.

Verifying 41CP CTD Settings

To use the CTD pass-through utility complete the following steps:

1. From the Bench Test option on the Main Menu, select <1> CTD Communications.

```
SBE 41CP McLane V 1.0
S>
```

Figure 3-19: 41CP CTD Settings

2. Type 'ds' at the prompt to display and verify the 41CP CTD settings (see Figure 3-20).

```
S>ds
SBE 41CP McLane V 1.0  SERIAL NO. 1001

stop profile when pressure is less than = -100.0 decibars

automatic bin averaging when p < -100.0 disabled

number of samples = 0

number of bins = 0

top bin interval = 10

top bin size = 10

top bin max = 100

middle bin interval = 50

middle bin size = 50

middle bin max = 1000

bottom bin interval = 100

bottom bin size = 100

do not include two transition bins

S>
```

Figure 3-20: Verifying 41CP CTD Settings display

3. At the next S>prompt, type [CTRL]-[C] to power off the CTD.

4. Type <CR> to return to the Bench Test Menu.

Option <2> CTD Pressure

Option <2> and Option <3> sample pressure data from the CTD. The CTD pressure measurements are primary inputs to the firmware routines that control each profile. Option <2> starts the CTD, queries for a scan of data, parses the response, displays the result, and shuts down the CTD. An example is shown in Figure 3-21.

```
Applying power to CTD . . . ready.

Pressure =    -0.712 dbar

Press any key to continue.
```

Figure 3-21: Testing Pressure Information

Option <3> CTD Average Pressure

This option can be used to acquire a time series response of the CTD pressure transducer. Option <3> asks for the number of pressure values to average, starts the CTD, queries the requested number of scans, parses the responses, displays the results, calculates and displays the average, and shuts down the CTD. An example is shown next.

Operator requests 3 measurements →
```
Enter number of measurements for average (1 to 5000) ? 3

Applying power to CTD . . . ready.

   -0.523 dbars
   +0.015 dbars
   +0.222 dbars

Average pressure =    -0.095 dbar

Press any key to continue.
```

Figure 3-22: CTD Average Pressure

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Option <4> CTD Temperature Record

This option sets the number and frequency of recording CTD temperature.

```
Enter number of measurements to record (1 to 1000) ? 3
Enter measurement interval [sec]      (1 to  600) ? 8

Temperature record duration:  00:00:16

Applying power to CTD . . . ready.

06/15/2006 15:03:56  +22.2104 °C
06/15/2006 15:04:04  +22.2239 °C
06/15/2006 15:04:12  +22.2084 °C
```

Figure 3-23: CTD Temperature Record

System Evaluation

System Evaluation checks the drive motor, brake, and watchdog circuit.

Option <7> Motor Operation

This option tests the drive motor. The motor direction and duration of the velocity ramp can be controlled for visual verification that the motor is spinning in the proper direction during the test. Use a 30 second ramp duration for a motor with load (a few seconds is sufficient for an unloaded motor). The date, time, motor current, and battery voltage scrolls on the display once the motor reaches full speed. The motor is automatically disabled and the dynamic brake set once the motor is stopped (the motor can be abruptly stopped or a velocity down ramp can be applied).

Default is up →
Motor in air, no load →

Ramp completed, Stop cmds →

Scrolling display begins →

```
Motor direction (Up/Down)       [U] ?
Enter ramp duration [sec] (2 to 60) ? 5

 Beginning start ramp.

 Full speed reached.  Setting low power run mode.
 Monitoring motor current and battery voltage.
 <R> to begin stop ramp.  <CTRL>-<C> to stop and exit.

 11/02/2006 12:00:49   17 mA   10.3 V
 11/02/2006 12:00:50   17 mA   10.3 V
 11/02/2006 12:00:51   17 mA   10.3 V
 11/02/2006 12:00:52   17 mA   10.3 V
 11/02/2006 12:00:53   17 mA   10.3 V
 11/02/2006 12:00:54   17 mA   10.3 V
 11/02/2006 12:00:55   17 mA   10.3 V
 11/02/2006 12:00:56   17 mA   10.3 V
 11/02/2006 12:00:57   17 mA   10.3 V
 11/02/2006 12:00:58   17 mA   10.3 V
 11/02/2006 12:00:59   16 mA   10.3 V
 11/02/2006 12:01:00   16 mA   10.3 V
 11/02/2006 12:01:01   16 mA   10.3 V
 11/02/2006 12:01:02   17 mA   10.3 V
 11/02/2006 12:01:03   17 mA   10.3 V
 Motor disabled.  Brake set.
 Press any key to continue.
```

Figure 3-24: Motor Operation

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Motor currents of 35 to 40mA are typical for an unloaded motor. Currents of 120 to 130mA are expected during a profile where hydrodynamic drag becomes a factor. In the ocean, where horizontal forcing and ballasting contribute, motor currents of 140 to 250mA have been recorded.

Option <8> Brake On/Off Change?

This option toggles the motor between free-wheeling and brake set. The motor will spin freely if 'Off' is selected and will resist external torques if the brake is set to 'On'. The current setting (On/Off) is displayed in the menu selection title.

```
                        ┌─────────────────────────────────┐
                        │         Bench Tests             │
                        └─────────────────────────────────┘
                             Mon Jan 22 16:46:55 2007


        Sensor Utilities:
            <1> CTD Communication       <4> CTD Temperature Record
            <2> CTD Pressure            <5> ACM Communication
            <3> CTD Average Pressure    <6> FSI ACM Tilt and Compass

          System Evaluation:
            <7> Motor Operation         <9> Independent Watchdog
            <8> Brake on.  Change?

          System Options Tests:
            <I> Inductive Telemetry     <F> Chl à Fluorometer
            <P> Acoustic Transponder    <C> CDOM Fluorometer
            <E> Battery Endurance       <T> IR Turbidity
            <S> SIM/UIM Transactions    <U> Power UIM
            <A> Inductive Charger Modem
```

Default sets brake 'on' → (points to `<8> Brake on.  Change?`)

Figure 3-25: Brake On

Select <8> and change Enable Free Wheel to 'Yes' to turn the brake off.

```
                        ┌─────────────────────────────────┐
                        │         Bench Tests             │
                        └─────────────────────────────────┘
                             Mon Jan 22 16:46:55 2007


        Sensor Utilities:
            <1> CTD Communication       <4> CTD Temperature Record
            <2> CTD Pressure            <5> ACM Communication
            <3> CTD Average Pressure    <6> FSI ACM Tilt and Compass

          System Evaluation:
            <7> Motor Operation         <9> Independent Watchdog
            <8> Brake off.  Change?

          System Options Tests:
            <I> Inductive Telemetry     <F> Chl à Fluorometer
            <P> Acoustic Transponder    <C> CDOM Fluorometer
            <E> Battery Endurance       <T> IR Turbidity
            <S> SIM/UIM Transactions    <U> Power UIM
            <A> Inductive Charger Modem
```

Brake selection changes to 'off' → (points to `<8> Brake off.  Change?`)

Figure 3-26: Brake Off

Option <9> Independent Watchdog

This option tests the watchdog circuit. The watchdog circuit is composed of the DS1306 chip, which sends periodic interrupt requests to the TT8v2, and a hardware counter, which can restart the TT8v2 if the IRQ from the DS1306 is not acknowledged.

```
        <1> Test Watchdog IRQ   ( 2 seconds)
        <2> Test Watchdog RESET (68 minutes)
        <B> Bench Tests Menu

          Selection  ?
```

Figure 3-27: Test System Watchdog

The Watchdog IRQ test temporarily resets the DS1306 clock, the Watchdog Clock (WDC), so that the time is 2 seconds before the regularly scheduled watchdog IRQ. The watchdog sends the IRQ when the 2 seconds have expired, the TT8v2 detects the interrupt and acknowledges it, and the firmware, including the WDC, is returned to normal. Failures are detected and reported to the operator. An example is shown next.

WDC rest →

IRQ sent and →
detected

System
restored to
normal
operating
condition

```
Initializing . . . done.

Waiting for IRQ (2 seconds) . . . IRQ detected.

Watchdog IRQ test complete.
Watchdog is functioning normally.
```
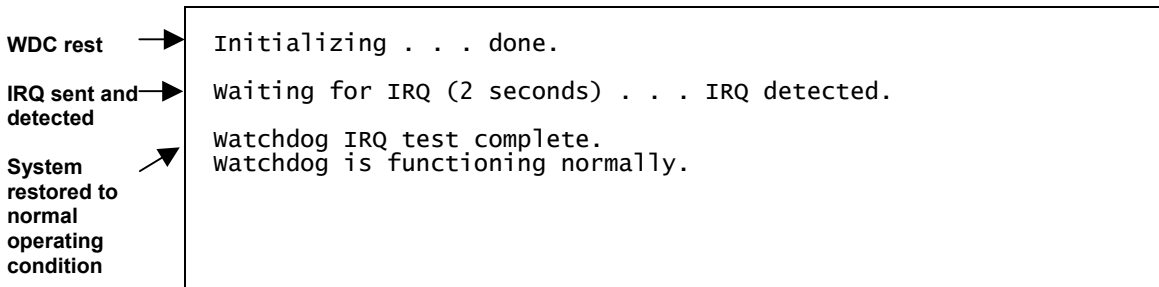
Figure 3-28: Test Watchdog IRQ

The Watchdog Reset test re-programs the watchdog IRQ pin on the TT8v2 so that interrupts from the DS1306 will be ignored, resets the hardware counter to zero and transitions to low power sleep. The counter re-boots the TT8v2 after 68 minutes (4096 seconds). The test will "time out" after 70 minutes if there is no reset and can be stopped manually at any time by typing [CTRL]-[C]. An example of an operator terminated test is shown in Figure 3-29.

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```
        This test verifies operation of the watchdog
        system RESET.  If successful, the system will
        be RESET and operation will proceed as it does
        when power is first applied to the system.
        The RESET will not occur until an interval of
        68 minutes and 16 seconds (4096 seconds) has
        passed.  The test will time out after 70 minutes
        if the RESET hardware fails.  The operator can
        cancel the test at any time by entering three or
        more <CTRL>-<C>s.

        Proceed with test (Yes/No) [N] ? y

        Current time:   02/09/2006 18:36:05
        Expected RESET: 02/09/2006 19:44:21
        Time out:       02/09/2006 19:46:05

        <02/09/2006 18:36:07> Sleeping . . .

        Enter <CTRL-C> now to wake up?

        02/09/2006 18:36:09
         Watchdog RESET test terminated by
         operator before completion.
```

Test timing information →

System enters LPS →

Awakened by operator before test completion →

System restored to normal ↗

Figure 3-29: Test Watchdog Reset

Watchdog Reset Test Example

A Watchdog Reset test in which the operator did not assert control after the re-boot, is shown in Figures 3-30 and 3-31. The test illustrates how the URAO (Unattended Reset, Autonomous Operation) automatically programmed and started a deployment without operator guidance. The firmware worked from a default set of parameters and reconstructed the other information it needed by searching through the files.

```
        This test verifies operation of the watchdog
        system RESET.  If successful, the system will
        be RESET and operation will proceed as it does
        when power is first applied to the system.
        The RESET will not occur until an interval of
        68 minutes and 16 seconds (4096 seconds) has
        passed.  The test will time out after 70 minutes
        if the RESET hardware fails.  The operator can
        cancel the test at any time by entering three or
        more <CTRL>-<C>s.

        Proceed with test (Yes/No) [N] ? y

        Current time:   03/21/2007 15:13:18
        Expected RESET: 03/21/2007 16:21:34
        Time out:       03/21/2007 16:23:18

        03/21/2007 15:13:20 Sleeping  until 03/21/2007 16:23:18 . . .

        03/21/2007 15:33:20 Sleeping  until 03/21/2007 16:23:18 . . .
```

Watchdog IRQ ignored at 1 minute after the hour →

System checks status every 20 minutes during low power sleep →

Figure 3-30: Watchdog Reset URAO (screen 1 of 2)

```
                            03/21/2007 16:13:20 Sleeping  until 03/21/2007 16:23:18 . . .
Watchdog
resets TT8 and
restarts    ──────▶        MMP-4_04
system. Power-
up sequence                 McLane Moored Profiler operator interface.
begins
                            The MMP operating system is initialized
                            and running.

                            Type <CTRL>-<C> within 30 seconds to
                            assert operator control and complete
                            system initialization.
Counter expires ────▶
                            0 seconds
Autonomous
recovery    ──────▶         Setting watchdog clock . . . done.initialization successful.
begins
                            Sizing flash card (~2 seconds / 100 Mbytes) . . . done.
Steps in the  ────▶
recovery                    521.347 Mbyte flash card installed
display as they             519.201 Mbyte currently free
occur
                            File system can accommodate  4080 data files

                            RECOVERED XMIT INDEX - OldestProfileNotXmitted is: 0 . . .

                            RECOVERED XMIT INDEX - OldestProfileStored is: 0 . . .

                            Performing final initialization . . .

                            Unattended Deployment Preparation routine
Deployment                  successfully completed.
continues   ──────▶         Continuing deployment.

                            3/21/2007 16:22:14

                            Initializing CTD logging pointers . . .
```

Figure 3-31: Watchdog Reset URAO (screen 2 of 2)

IMPORTANT
Profiling typically starts less than 3 minutes after connecting the battery. Do not pre-program then connect the battery and launch the ITP later without operator interaction. When the URAO is triggered, it is assumed that the profiler and moooring are in the water and fully deployed.

System Options Tests

System Options Tests check functions of other enabled options such as the underwater inductive modem (UIM). A battery endurance estimate can also be viewed.

Option <I> Inductive Telemetry

This option starts an inductive telemetry session and makes three attempts to communicate inductively by sending a tone. For more information, see "Optional Underwater Inductive Modem (UIM)" in this User Manual.

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```
           Selection  ? i

The inductive telemetry bench test sets up
a SIM/UIM session.  A single CTRL-C will
end the session.
attempt count is at: 1
attempt count is at: 2
attempt count is at: 3
```

Figure 3-32: Inductive Telemetry Session

Option <E> Battery Endurance

This option displays the estimated battery expiration. The estimate is recalculated each time a deployment parameter is changed.

NOTE
The firmware also displays estimated battery expiration when <D>, Deploy Profiler is selected.

```
 Selection  ? e


Endurance  | Power for single profile =         32.7 [mAh]
           | Total profiles/(240 Ah)  =         7269
           | Estimated date           =    03/17/2007 17:03:11
```

Figure 3-33: Estimated Battery Expiration

Option <S> SIM/UIM Transactions

This option creates PROFILES.DAT and LASTSENT.DAT with specified starting values and attempts to send the transactions at the specified wake interval. The appendix "Optional Underwater Inductive Modem" in this User Manual details SIM/UIM communications protocol.

```
             Selection  ? s
Enter sleep interval in seconds (0 to 500000) ? 60
Enter the starting value of LastProfileSent (0 to 7000) ? 5
Enter the starting value of ProfileCount (-1 to 7000) ?  10
   Creating PROFILES.DAT . . .
   Creating LASTSENT.DAT . . .

 SIM/UIM transaction will begin at 10/09/2006 14:36:04

 10/09/2006 14:35:05 Sleeping . . .
Waking and proceeding
attempt count is at: 1
attempt count is at: 2
attempt count is at: 3

 SIM/UIM transaction will begin at 10/09/2006 14:39:07

 10/09/2006 14:38:09 Sleeping . . .

 Enter <CTRL-C> now to wake up?
```

Figure 3-34: SIM/UIM Transactions

Option <U> Power UIM

This option switches the Underwater Inductive Modem (UIM) on and off.

```
  Selection  ? u

 Power UIM off (Yes/No) [Y] ? y
```

Figure 3-35: Power UIM On/Off

Option <C> Configure

The System Configuration menu contains system parameters and sensor selections. This menu prevents sensor selections that are mutually exclusive. Confirm that the correct sensor and parameters are configured and if using the Inductive Modem to transmit data, confirm that Inductive Telemetry is 'Enabled'.

```
                    ┌─────────────────────────────────────┐
                    │         System Configuration        │
                    └─────────────────────────────────────┘
         System Parameters:
           <E> Nominal Endurance          240 Ah
           <I> Inductive Telemetry        Enabled
           <T> Acoustic Transponder       Disabled
           <C> Inductive Charger Modem    Disabled
           <F> File Deletion              Enabled, size= 60

         Sensor Suite:
           <1> FSI EM          CTD        Disabled
           <2> SeaBird 41CP    CTD        Enabled
           <3> SeaBird 52MP    CTD        Disabled
           <4> FSI 2D          ACM        Disabled
           <5> Nobska MAVS     ACM        Disabled
           <6> SeaPoint        Fluorometer Disabled    (Chlorophyll à)
           <7> Wetlabs         Fluorometer Disabled
           <8> SeaPoint        Turbidity  Disabled     (IR)
           <9> Aanderaa Optode            Disabled

Disabling alternate CTDs.
```

Mutually exclusive selections are prevented →

Figure 3-36: System Configuration Menu

NOTE
Battery energy is used to calculate the estimated battery expiration. The battery energy used in the calculation can be changed by selecting <E>. The L24-1000 battery has 240Ah of battery energy. The L12-1733 battery has 120Ah of battery energy.

```
 Selection  ? e
The battery energy is: 240 Ah
Enter nominal battery endurance [Ah] (10 to 1000) ? 500
```

Figure 3-37: <E> Change Nominal Battery Endurance

<6> Deploy Profiler

This option provides the interface for programming the deployment. The deployment parameters are stored in EEPROM (and on the flash card in non-volatile storage) and loaded at firmware startup. The parameters also reside in RAM and will be unchanged if the battery remains connected. When 'Deploy Profiler' is selected, the firmware completes an initialization and then displays settings that define the profiling behavior.

NOTE
The ITP shares the same version 4.x firmware as the McLane Moored Profiler (MMP).

Initialization

During deployment initialization the firmware does the following:

Step 1 – Checks for successful firmware initialization.

Step 2 – Prompts to set the RTC (real-time clock).

Step 3 – Displays the profiling history for informational purposes.

Step 4 – Verifies CTD settings (automatic, manual, or skip).

Automatic sensor verification confirms that the standard CTD settings have been programmed into the sensor EEPROMs. This sensor "roll call" detects whether the configured CTD is installed, and changes the configuration if a different sensor is found. During roll call, if the configured CTD is not found but an alternate is found, the firmware reconfigures the settings based on the detected sensor. If a configuration change is made, the firmware prompts the operator to re-run sensor verification. If no CTD is found or if the detected sensor matches the Configuration, the system makes no Configuration change. If a sensor problem is detected, a warning will be displayed and the firmware will terminate the deployment.

Manual sensor verification establishes pass-through communications channels to the sensors, allowing the operator to verify (and change), the CTD settings.

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The data offload utility and the Unpacker work only with binary files created using standard sensor settings. Also, some combinations of non-standard settings can inhibit data collection during a deployment. Contact McLane before attempting to use non-standard sensor settings.

An example of the initialization sequence is shown in Figures 3-38 and 3-39 with automated sensor verification, and a Sea-Bird 41CP CTD.

```
              McLane Research Laboratories, USA
                    McLane Moored Profiler
               Version: MMP-4_05  S/N: ML12345-00D


              ┌─────────────────────────────────────┐
              │             Main Menu               │
              └─────────────────────────────────────┘
                     Fri May 11 09:07:31 2007

              <1> Set Time         <5> Bench Test
              <2> Diagnostics      <6> Deploy Profiler
              <3> Flash Card Ops   <7> Offload Deployment Data
              <4> Sleep            <8> Contacting McLane
              <C> Configure

                 Selection  ? 6

    Clock reads 05/11/2007 09:07:37
    Change time & date (Yes/No) [N] ?

    Setting watchdog clock . . . done.

    Profiling history:
      Total motor hours:                   0.02 hours
      Total meters traveled:                  0 meters

    Verification of sensor settings

    <A> Automated (standard settings only)
    <M> Manual    (operator controlled)
    <S> Skip Verification

     Selection  ? a

    Automated verification of sensor settings.

     Applying power to CTD . . .
     Starting verification . . .

    SBE 41CP McLane V 2.2

    S>

     Sending command  initprofile

    S>

     Expected response received.
     Proceeding to next command.

     Sending command  ds
```

Step ❷
Step ❸
Step ❹

Figure 3-38: Deployment Initialization (screen 1 of 2)

```
 SBE 41CP McLane V 2.2  SERIAL NO. 1972

stop profile when pressure is less than = -100.0 decibars

automatic bin averaging when p < -100.0 disabled

number of samples = 0

number of bins = 0

top bin interval = 10

top bin size = 10

top bin max = 100

middle bin interval = 50

middle bin size = 50

middle bin max = 1000

bottom bin interval = 100

bottom bin size = 100

do not include two transition bins

S>

 Expected response received.

 Standard CTD settings verified.


 Sensor suite initialized and ready for deployment.

 Press any key to continue.
```

Figure 3-39: Deployment Initialization (screen 2 of 2)

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Programming a Deployment

When deployment initialization is complete, the Deployment Menu displays. The menu re-displays after each change.

```
ID        M| Mooring ID             = 001

Start     Z| Scheduled start        =    05/11/2007 09:40:00

Schedule  I| Pair start interval    = 000 00:20:00 [DDD HH:MM:SS]
          R| Reference date/time    =    05/11/2007 09:10:00
          B| Burst Interval         =      Disabled
          N| Pairs per burst        =      Disabled
          P| Paired profiles             Enabled
          F| Profiles / file set    =             1

Stops     S| Shallow pressure       =           1.5 [dbar]
          D| Deep pressure          =          11.7 [dbar]
          H| Shallow error          =           1.0 [dbar]
          E| Deep error             =           1.0 [dbar]
          T| Profile time limit     =      00:01:30 [HH:MM:SS]
          C| Stop check interval    =             2 [sec]
          L| Fluorometer            =      Disabled
          O| OBS Turbidity          =      Disabled

Endurance  | Power for single profile =         5.4 [mAh]
           | Total profiles/(240 Ah)  =       43550
           | Est. battery expiration  =  03/08/2008 20:00:00

Deploy    V| Verify and Proceed
```

Figure 3-40: Deployment Menu (firmware version 4.05)

Deployment parameters are grouped on the display by general function: Mooring ID, Start, Schedule, Stops, Endurance and Deploy. The Start parameters (countdown delay or specific date and time) control the start time of Profile 0 (Dive 0). The ITP executes Profile 0 to move to the bottom stop. The Start setting provides time to launch the ITP and set the mooring before profiling begins.

A Quick Reference overview of each deployment parameter is provided next. More detailed descriptions of the deployment parameters follow the Quick Reference.

Profiler Deployment Definition Parameters

Quick Reference

Mooring ID: Three position numeric identifier (001 to 999) sent with UIM metadata (stored with deployment data in the URAO). Differentiates data if more than one profiler is deployed.

Countdown delay: The profiler wakes from 'sleep' when the countdown alarm reaches zero. If the transponder is installed, the countdown begins when the firmware pings the transponder and profile 0 begins when the countdown reaches zero (one to two minutes after confirming deployment). *Range: 0 seconds to 24 hours in 1 second increments.*

OR

Scheduled start: Scheduled start is an absolute date and time. Profile 0 begins when the RTC reaches the specified time. *Range: Years 1970 to 2038 in 1 second increments and at least 10 minutes in the future as measured by the RTC.*

Profile start interval/Pair start interval: Interval between profiles or profile pairs measured between the start of profiling motion of sequential profiles or pairs of profiles. Continuous profiling results from a 0 setting. *Range: 0 seconds to 366 days in 1 second increments.*

Reference date/time: Initial reference time for the deployment (start of Profile 1). Subsequent profiles reference this time. *Range: Years 1970 to 2038 in 1 second increments.*

Burst interval: Interval between profile bursts or profile pairs. Continuous bursts are selected by setting the burst interval to 0. *Range: 0 seconds to 366 days in 1 second increments.*

Profiles per burst/ Pairs per burst: The number of profiles or pairs of profiles in a burst. Setting this to 1 disables burst profiling. *Range: 1 – 1000 profiles or pairs of profiles.*

Paired profiles: Enables or disables paired profiles. When paired profiles are enabled, the deployment is scheduled in up-down pairs. *Range: Enabled/Disabled.*

Profiles/file set: Profiles stored on the flash card as a single data file. Example: '10' places profiles 1 through 10 into a single data file on the flash card. (Unpacker produces 1 file per profile when the raw data is processed from the flash card).

Shallow pressure: "Top" of the profiling range. The profiler stops profiling on an upward profile when the ambient pressure drops below this limit. *Range: 0.0 dbar to Deep pressure.*

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Deep pressure: "Bottom" of the profiling range. The profiler stops profiling on a downward profile when the ambient pressure exceeds this limit. *Range: Shallow pressure to 6000.0 dbar.*

Shallow error: A relative pressure below (deeper than) the shallow pressure stop. If a zero pressure rate is detected while inside the shallow error window on an upward profile, profiling stops. This value is relative to the shallow pressure. *Range: 0.0 dbar to 6000.0 dbar.*

Deep error: A relative pressure above (more shallow than) the deep pressure stop. If a zero pressure rate is detected while inside the deep error window on a downward profile, profiling stops. This value is relative to the deep pressure. *Range: 0.0 dbar to 6000.0 dbar.*

Profile time limit: Maximum time for profiler motion. If the time limit expires while profiling, the profiler stops. Calculation: profile time limit = 1.25 × (deep pressure - shallow pressure) / nominal profiling speed. *Range: 10 seconds to 8 hours in 1 second increments.*

Stop check interval: Frequency to check ambient pressure, pressure rate, elapsed time, battery voltage and motor current. *Range: 1 second to 60 seconds in 1 second increments.*

Fluorometer: If the fluorometer is enabled, this option can be used to change the gain and the average number of samples to record.

OBS Turbidity: If the turbidity is enabled, this option can be used to change the gain and the average number of samples to record.

Power for a single profile: Single profile battery drain is one of the components of the battery endurance estimate.

Total profiles/ (240 Ah): Total estimated profiles based on battery energy (the L24-1000 battery has 240Ah). Battery energy can be changed in the System Configuration menu).

Est battery expiration: Estimated battery expiration. Estimate basis: battery energy, single profile drain, and total profile number (estimate recalculates as parameters change).

Verify and proceed: Selecting 'V' instructs the firmware to conduct parameter range and consistency checks and perform the endurance calculation but does <u>not</u> start the deployment.

Detailed Descriptions of Deployment Parameters

A more detailed description of deployment parameter settings follows. Refer to Figure 3-40 to view the Deployment Menu display.

Mooring ID

Mooring ID <M>

Mooring ID is a three position mooring identifier (001 to 999) that is stored in the URAO to differentiate deployment data when multiple profilers are deployed. The firmware displays the entry with leading zeros. Mooring ID is also embedded in the metadata that precedes files transferred via inductive modem. For details about the inductive modem metadata structure, refer to the "Underwater Inductive Modem" appendix in this User Manual.

Start Parameters

Start parameters enable selection of a countdown delay or scheduled start for the deployment.

Select Start Parameters <Z>

Option 'Z' specifies the deployment start parameters.

Countdown delay - A countdown delay in hours, minutes, and seconds can be set between 00:00:00 and 24:00:00. When the operator commits to the deployment, the countdown timer begins decrementing. When the alarm is triggered the profiler wakes up and begins operations. If an optional transponder is installed, the firmware pings the transponder at the start of a deployment and the countdown begins 1 to 2 minutes after the operator commits to a deployment. Profile 0 begins when the countdown reaches zero.

Scheduled start - A scheduled start is specified as an absolute date and time. Profile 0 begins when the RTC reaches the specified time. A scheduled start time must be at least 10 minutes in the future when 'V' Verify and Proceed is selected, indicating that deployment programming is complete. Allowed range is 1970 to 2038 in 1 second increments and at least 10 minutes in the future as measured by the RTC.

Schedule Parameters

The Schedule parameters control profile timing. Profiles can be scheduled individually or in up-down pairs. The profiles or pairs of profiles can be scheduled at regular intervals or in bursts. Burst profiling is executed with regular intervals between bursts and (shorter) intervals within a burst.

Profile Start Interval/Pair Start Interval <I>

Profile start interval is the time between profiles (or pairs). If the interval is less than the time required to complete a profile (or pairs), the next profile (or pair) will be skipped to prevent asynchronous profiling. Enter a Profile Start Interval greater than the Profile Time Limit.

```
Profile start
interval ──────────►Schedule    I| Profile start interval = 000 01:30:00 [DDD HH:MM:SS]
                                R| Reference date/time   =   11/03/2006 12:00:00
                                B| Burst interval        = 010 00:00:00 [DDD HH:MM:SS]
                                N| Profiles per burst    =            4
                                P| Paired profiles            Disabled
                                F| Profiles / file set   =            1

                    Stops       S| Shallow pressure       =         50.0 [dbar]
                                D| Deep pressure          =       1050.0 [dbar]
                                H| Shallow error          =        500.0 [dbar]
                                E| Deep error             =        500.0 [dbar]
Profile time ──────────────────►T| Profile time limit     =     01:23:20 [HH:MM:SS]
limit                           C| Stop check interval    =           30 [sec]
                                L| Fluorometer            =       Disabled
                                O| OBS Turbidity          =       Disabled

                    Endurance   | Power for single profile =       301.9 [mAh]
                                | Total profiles/(240 Ah)  =         712
                                | Est. battery expiration  =   09/18/2011 08:00:00

                    Deploy     V| Verify and Proceed

                           Selection  ? i

                    Enter profile start interval

                           Days    (  0 to 366) ? 0
                           Hours   (  0 to  23) ? 1
                           Minutes (  0 to  59) ? 30
                           Seconds (  0 to  59) ? 0
```

Figure 3-41: <I> Profile Start Interval

Figure 3-42 shows a deployment with single profiles.
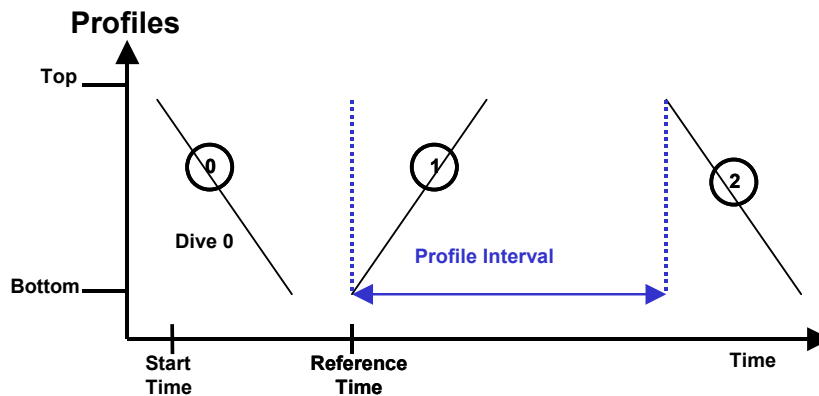
Figure 3-42: Profiles Example

Continuous profiling is set by entering 0 for the Profile Start Interval. This profiling is asynchronous and provides the most dense sampling possible. During continuous profiling there is no delay between profiles (each profile begins as soon as the data from the previous profile is saved).

Reference Date/Time <R>

Reference date/time is a calculation that takes place throughout the deployment to keep the schedule in sync. The initial reference time is set to the intended start time of Profile 1 (as illustrated in Figure N-63). Range is 1970 to 2038 in 1 second increments. An example of how reference time is used is shown below (profiles are intended to start at 0000, 0600, 1200, 1800, and so on). Reference time is also used during recovery from a Watchdog reboot.
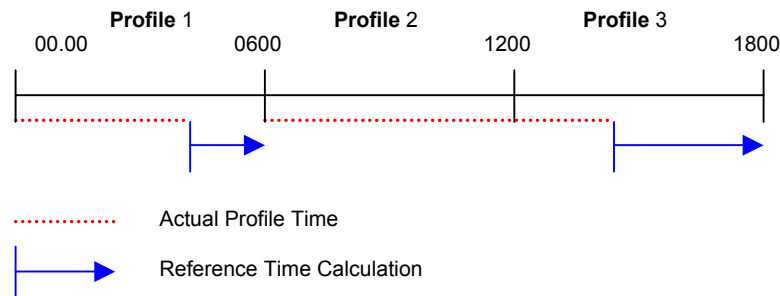
The actual time required for Profile 1 is less than the start interval for the deployment, so the reference time calculation yields 0600 – the expected start time for Profile 2. In Profile 2, the actual time required exceeds the start interval, therefore the reference time calculation yields 1800 and the profile scheduled at 1200 is skipped. The reference time algorithm synchronizes the profile start time with the programmed deployment schedule, in the event of an unexpectedly long profile time. In this example, Profile 3 would begin at 1800hrs.

Burst Interval <B>

The burst interval is the time between bursts of profiles or pairs. Sampling with profile bursts or profile pairs strikes a balance between the need for relatively high frequency profiling given the need for long time series and the finite battery endurance. When Profiles per Burst is enabled (set to a number greater than 1), the firmware displays a default Burst Interval. Change this default to the desired Burst Interval. Range is 0 seconds to 366 days in 1 second increments.

```
            Selection  ? n

  Enter profiles per burst (1 to disable) (1 to 1000) ? 4

  Schedule  I| Profile start interval   = 000 12:00:00 [DDD HH:MM:SS]
            R| Reference date/time      =   11/03/2006 12:00:00
            B| Burst interval           = 010 00:00:00 [DDD HH:MM:SS]
            N| Profiles per burst       =          4
            P| Paired profiles              Disabled
            F| Profiles / file set      =          1

              Selection  ? b

   Enter burst interval
        Days     (  0 to 366) ? 0
        Hours    (  0 to  23) ? 9
        Minutes  (  0 to  59) ? 0
        Seconds  (  0 to  59) ? 0
```

Profiles per burst →

Burst interval →

Figure 3-43: <B> Burst Interval

Profiles Per Burst/ Pairs Per Burst <N>

Enter a number greater than 1 to enable Profiles per Burst (the firmware also displays a default Burst Interval which should be changed based on specific deployment needs). If Burst Profiling is disabled (set to 1), the profiling schedule is determined by the profile start interval alone. Profile 0 is not part of the number of Profiles per Burst, as shown in Figure 3-44.

```
            Selection  ? n

  Enter profiles per burst (1 to disable) (1 to 1000) ? 4

  Schedule  I| Profile start interval   = 000 12:00:00 [DDD HH:MM:SS]
            R| Reference date/time      =   11/03/2006 12:00:00
            B| Burst interval           = 010 00:00:00 [DDD HH:MM:SS]
            N| Profiles per burst       =          4
            P| Paired profiles              Disabled
            F| Profiles / file set      =          1
```

Profiles per burst →

Burst interval →

Figure 3-44: <N> Profiles per Burst

The profiler continues a burst until it has completed all of the profiles or pairs in the burst. If this requires longer than the burst interval, the next burst (or bursts) will be skipped. Range is 1 – 1000 profiles or pairs of profiles. Figure 3-45 shows a deployment with bursts.
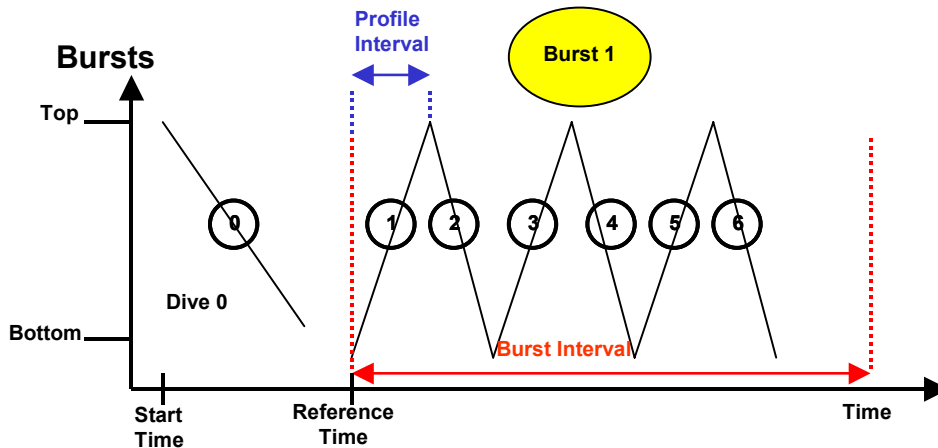
Figure 3-45: Burst Example

Paired Profiles <P>

When Paired Profiles are enabled, the deployment is scheduled in up-down pairs. The down profile starts as soon as the up profile data storage is completed. The start interval is the time between the start of motion for sequential up profiles. When paired profiles are disabled, the deployment is conducted in single profiles and the start interval is the time between the start of motion for sequential profiles. Figure 3-46 shows a deployment with paired profiles.
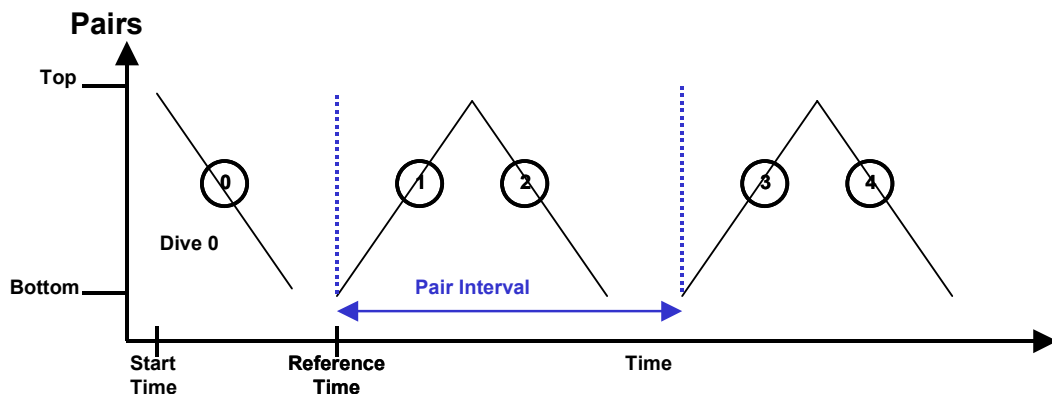
Figure 3-46: Pairs Example

Figure 3-47 shown next illustrates three deployment programming styles, for visual comparison.

Deployment Programming
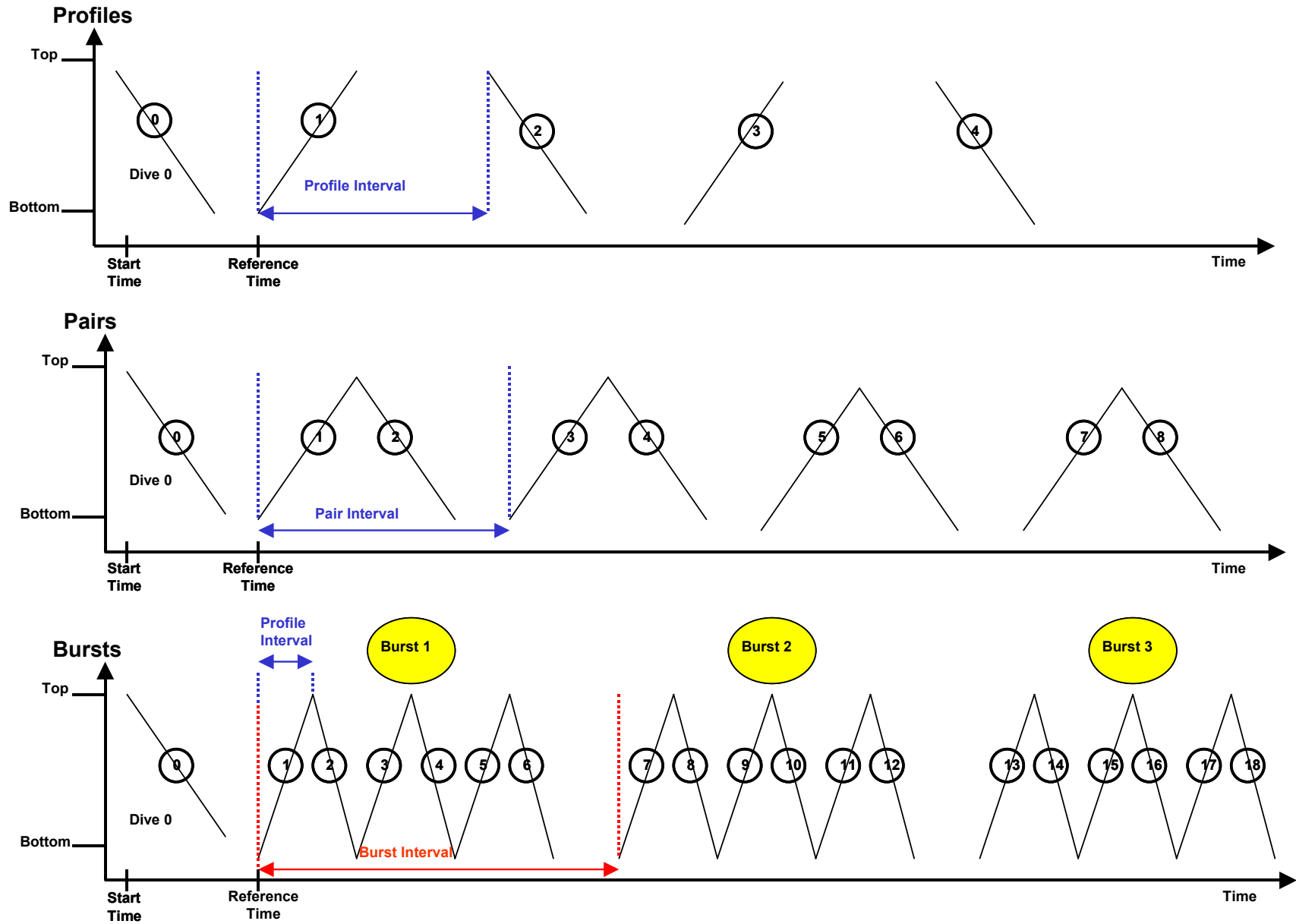
Figure 3-47: Deployment Programming

<u>Profiles/File Set <F></u>

A deployment with many short profiles may exceed the flash card file limit before the battery expires. For deployments that include more than 1,300 profiles, use Profiles per File Set to multiplex an operator-defined number of profiles into a single data file and maximize flash card file storage capacity. For example, setting Profiles/File Set to 10 places profiles 0 through 9 into a single data file on the flash card. When Profiles per File Set changes, the firmware recalculates and redisplays the battery endurance estimate.

Do not set this value higher than necessary. The firmware displays a message if a setting other than 1 is entered but not required based on the programmed deployment. The firmware also displays a warning if the programmed deployment will exceed the flash card file limit before the battery expires.

Regardless of the Profiles per File Set setting, the Unpacker produces one file per profile when the raw data from the flash card is processed. Accepted range is 1 to 1018.

NOTE
If using the Underwater Inductive Modem (UIM), set Profiles/File Set to 1 (real-time communication does not support multiplexing).

Stops Parameters

Stops parameters define limits that end a profile. The profiler depends primarily on CTD pressure measurements to detect the end of a profile. The pressure measurements acquired through the CTD are time tagged and stored in the engineering data file. This time and pressure information is used to dynamically calculate the pressure rate, dP/dt. Status and elapsed profiling time are also monitored. Typically, a profile is terminated based on the pressure limits.

NOTE
The dP/dt calculation is not performed for the first 3 minutes and 30 seconds of a profile. The pressure measurements and time tags are kept in rolling, indexed buffers so that the mooring motion filtering requirement of the calculation can be verified. Failed pressure acquisitions are flagged and not used in the calculation.

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Pressure Rate

The pressure rate is also used to detect obstacles on the mooring cable that hinder profiling motion. Nominal profiling speed is 25cm/s. When the pressure rate, averaged over at least 3 minutes, falls below a threshold of 0.045 dbar/s ~ (4.5 cm/s), the firmware detects a zero pressure rate.

NOTE
Wave induced mooring motions that modulate steady profiler progress could lead to false detection of a zero pressure rate.

The action taken after a zero pressure rate detection depends on the depth, current profiling direction, and the shallow or deep error programmed by the operator.

Ramming Action

In the mid-water region away from the shallow and deep error windows, a zero pressure rate is interpreted as an obstacle on the mooring cable. The mid-water obstacle ramming behavior is triggered in an effort to clear the cable and get past the obstruction.

The profiler first backs away from the obstacle for 30 seconds, then moves forward again. If the ramming behavior is successful, the profiler continues the profile. If the obstruction remains, another zero pressure rate will be detected after 3 minutes and the ramming behavior is repeated.

Ramming is limited to a maximum of five occurrences during any one profile (battery energy and drive train wear required for 15 minutes of drive wheel slip on the cable is required to make five detections). A sixth zero pressure rate detection terminates the profile. The sensor data acquisition continues for two minutes before the firmware stops logging and transfers the sensor data to the flash card. The detections do not have to be at or near the same depth. Each restart is logged in the engineering data file.

Ramming can be disabled by extending the shallow and deep errors to cover the full extent of the profiling range.

Shallow and Deep Pressure Limits

The shallow and deep pressure limits or "stops" are ambient pressure levels (dbars) between which the profiler travels. When the ambient pressure is less than the shallow pressure stop on an upward profile or greater than the deep pressure stop on a downward profile, the

profiler stops. The sensor data acquisition continues for two minutes before the firmware stops logging and transfers the sensor data to the flash card.

<div style="border:1px solid black;">
<div style="background-color:#66ff66;">

NOTE

</div>

The pressure stops are pressures (dbar). Normally, physical locations on the mooring are commonly referenced in meters. The profiler does not integrate state variables over the depth of the water column to construct a mapping between decibars and meters.

</div>

Shallow Pressure <S>

Shallow pressure is the intended "top" of the profiling range. The profiler stops profiling on an upward profile when the ambient CTD pressure becomes less than the shallow pressure limit. The shallow pressure limit is ignored during downward profiles. Range is deep pressure to 0.0 dbar.

Deep Pressure <D>

Deep pressure is the intended "bottom" of the profiling range. The firmware stops profiling on a downward profile when the ambient CTD pressure becomes greater than the deep pressure limit. The deep pressure limit is ignored during upward profiles. Range is shallow pressure to 6000.0 dbar.

Shallow Error <H>

Shallow error defines a pressure below (deeper than) the shallow pressure stop. If a zero pressure rate is detected while inside the shallow error window on an upward profile, the profiler stops profiling. The mid-water obstacle ramming behavior is not triggered. The shallow error is ignored on downward profiles.

The shallow error allows the operator to compensate for mooring dynamics and uncertainty in the actual depth of the bottom. As the mooring leans over in a current or if the anchor is deeper than expected the shallow bumper may be pulled below the shallow pressure stop. In these cases the obstacle ramming behavior would be undesirable. The shallow error is chosen based on calculations of the dynamic mooring behavior and knowledge of the possible depth error. Inside that window a zero pressure rate is interpreted as the shallow bumper and the ramming behavior is not triggered. The profile terminates as if the shallow pressure stop had been detected.

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The mid-water obstacle ramming behavior can be disabled during upward profiles by setting the shallow error below (deeper than) the deep pressure. Range is 0.0 dbar to 6000.0 dbar.

Deep Error <E>

Deep error defines a pressure above (more shallow than) the deep pressure stop. If the firmware detects a zero pressure rate while inside the deep error window on a downward profile, the profiler stops profiling. The mid-water obstacle ramming behavior is not triggered.

The deep error is ignored on upward profiles. The deep error allows the operator to compensate for mooring dynamics and uncertainty in the actual depth of the bottom. If the mooring dynamics are less than anticipated or if the bottom is shallower than expected, the deep bumper may rise above the deep pressure stop. In these cases the obstacle ramming behavior would be undesirable. The deep error is chosen based on calculations of the dynamic mooring behavior and knowledge of the possible depth error. Inside that window a zero pressure rate is interpreted as the deep bumper, and the ramming behavior is not triggered. The profile terminates as if the deep pressure stop had been detected. Range is 0.0 dbar to 6000.0 dbar.

Profile Time Limit <T>

Profile time limit is the maximum time allowed for profiler motion. The firmware displays a default Profile Time Limit after the shallow and deep pressure stops are entered (this should be changed for the specific deployment). When the firmware cannot detect a pressure or pressure rate based stop (and the battery voltage and motor current are within their prescribed limits), the profile terminates based on elapsed travel time.

```
Enter deep pressure limit (55.0 to 6000.0) ? 1050

ID         M| Mooring ID            = 001

Start      Z| Scheduled start       =   11/03/2006 08:00:00

Schedule   I| Profile start interval = 000 12:00:00 [DDD HH:MM:SS]
           R| Reference date/time   =   11/03/2006 12:00:00
           B| Burst Interval        =     Disabled
           N| Profiles per burst    =     Disabled
           P| Paired profiles             Disabled
           F| Profiles / file set   =            1

Stops      S| Shallow pressure      =         50.0 [dbar]
           D| Deep pressure         =       1050.0 [dbar]
           H| Shallow error         =        500.0 [dbar]
           E| Deep error            =        500.0 [dbar]
           T| Profile time limit    =     01:23:20 [HH:MM:SS]
```

Profile time limit →

Figure 3-48: <T> Profile Time Limit

If the time limit expires while profiling is in progress, the firmware halts motion. The sensor data acquisition continues for two minutes before the firmware stops logging and transfers

the sensor data to the flash card. The time limit applies only to the period of profiler motion during a single profile. It does not include the sensor logging intervals that occur before and after profile motion or the time required to move data from the sensors to the flash card.

Changes to shallow or deep pressure settings trigger the firmware to calculate the time that will be required to cover that distance: *profile time limit = 1.25 × (deep pressure - shallow pressure) / nominal profiling speed.*

The additional time (25%) is added to account for slower profiling near the battery life limit.   The operator can accept or manually change the suggested time limit. Note that any subsequent changes to the shallow or deep pressures will automatically update the profile time limit, overwriting the manual change.

The profile time limit has an absolute maximum value of 8 hours. The memory capacity and the data rate of the CTD limit internal logging to approximately 8.5 hours.

The time limit is dynamically incremented during a profile whenever the mid-water obstacle ramming behavior is triggered.   The increment includes the duration of the two additional velocity ramps, the zero pressure rate interval, and the stop check interval. The time limit is reset to 8 hours whenever an increment raises the time limit above the absolute maximum.

In general, the profile time limit will not be reached. Setting the time limit to 8 hours maximizes the amount of time to reach the stop on each profile and each profile will likely terminate on pressure or pressure rate.   However, if there are problems acquiring pressure measurements, this approach will also result in the maximum amount of time pushing against the physical stop and wasting battery energy. Range is 10 seconds to 8 hours in 1 second increments.

Stop Check Interval <C>

Stop check interval sets the frequency of checks during profile motion to determine if the profiler has reached a stop. The checks include examination of the ambient pressure, the pressure rate, the elapsed time, battery voltage and motor current. The electronics enters low power sleep (LPS) between checks.

> **NOTE**
>
> During a profile, the firmware periodically sends a data request to the CTD while the CTD is logging internally. The CTD responds with the most recent scan of data which is parsed to extract the pressure used in the stop check internal algorithm.

Infrequent checks (30 to 60 second intervals) save a small amount of power and are appropriate for relatively long profiles (>500m). Unfortunately, a 30-60 second stop check interval also permits the profiler to overshoot the pressure stop and push against the physical stop until the next stop check. More frequent checks (5 to 15 second intervals), use more power but also reduce overshoot. Frequent checks are appropriate for relatively short profiles (< 500m).

Motor currents above 1500 mA indicate a catastrophic circuit failure and result in immediate termination of profiler motion. High motor currents initiate the ramming behavior, similar to the repetitive attempts to pass an obstacle. High motor currents do not end the deployment.

The profiler uses a threshold of 7.5 V to detect battery exhaustion and terminate the deployment. The output voltage of the main lithium battery is nominally 10.8 V until ~90% of the available energy in the battery has been used. The voltage then drops rapidly to ~7.8 V and remains at that level while most of the remaining available energy is used. As the battery nears complete exhaustion (99+% of the available energy extracted), the voltage falls rapidly to zero unless the current drain is drastically reduced. To avoid a premature or erroneous termination of the deployment, the battery voltage is averaged over five clean measurements obtained during sequential stop checks. Allowed range: 1 second to 60 seconds in 1 second increments.

The stop check "algorithm" is:

- Firmware always checks:
  - Motor current below 1500 mA
  - Elapsed time less than profile time limit
  - Battery voltage above 7.5 V
- Firmware checks after velocity ramp:
  - Pressure
  - Pressure rate

Battery Endurance Parameters

The Endurance parameters on the Deployment menu (see Figure 3-40) are explained in this section. Endurance parameters show an estimated battery expiration that is recalculated each time a deployment parameter is changed. The single profile battery drain and total profiles per battery are also provided in the Endurance Parameters.

Power for Single Profile

An estimate in mAh of the battery drain for a single profile.

Total Profiles (per Battery)

The estimated total profiles per battery pack. The default battery energy is 240Ah (the energy of the L24-1000 battery). Change this default, if necessary in the 'Nominal Endurance' option on the System Configuration menu (see Figure 3-36).

Est. Battery Expiration

An estimate of battery expiration based on the listed battery energy, the power for a single profile, and the total number of profiles. The estimate is recalculated each time a deployment parameter is changed.

Deploy

<V> Verify and Proceed

This option indicates that deployment parameter selection is complete. The firmware conducts parameter range and consistency checks and estimates battery expiration. Range violations and parameter inconsistencies trigger user prompts for changes.

If the consistency checks pass, the operator is prompted to store the parameters in non-volatile EEPROM. A 'No' response returns to the Deployment menu for further parameter entry. A 'Yes' response stores the parameters and runs the Diagnostics routine, including the 10 V and 7.5 V battery warning checks.

The final prompt is 'Proceed with the deployment (Yes/No) [N]?' This option starts the deployment.

Parameter Range Check

The parameter range checks verify that each of the deployment parameters is within its allowed range. If a range violation is detected, the operator is prompted to change the parameter and then returns to the deployment menu.

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Schedule Check

When all of the deployment parameters are within the specified ranges, the firmware performs a profile consistency check on the proposed schedule. The consistency checks begin with the calculation of the minimum profile duration (MPD) where:

$$MPD = \left\{ \left[\frac{DPL - SPL}{NPS} + SLBP + SLAP \right] \left(1 + \frac{DGR}{DTR} \right) \right\} \times 1.10$$

Profile travel time → $\frac{DPL - SPL}{NPS}$

Sensor logging → $SLBP + SLAP$

Data transfer time → $\frac{DGR}{DTR}$

Time buffer → $\times 1.10$

DPL	=	Deep Pressure Limit	[dbar]
SPL	=	Shallow Pressure Limit	[dbar]
NPS	=	Nominal Profiling Speed	[dbar/sec]
SLBP	=	Sensor Logging Before Profiling	[sec]
SLAP	=	Sensor Logging After Profiling	[sec]
DGR	=	Data Generation Rate	[byte/sec]
DTR	=	Data Transfer Rate	[byte/sec]

NOTE

If continuous profiling is selected, the profile consistency check is not performed.

The MPD is compared to the profile start interval. If the programmed start interval is shorter than the MPD the operator will be prompted to change the selections. The operator may choose to disregard the warning and proceed, thus accepting the risk of skipped profiles (or bursts) during the deployment.

For example, the pair start interval in the ongoing deployment example was reduced from 6 hours to 3 hours to trigger the warning.

```
                    Checking entries . . . done.
                    All entries are within allowed ranges.
Calculated pair
duration ─────────▶ Checking profile schedule . . . done.
                    Calculated minimum profile pair duration:    05:02:08
System alerts
operator ─────────▶ Estimated minimum profile pair duration exceeds pair
                    start interval.  System will skip pairs whenever a
                    pair start time is missed.

                    Change selections (Yes/No) [Y] ?
```
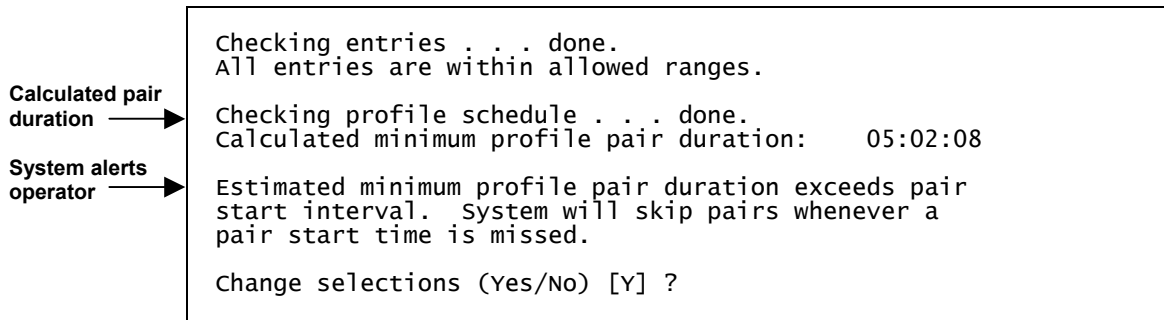
Figure 3-49: Profile Consistency Check

NOTE
If burst mode is disabled (profiles/pairs per burst set to 1) or if continuous bursts are selected (burst interval set to 00 00:00:00), no burst consistency check is performed.

When burst mode is enabled and the burst interval is not zero, the firmware compares the minimum burst duration with the burst interval which is one of:

- MPD × profiles per burst   if continuous profiling is enabled
- start interval × profiles per burst   if MPD < a non-zero start interval
- [MPD / start interval] × profiles per burst if MPD ≥ a non-zero start interval

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An inconsistent (but operator approved) start interval can also be detected. If the programmed burst interval is shorter than the calculated time to conduct the burst the user is prompted to change the selections.

```
Checking entries . . . done.
 All entries are within allowed ranges.

 Checking profile schedule . . . done.
 Calculated minimum profile pair duration:    05:02:08
 Profile schedule selections are consistent.

 Checking burst schedule . . . done.
 Calculated burst duration:               003 00:00:00

 Estimated minimum burst duration exceeds burst
 interval.  System will skip bursts whenever a
 a burst start time is missed.

 Change selections (Yes/No) [Y] ?
```

Calculated pair duration →
Calculated burst duration →
System alerts operator →

Figure 3-50: Inconsistent Start Interval

> **NOTE**
>
> Consistency checks are based on the calculated travel time for a profile, not on the profile time limit set by the operator.

Flash Card File Limit Check

When consistency checks are complete, the firmware displays a warning if the scheduled deployment will exceed the flash card file limit before the estimated battery expiration (which compares the battery energy, the single profile drain, and the total number of profiles).

```
Checking entries . . . done.
All entries are within allowed ranges.

Checking profile schedule . . . done.
Calculated minimum profile duration:        00:11:44
Profile schedule selections are consistent.

Checking burst schedule . . . done.
Burst mode disabled.

>>>>> WARNING: Flash card file limit will be reached
              before the battery expires.

Accept and store schedule selections (Yes/No) [Y] ? y

Storing deployment definition parameters . . . done.
```

Warning →

Figure 3-51: Endurance Check

When the deployment definition parameters are consistent (or have been approved by the operator) the operator is prompted to store the parameters in the EEPROM.

A 'No' response returns to the deployment menu for further parameter entry. This feature can be used to quickly loop through the range and consistency checks and the endurance calculation while making iterative adjustments to the deployment parameters. This loop can be a useful tool when developing profiling schedules for a deployment.

A 'Yes' response stores the deployment definition parameters in the EEPROM and then runs a single iteration of Diagnostics, the Main Menu utility that scrolls status information. Diagnostics includes the 10 V and 7.5 V battery warning checks (a warning message displays if more than ~90% of the energy in the battery has been used).

Committing to the Deployment

The final deployment prompt is 'Proceed with the deployment (Yes/No) [N]?' Two separate keystrokes are required, making an accidental deployment unlikely.

IMPORTANT
Before a deployment, archive a copy of the data files stored on the flash card. Once the firmware is initialized for use, the flash card is reformatted, erasing stored data files.

Once 'Proceed with Deployment' is 'Yes' the firmware enters LPS for the programmed interval so that the profiler can be deployed in the water. The firmware 'wakes' at the specified schedule start time and performs Profile 0 (Dive 0), taking the profiler to the bottom of the programmed range. Subsequent profiles are numbered sequentially, and follow the programmed schedule. The sensors power on two minutes before the scheduled start time of each profile, log data autonomously during the profile, and the profiler records engineering and status information.

Odd numbered profiles proceed from the bottom to the top of the programmed range. Even numbered profiles proceed from top to bottom.

Profiling stops when the end of the programmed profiling range is detected. The sensors continue to log internally for two minutes, stop, and transfer data to the flash card. A profile is complete when the sensor and engineering files have been closed. The firmware enters LPS and waits for the next scheduled profile. Profiling continues until the deployment is terminated.

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Profile and Deployment Termination Conditions

A deployment can be manually terminated after profiler recovery. Profiles and deployments are also terminated by any of the following conditions:

- Shallow or deep pressure limit reached

- Zero pressure rate inside the shallow or deep error window

- Time limit expired

- Operator command

- Flash card or file system full

- Low average battery voltage

- Zero pressure rate in mid-water more than five times

- High motor current more than five times (a combination of mid-water zero pressure rates and high motor currents totaling six, also terminates a profile).

- Too many open files (failure of file system hardware)

Sample Deployment Display

```
           Accept and store schedule selections (Yes/No) [Y] ?

Stores     ►Storing deployment definition parameters . . . done.
deployment
parameters
            WARNING:  If you have not already done so,

                      REMOVE the flow path CAPS from the CTD NOW.

                      Failure to remove the caps will prevent proper
                      CTD operation during the deployment and may
                      cause permanent damage to the sensor.

                      After removing the caps, press any key
                      to continue.


            CAUTION:  Deployment will erase all data
                      files stored on the flash card.

One line of ►System status:
diagnostics
           RTC: 05/08/2007 16:57:28 WDC: 05/08/2007 16:57:27  12.4 Vb    0 mA
Commit to
deployment ►
(default is No)  Proceed with the deployment (Yes/No) [N] ? y


            >>> Initializing autonomous operation <<<

              DO NOT remove the communication cable
                until initialization is complete.

            Setting motor to Free Wheel during launch . . . done.

            Powering on the UIM . . .done.

            Initializing data pointers and status flags . . . done.

            Initializing flash card . . .
              Deleting all previous data files
                (process may take several minutes) . . . .

            Deleting all files                              . . .
              Initializing flash pointers . . .
              Creating DEPLOY.DAT . . .
              Creating PROFILES.DAT . . .
              Creating IRQ_XCPT.LOG . . .
              Creating LASTSENT.DAT . . .
            Flash card initialization complete.

            05/08/2007 16:57:45

            Sensor warm-up will begin at              05/08/2007 17:13:00
            Initial dive to bottom stop will begin at  05/08/2007 17:15:00.


            System is ready to deploy.

            Remove communication cable, apply dummy
            plug to communications port, and attach
            faired bottom cap to vehicle.

            05/08/2007 16:57:47 Sleeping  until 05/08/2007 17:13:00 . . .
```

Figure 3-52: Sample Deployment

NOTE

After the confirmation that deployment definition parameters are stored and a reminder is displayed to remove the CTD flow path caps.

```
WARNING:  If you have not already done so,

          REMOVE the flow path CAPS from the CTD NOW.

          Failure to remove the caps will prevent proper
          CTD operation during the deployment and may
          cause permanent damage to the sensor.

          After removing the caps, press any key
          to continue.
```

Figure 3-53: Remove CTD Flow Path Caps

<7> Offload Deployment Data

This option is used to read binary data from the flash card while the flash card is still in the profiler. Use this option with the file capture utility to store the data as ASCII text. Within each Offload Deployment Data option, all data files, or specific files can be selected. Deployment Log files can also be selected.

NOTE
Offloading data reads from the flash card without altering the binary data files. The flash card is erased only when (1) the flash card is reformatted during deployment initialization after the operator commits to the deployment, (2) files are manually deleted using options in the Flash Card Operations menu, or (3) files are manually deleted using PC tools.

Before selecting Data Offload options, press [CTRL]-[C] to terminate the deployment, if it is still in progress. If the firmware automatically terminated the deployment before recovery and is in LPS, pressing [CTRL]-[C] wakes the firmware. If a profile was in progress, the firmware prompts after the first [CTRL]-[C] to save or discard that portion of the data.

```
                      ┌─────────────────────────────┐
                      │  Serial Dump Files From FLASH │
                      └─────────────────────────────┘
                          Fri Jan  7 12:48:42 2006

  Stream serial data from:
     <D> Deployment
     <S> Single profile
     <R> Range of profiles

     <L> Logging files

  Exit to:
     <M> Main menu
```

Figure 3-54: Serial Dump Files From FLASH

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<D> Deployment

This option selects specific files or all files from within the entire deployment data file.

```
Select data files to download:
 <1> All data files
 <2> Engineering data files only
 <3> CTD data files only
 <4> ACM data files only

 Exit to:
 <P> Previous menu
 <M> Main menu

        Selection  ? 1

Processing deployment.
```

Figure 3-55: Download Deployment Data

```
Profile 0

 Sensors were turned on at  03/21/2007 11:47:57
 Vehicle began profiling at 03/21/2007 11:48:00

    Date       Time      [mA]    [V]      [dbar]

 03/21/2007 11:48:00     -2    10.8       0.000
 03/21/2007 11:48:02     58    10.7       0.000
 03/21/2007 11:48:04     57    10.7       0.000
 03/21/2007 11:48:06     65    10.7       0.000
 03/21/2007 11:48:08     67    10.7       0.000
 03/21/2007 11:48:10     68    10.7       0.000
 03/21/2007 11:48:12     68    10.7       0.000
 03/21/2007 11:48:14     68    10.7       0.000
```

Figure 3-56: Engineering Data

<S> Single Profile

This option selects specific data files or all files from within a specific profile.

```
      Selection  ? s
Select data files to download:
<1> All data files
<2> Engineering data files only
<3> CTD data files only
<4> ACM data files only
Exit to:
<M> Main menu

      Selection  ? 2

Enter ID# of profile to be read: (0 to 1088) ? 5
```

Figure 3-57: Download a Single Profile

<R> Range of Profiles

This option selects specific data files or all files for a range of profiles.

```
      Selection  ? r
Select data files to download:
<1> All data files
<2> Engineering data files only
<3> CTD data files only
<4> ACM data files only
 Exit to:
<M> Main menu

      Selection  ? 1

Enter ID# of first profile to be read: (0 to 1088) ? 20
Enter ID# of last profile to be read: (0 to 1088) ? 100
```

Figure 3-58: Download a Range of Profiles

<L> Logging Files

This option selects deployment log files.

```
        Selection  ? l
Select log file to download:
<1> Profiles.dat
<2> Deploy.dat
<3> IRQ/Xcpt Log
<4> Profile Termination Log
<5> Inductive Charger Communications Log
<6> Last sent

Exit to:
<M> Main menu        Selection  ? 5

Opening file ICM_CLOG.LOG, the inductive charger modem communications log
file.
```

Figure 3-59: Download a Range of Profiles

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Examples of each log file are shown next.

```
 Selection  ? l
 Select log file to download:
 <1> Profiles.dat
 <2> Deploy.dat
 <3> IRQ/Xcpt Log
 <4> Profile Termination Log
 <5> Inductive Charger Communications Log
 <6> Last sent
Exit to:
 <M> Main menu
   Selection  ?
```

Figure 3-60: Download Log Files

<1> Profiles.DAT displays the profile count (the number of the last profile of the deployment). If the profile count is unavailable, the firmware uses the maximum number of files that can be accommodated.

```
Select log file to download:
 <1> Profiles.dat
 <2> Deploy.dat
 <3> IRQ/Xcpt Log
 <4> Profile Termination Log
 <5> Inductive Charger Communications Log
 <6> Last sent
Exit to:
 <M> Main menu
   Selection  ? 1

 Profile count: 560
```

Figure 3-61: Profiles.DAT Log File

<2> Deploy.DAT displays the conditions under which the deployment data was collected categorized as Deployment Parameters, System Configuration, and Internal Parameters.

```
DEPLOYMENT PARAMETERS
─────────────────────

Scheduled start              05/18/2007 11:25:00
Profile start interval       000 00:20:00 [DDD HH:MM:SS]
Reference date/time          05/18/2007 11:10:00
Burst interval               010 00:00:00 [DDD HH:MM:SS]
Pairs per Burst                 Disabled
Paired profiles                 Enabled
Profiles / file set                   1
Shallow pressure                    1.5 [dbar]
Deep pressure                      11.7 [dbar]
Shallow error                       1.0 [dbar]
Deep error                          1.0 [dbar]
Profile time limit             00:01:30 [HH:MM:SS]
Stop check interval                   2 [sec]
Transmission duration                15 [min]



SYSTEM CONFIGURATION
────────────────────

Nominal Battery Life                240 Ah
Inductive Telemetry             Enabled
Acoustic Transponder            Disabled
Inductive Charger Modem         Disabled
FSI EM        CTD               Disabled
SeaBird 41CP  CTD               Enabled
SeaBird 52MP  CTD               Disabled
FSI 2D        ACM               Disabled
Nobska MAVS3  ACM               Disabled
Aanderaa Optode                 Disabled
SeaPoint      Fluorometer       Disabled
              AutoGain          True
              Current Gain            1
              Sample/avg =            5
Wetlabs       Fluorometer       Disabled
              Sample/avg =            5
SeaPoint      Turbidity         Disabled (IR)
              AutoGain          True
              Current Gain            1
              Sample/avg =            5
File Deletion                   Enabled   with profiles stored = 60



INTERNAL PARAMETERS
───────────────────

FullSpeed                         0.250 [dbar/sec]
PR_Threshold                      0.045 [dbar/sec]
PR_TimeThreshold                    180 [sec]
sensor_warmup                       120 [sec]
sensor_warmdown                     120 [sec]
InfiniteDeployment              Enabled


PR_Threshold for Inductive Charger                0.045 [dbar/sec]
PR_TimeThreshold for Inductive Charger              30 [sec]
```

Figure 3-62: Deploy.DAT Log File

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<3> IRQ/Xcpt Log displays the time tagged log of interrupt requests (IRQ) and exceptions. The first entry is the creation time of the file and subsequent entries include regular watchdog IRQs at one minute after each hour and transponder IRQs (if the transponder is used).

```
Select log file to download:
 <1> Profiles.dat
 <2> Deploy.dat
 <3> IRQ/Xcpt Log
 <4> Profile Termination Log
 <5> Inductive Charger Communications Log
 <6> Last sent
Exit to:
 <M> Main menu
        Selection  ? 3
 Opening file IRQ_XCPT.LOG, the processor interrupt
 and exception processing log file.

 05/18/2007 10:56:24  Log file creation time.
 05/18/2007 11:01:00  Watchdog IRQ acknowledged.
 05/18/2007 12:00:58  Watchdog IRQ acknowledged.
 05/18/2007 13:00:59  Watchdog IRQ acknowledged.
 05/18/2007 14:00:59  Watchdog IRQ acknowledged.
 05/18/2007 15:00:59  Watchdog IRQ acknowledged.
 05/18/2007 16:00:59  Watchdog IRQ acknowledged.
 05/18/2007 17:00:59  Watchdog IRQ acknowledged.
 05/18/2007 18:00:59  Watchdog IRQ acknowledged.
 05/18/2007 19:00:58  Watchdog IRQ acknowledged.
 05/18/2007 20:00:59  Watchdog IRQ acknowledged.
 05/18/2007 21:00:59  Watchdog IRQ acknowledged.
 05/18/2007 22:00:59  Watchdog IRQ acknowledged.
 05/18/2007 23:00:59  Watchdog IRQ acknowledged.
 …


 05/21/2007 06:00:59  Watchdog IRQ acknowledged.
 05/21/2007 07:00:59  Watchdog IRQ acknowledged.
 05/21/2007 08:00:59  Watchdog IRQ acknowledged.
 05/21/2007 09:00:59  Watchdog IRQ acknowledged.

 End of file mark reached for file IRQ_XCPT.LOG End of file mark reached for
file IRQ_XCPT.LOG
```

Figure 3-63: IRQ/Xcpt. Log File

<4> Profile Termination Log displays the last 10 profiles prior to termination. The Profile Termination Log is recorded only in EEPROM.

```
Select log file to download:
 <1> Profiles.dat
 <2> Deploy.dat
 <3> IRQ/Xcpt Log
 <4> Profile Termination Log
 <5> Inductive Charger Communications Log
 <6> Last sent
Exit to:
 <M> Main menu
    Selection  ? 4


 The profile termination log consists of data from
 the last 10 profiles stored in a non-volatile rolling
 buffer.  The display below is not date sorted.

 Profile:               560
 Motion start:    11/25/2006 11:35:39
 Motion stop:     11/25/2006 11:38:35
 Start pressure:        0.1 [dbar]
 Stop pressure:         0.0 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    TIMER EXPIRED
 Log time:        11/25/2006 11:38:39

 Profile:               551
 Motion start:    11/25/2006 10:30:01
 Motion stop:     11/25/2006 10:31:07
 Start pressure:       13.1 [dbar]
 Stop pressure:         2.1 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    TOP PRESSURE
 Log time:        11/25/2006 10:34:09

 Profile:               552
 Motion start:    11/25/2006 10:36:10
 Motion stop:     11/25/2006 10:37:10
 Start pressure:        2.1 [dbar]
 Stop pressure:        13.1 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    BOTTOM PRESSURE
 Log time:        11/25/2006 10:40:11

Profile:                553
 Motion start:    11/25/2006 10:45:01
 Motion stop:     11/25/2006 10:46:10
 Start pressure:       13.2 [dbar]
 Stop pressure:         1.9 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    TOP PRESSURE
 Log time:        11/25/2006 10:49:12
```

Figure 3-64: Profile Termination Log (screen 1 of 2)

```
Profile:                554
 Motion start:    11/25/2006 10:51:13
 Motion stop:     11/25/2006 10:52:13
 Start pressure:          1.9 [dbar]
 Stop pressure:          12.1 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    BOTTOM PRESSURE
 Log time:        11/25/2006 10:55:15

 Profile:                555
 Motion start:    11/25/2006 11:00:01
 Motion stop:     11/25/2006 11:01:05
 Start pressure:         13.1 [dbar]
 Stop pressure:           3.6 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    TOP PRESSURE
 Log time:        11/25/2006 11:04:07

 Profile:                556
 Motion start:    11/25/2006 11:06:08
 Motion stop:     11/25/2006 11:07:06
 Start pressure:          2.6 [dbar]
 Stop pressure:          10.4 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    BOTTOM PRESSURE
 Log time:        11/25/2006 11:10:08

 Profile:                557
 Motion start:    11/25/2006 11:15:01
 Motion stop:     11/25/2006 11:16:07
 Start pressure:         13.2 [dbar]
 Stop pressure:           2.1 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    TOP PRESSURE
 Log time:        11/25/2006 11:19:09

 Profile:                558
 Motion start:    11/25/2006 11:21:10
 Motion stop:     11/25/2006 11:22:12
 Start pressure:          2.2 [dbar]
 Stop pressure:          12.2 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    BOTTOM PRESSURE
 Log time:        11/25/2006 11:25:14

 Profile:                559
 Motion start:    11/25/2006 11:30:01
 Motion stop:     11/25/2006 11:30:34
 Start pressure:          0.4 [dbar]
 Stop pressure:           8.4 [dbar]
 Ramp exit:       SMOOTH RUNNING
 Profile exit:    TOP PRESSURE
 Log time:        11/25/2006 11:33:36

 Terminate file logging operation now
 and press any key to continue..
```

Figure 3-65: Profile Termination Log (screen 2 of 2)

<5> Inductive Charger Communications Log displays each message or response between the profiler and an optional inductive charging controller.

```
        Selection  ? l
Select log file to download:
<1> Profiles.dat
<2> Deploy.dat
<3> IRQ/Xcpt Log
<4> Profile Termination Log
<5> Inductive Charger Communications Log
<6> Last sent

Exit to:
<M> Main menu        Selection  ? 5

Opening file ICM_CLOG.LOG, the inductive charger modem communications log
file.
```

Figure 3-66: Inductive Charger Communications Log

<6> Last sent displays the beginning of the file deletion queue. If a firmware reset occurs, this data is used to indicate the point from which file deletion should resume.

<8> Contacting McLane

This option displays McLane contact information and includes the firmware version and serial number.

```
    McLane Research Laboratories, Inc.
    Falmouth Technology Park
    121 Bernard E. Saint Jean Drive
    East Falmouth, MA 02536, USA

    Tel:    (508) 495-4000
    Fax:    (508) 495-3333
    Email:  mclane@mclanelabs.com
    WWW:    http://www.mclanelabs.com

    Software version:  MMP-4_05.c
    Compiled:          Apr 20 2007 16:23:30
    Profiler S/N:      ML12345-01D
```

Figure 3-67: McLane Contact Information

Technical Support

Contact McLane technical support with any questions. Please provide the following:

- Firmware version and profiler serial number.

- A description of the problem.

- A text file of any firmware problem created using the Crosscut file capture utility.

<W> Watchdog Initialization

If the automatic watchdog initialization fails during the power-up sequence, select this hidden option from the Main Menu. Typing 'W' or 'w' commands the firmware to re-initialize the watchdog, provides a prompt to reset the RTC, and synchronizes the WDC.

The profiler cannot be deployed if the watchdog is not functioning properly and communicating cleanly with the firmware. Therefore, all watchdog operations (automatic and operator initiated, including deploying the profiler), are locked out until the watchdog is successfully initialized.

```
Selection  ? w

 Independent system watchdog successfully initialized.
 Watchdog alarm IRQ has been activated.

 Clock reads 01/30/2006 12:04:16
 Change time & date (Yes/No) [N] ? y

 Enter date as MM DD YY HH MM SS
 Enter year 2001 as 1, 01, 101, or 2001

 Enter correct time [01/30/2002 12:04:19] ? 1 30 2002 12 4 35

 Clock reads 01/30/106  12:04:35
 Change time & date (Yes/No) [N] ?

 Setting watchdog clock . . . done.
```

Figure 3-68: Re-initialize System Watchdog

<O> Profiling History

Profiling history is tracked as motor hours and total meters traveled. Typing 'O' or 'o' from the Main Menu displays this information.

```
 Selection  ? o

Profiling history:
Total motor hours:                    15.33 hours
Total meters traveled:                 8456 meters
```

Figure 3-69: Profiling Odometer

<Q> Exiting to the Monitor

To exit to the monitor, at the Main Menu type 'q' or 'Q' followed by [ENTER]. A password prompt will display. Type *mclane* (no quotes, all lower case), and press [ENTER] to halt the firmware and exit to the TOM8 monitor (Tiny Onset Monitor, TT8v2). This command removes the running copy of the firmware in RAM, however, it remains on the flash card.

```
     Selection  ? q   Password:  McLane

Tattletale Model 8
Onset Computer, Pocasset MA USA
TOM8 V1.09,  PIC V1.00,  Copyright 1994

TOM8>
```

Figure 3-70: Exit to the Monitor

To re-start the firmware type 'g' or 'go' (no quotes), followed by [ENTER] at the TOM8 prompt. This will start the normal power-up initialization sequence.

NOTE
To conserve the battery, limit the time the firmware is in 'Exit to the Monitor' (the profiler draws a current of ~40 mA from the battery while in the TOM 8 monitor).

Chapter 4
Maintenance and Storage

Several maintenance procedures are recommended for the ITP. Rinsing the entire instrument assembly with clean fresh water after every deployment is important to prevent corrosion. Before and after deployment and storage, inspect the following:

- Controller housing
- O-rings
- Cables and bulkhead connectors
- Nylon and stainless steel hardware

Controller Housing

Inspect and if necessary replace the zinc anode prior to each deployment. Keep hard objects such as tools and shackles from coming into contact with the controller housing as scratches that penetrate the anodized aluminum hard coating will localize galvanic action and can lead to deep crevices or pits.

O-Rings

Both ends of the controller housing are sealed with an o-ring. Inspect the o-ring for damage, wear, and foreign material to protect the seal. Look for small cracks and feel for bumps, grit, or hair. Spare o-rings are included in the toolkit. Apply a thin, even coating of lubricant, such as Parker O-Lube to the o-rings when they are installed and inspected.

Cables and Bulkhead Connectors

The bulkhead connector is fabricated from glass reinforced epoxy and neoprene. The connectors are threaded into their end caps and sealed with o-rings. These are long term seals as long as the connectors and end caps are thoroughly rinsed and soaked in fresh water after recovery. The pins and bodies of the bulkhead connectors and the sockets cowls of the cable connectors must be regularly inspected, cleaned, and greased to prevent leaks.

Connectors that are regularly connected and disconnected, such as the COM connector, require regular maintenance. Apply a thin coating of grease to all contact surfaces, including pins, sockets, cowls, and bodies. Dow-Corning 55, an o-ring lubricant, is suitable for this purpose. Dow-Corning 4 or Dow-Corning 5 are silicon based lubricants that are also suitable.

<u>Stainless Steel Hardware</u>

The socket head cap screws securing the controller end caps are 316 stainless steel. Do not over tighten. A thin coating of non-metal, anti seize thread compound (such as Lub-O-Seal's NM-91 non-metal compound) should be applied to the screws before they are threaded.

Tighten the controller housing end cap screws evenly and carefully. The end cap should slide smoothly into the pressure housing. Visually check that wires are not caught between the end cap and the housing.

Battery Maintenance

The ITP has two lithium battery pack options (240 Ahr and 360 Ahr).

IMPORTANT
Lithium battery packs qualify as Class 9 hazardous goods. U.S. and international regulations require shipping the main lithium battery via an approved hazardous goods shipper.

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Packing and Storing the ITP

The ITP crate is a fitted, reusable international freight container that is ISPM-15 compliant. The crate is intended for both shipping and storing the ITP. If the ITP is to be stored unused for more than one month, complete the following:

- Offload and archive any data stored on the flash card.

- Rinse all instrument components with clean, fresh water.

- Remove both batteries (main lithium battery pack and lithium half pack if installed) from the controller housing.

- Reassemble the battery holder and insert the electronics chassis into the controller housing.

- Check the o-rings.

- Replace all bolts.

- Apply anti-seize to the threads.

Storage facility temperatures between -35°C and 40°C are recommended. Temperatures above this range should not cause damage, however, temperatures below -35°C could cause damage if water is still present in crevices or seals.

If the main battery is fully discharged, dispose it accordance with safety and environmental regulations. If the main battery is not fully discharged, cover the connector with insulating tape and store the battery within the -35°C and 40°C temperature range. Never expose the battery to temperatures in excess of 93°C.

Notes

Chapter 5
Operations

Ballasting the ITP

Ballast sheet calculations must be performed for each new deployment. <u>Accurate ballasting is absolutely essential</u>, as the lift capacity of the profiler is limited by the strength of the coupling between the drive wheel and the mooring cable. Ballasting errors of a few pounds will trap the profiler against one of the stops for the duration of the deployment. Data will be returned by the system, but it will all be from a single depth. Accurate ballasting requires:

- Precise measurements of the ITP air weight and ITP weight in water of some known density.

- Knowledge of the effective compressibility of the profiler and the dependence of profiler density on temperature.

With these numbers available, the required weight of lead ballast can be calculated for a particular deployment if the density, pressure, and temperature of the water at the neutral point of the planned profile are known. It is the *in situ* quantities that are required, not the potential density or temperature.

A completed ballast sheet with computed ballast values is included in hard copy form with the ITP documentation and in electronic form on the CD-ROM. McLane calculates and attaches an appropriate quantity of lead ballast for the initial deployment based on this ballast sheet. The ballast calculation is based on *in situ* density and deployment defined pressure information supplied to McLane.

IMPORTANT
Any weight change must be considered in the ITP ballast calculation. Changes that affect ballast include changing the main battery pack or swapping existing sensors. If deployment parameters change, contact McLane for assistance with ballast re-calculation.

Understanding the Ballast Sheet

A sample ballast sheet is included in the section that follows.

<u>Deployment Parameters</u>

The deployment parameters on the ballast sheet are the *in situ* pressure, temperature, salinity, and density of water at the planned neutral depth for the deployment. That density may be available directly or it may be calculated, using an equation of state for seawater, from measurements of pressure, temperature, and salinity at the neutral depth. The neutral depth is generally the mid-point of the planned profile. The hull of the ITP is designed to be buoyant and is less compressible than seawater. Buoyancy increases on down profiles and decreases on up profiles. To avoid exceeding the lift capacity of the profiler at the deep and shallow limits of travel, the aim of the ballast calculation is to make the ITP neutrally buoyant at the mid-point of the profile. Maintaining neutral buoyancy at the mid-point also reduces drive train losses, which increases endurance.

Ice Tethered Profiler Ballast Sheet

Project:	**Customer**
Date Ballasted:	**25 Apr 2007**
ITP S/N:	**12345-01**
ITP Electronics S/N:	**999999 Rev D**
CTD S/N:	**0000 McLane V2.2**
ITP Software Version:	**4.05**

Deployment Defined Values (Given By User)

Deployment (Neutral) Pressure (in db):	400
Deployment (Neutral) Temperature (in °C):	0.4
Deployment (Neutral) Salinity (pss):	34.8
Deployment (Neutral) Density (in g/cc):	1.0298
Deployment Site Latitude:	
Deployment Site Longitude:	
Deployment Date:	

Measured Weights (note: water weights are to 1g accuracy and air weights are to 10g accuracy)

ITP Air Weight w/o battery (in g):	22340
Tare Water Weight (includes test battery air weight) (in g):	9160
ITP+Tare Water Weight (in g):	298
Lithium Battery Air Weight (in g):	5155

Calculated Values and Ballasting Constants

1 - ITP Water Weight (in g):	-3707
2 - Ballast Tank Water Temperature (in °C):	16.6
3 - Water Density (from table in g/cc):	0.998918755
4 - ITP Volume (in cc)	31235.77
5 - ITP Compressibility Constant (in cc/db)	0.1
6 - ITP Volume Change @ Deployment Pres. (in cc):	40
7 - ITP Volume @ deployment Pres. (in cc):	31195.77
8 - ITP Volume Temp. Correction Const. (in cc/°C):	3.25
9 - Temperature Difference (in °C):	16.2
10 - ITP Volume Change @ Deployment Temp.(in cc):	52.65
11 - ITP Volume @ Deployment Temp. & Pres.(in cc):	31143.12
12 - Calculated Air Weight for Neutral ITP @ Deployment Pressure (in g):	32071.19
13 - Weight Difference (in g):	4576.19
14 - Ballast Weight (in g):	**4448**
15 - Average Motor Current Difference from Previous Deployment (in mA):	0
16 - Effective Motor Current Change for Neutrally Bouyant ITP (in mA):	0
17 - Ballast Air Weight Correction based on 4 g/mA Effective Motor Current (in g):	0
18 - Ballast Water Weight Correction based on density of lead (in g):	0
19 - Corrected Ballast Weight (in g):	**4448**

Notes:

Item 15 is calculated as Average Down Profile Motor Current - Average Up Profile Motor Current

If ballast is added to pressure housing item 19 is ballast air weight.

If ballast is added outside the pressure housing item 19 is ballast water weight.

Determining Air and Water Weights

Normally, the operator should not be required to make the air and water weight measurements, however, a complete description is included here to provide an understanding of the process, the accuracy requirements, and the known pitfalls of making these measurements. McLane provides a re-ballast service upon request.

IMPORTANT
All air weights should be measured on a scale with an accuracy of ± 10 grams, water weights ± 1 gram.

Accuracy of the water weight measurement may be affected by microscopic bubbles on the exposed surfaces of the ITP. A continuous sheet of bubbles can coat the ITP within a few minutes of immersion. The bubbles add a significant amount of buoyancy to the profiler and invalidate the weight measurement. To prevent bubble formation, submerge the ITP to a depth of two meters or more.

In addition, the density of the ITP has a distinct temperature dependence. Changes occur in the ITP water weight during temperature equilibration. A plot of these changes over a five hour period is shown in Figure 5-1. In this case the water temperature was approximately 18°C and the initial temperature of the ITP was approximately 25°C. The ultimate change in weight was approximately 40 g (out of a total mass of ~70000 g) or 6 g/°C.

To allow for complete temperature equilibration McLane leaves ITPs suspended at the bottom of the test well for a minimum of ten hours before recording their water weight.

Measured Weights (note: water weights are to 1g accuracy and air weights are to 10g accuracy)

ITP air weight w/o battery (in g)
_____

Tare water weight (includes test battery air weight) (in g)
_____

The ITP is buoyant in fresh water (and seawater), so a tare weight is required to fully submerge it for the water weight measurement. The water weight of the lead tare weight is measured using a triple beam balance (± 1g accuracy)

ITP + Tare Water Weight (in g)
_____

Lithium Battery Air Weight (in g)
_____

Check your battery weight (± 10g)

Calculated Values and Ballasting Constants

1 -   ITP Water Weight (in g)
_____

This is calculated as (Item C − Item B) + Item D and is a negative number because the profiler is positively buoyant.

2 –   Ballast Tank Water Temperature (in °C)
_____

In the McLane lab tank, fresh water is used, so the density depends only on temperature.

3 -   Water Density (from table in g/cc)
_____

This is the density, from the table provided with the ballast sheet. If the ballasting is done in seawater, you would measure the pressure, temperature, and salinity of the water and calculate the in situ density using an equation of state.

4 -   ITP Volume (in cc)
_____

The formula for volume calculation is: (Item A + Item D) − 1 / , or, ITP Air Weight − ITP Water Weight / Water Density. Physically, this is the mass of the water displaced by the profiler divided by the fluid density.

5 -   ITP Compressibility Constant (in cc/db)
_____

This is experimentally a constant of 0.3.

6 -   ITP volume change @ deployment pressure
_____

This is the compressibility constant multiplied by the pressure at the Deployment (Neutral) Depth (Item 5 × Deployment (Neutral) Pressure).

7 - ITP volume @ deployment pressure
_____

This is the calculated volume change at the planned neutral depth. In this calculation, the volume change is subtracted from the reference volume (Item 4 − Item 6).

8 - ITP volume temperature correction constant
_____

This is the constant characterizing the dependence of ITP volume (density) on temperature.

9 -   Temperature difference
_____

This calculation is the temperature difference between the reference water and the temperature at the planned neutral depth (Item 2 − Deployment (Neutral) Temperature).

10 - ITP volume change @ deployment temperature_____

This calculation is the temperature constant × temperature difference (Item 8 × Item 9).

11 - ITP volume @ deployment temp & pressure _____	_This calculation is the temperature (and pressure) of the corrected volume of the profiler, i.e., the volume at the neutral pressure and temperature (Item 7 − Item 10)._
12 - Calculated Air Weight for Neutral ITP @ Deployment Pressure (in g) _____	_The air weight for which the ITP will be neutrally buoyant at the planned neutral depth, neutral volume × neutral density (Item 11 − × Deployment (Neutral) Density ._
13 - Weight Difference (in g) _____	_The difference between the required air weight and the actual air weight is the weight of lead that must be attached as ballast for the profiler to be neutrally buoyant at the planned mid-point depth (Item 12 − (Item A + Item D)._
14 - Ballast Weight (in g) _____ **Note that Items 15 through 19 are used only if ballast weight adjustments are necessary after the initial deployment.**	_The final calculation is the empirical correction for the remaining uncertainty in the compressibility constant (Item 13 − 128 g). This weight is the quantity of lead to be added as ballast (removed if the quantity is negative). McLane uses an external tare weight, so the value in Item 14, (positive), is the <u>water</u> weight of lead that must be added to the profiler. If the tare weight of lead used to sink the profiler for the water weight measurement had been placed inside the pressure housing, Item 14 would be the air weight of lead to add to the lead inside the pressure housing. The lead will be added externally._
15 - Average Motor Current Difference from Previous Deployment (in mA) _____	_Item 15 is the average down motor current <u>minus</u> the average up motor current. This difference can be used to calculate a ballast adjustment._ _Retain the sign (+ or −) that results from this calculation for Items 16-19. A positive difference (+) indicates a light ITP (add ballast); a negative difference (−) indicates a heavy ITP (remove ballast)._
16 – Effective Motor Current Change for Neutrally Bouyant ITP (in mA) _____	_Item 16 = Item 15 / 2._
17 – Ballast Air Weight Correction based on 4 g/mA Effective Motor Current (in g) _____	_Item 16 × (4 g / mA)_
18 – Ballast Water Weight Correction based on density of lead (in g) _____	_Item 17 × (.907)_
19 – Corrected Ballast Weight (in g) _____	_Item 14 + Item 18_

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Chapter 6
Data Offload & Unpacking

ITP data is transmitted near real-time via inductive modem when used with a surface controller. If not using the inductive modem option, data can be offloaded from the flashcard once the profiler has been recovered and disconnected from the mooring cable.

Reviewing Deployment Data

Data can be checked before opening the controller housing (such as examining the profile count and viewing the list of data files) by connecting the COM cable to a PC while the flashcard is still in the instrument. See Chapter 3, ITP User Interface for more information.

Once the flash card is removed from the electronics housing, there are several tasks to recover, process and interpret the binary data. These tasks must be completed in the following sequence:

- Remove the flash card from the electronics housing and insert into a PCMCIA slot on a PC.
- Unpack the binary data files and translate into ASCII text files.
- Perform further data analysis for example, mapping velocity measurements and synchronizing sensor data streams.

IMPORTANT
Avoid exposing the electronics or flash card to salt water by moving the profiler to a sheltered area before connecting to a PC and/or opening the pressure housing. If the electronics get wet, immediately disconnect power, immerse in fresh water (do not immerse the lithium battery) and dry.

To review deployment data while the flash card is in the electronics housing, complete the following steps:

1. Boot the PC and start Crosscut (with capture 'On').

2. Connect the COM cable provided in the Toolkit to the PC.

3. Remove the dummy plug from the profiler connector and connect the COM cable to the COM port (on the pressure housing end cap).

4. Press [CTRL]-[C] to terminate the deployment, if it is still in progress. If the deployment was automatically terminated by the system before recovery, pressing [CTRL]-[C] wakes the system from low power sleep. If the ITP was conducting a profile, the operator will be prompted after the first [CTRL]-[C] to save or discard that portion of the data.

5. From the Main Menu Select <3> Flash Card Ops and then select <2> List flash card files.

6. Examine the profile count and view the list of data files.

7. From the Main Menu select <7> Offload Deployment Data to view other deployment data. See Chapter 3 in this User Manual for more information about the Offload Deployment Data selections.

8. After viewing deployment data, return to the Main Menu and select <4> Sleep.

9. Turn the Crosscut capture feature 'off'.

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Offloading Data

In the Data Offload option as shown in Figure E-3, the firmware prompts for whether or not oxygen is installed. If using the 41CP CTD with integrated dissolved oxygen, see the 'SBE 41CP CTD with Integrated Dissolved Oxygen appendix in this User Manual for more details.

```
┌─────────────────────────────────────────────┐
│         ┌──────────────────────────────────┐ ║
│         │   Serial Dump Files From FLASH   │ ║
│         └──────────────────────────────────┘ ║
│                Sun Jun 17 16:53:49 2007       │
│                                               │
│      Stream serial data from:                 │
│         <D> Deployment                        │
│         <S> Single profile                    │
│         <R> Range of profiles                 │
│                                               │
│         <L> Logging files                     │
│                                               │
│      Exit to:                                 │
│         <M> Main menu                         │
│                                               │
│     Selection  ? s                            │
│      Select data files to download:           │
│      <1> All data files                       │
│      <2> Engineering data files only          │
│      <3> CTD data files only                  │
│      <4> ACM data files only                  │
│                                               │
│      Exit to:                                 │
│      <P> Previous menu                        │
│      <M> Main menu                            │
│                                               │
│            Selection  ? 3                     │
│                                               │
│      Enter ID# of profile to be read: (0 to 419) ? 10 │
│                                               │
│     Processing profile.                       │
│                                               │
│     Does this 41CP data file have oxygen?  (Yes/No) [N] ? n │
│                                               │
│      Profile 10                               │
│                                               │
│       mmho/cm   Celsius    dbars              │
│                                               │
│      +00.6001  +17.2978  +0000.850            │
│      +00.5958  +17.2989  +0000.840            │
│      +00.5950  +17.2976  +0000.850            │
│      +00.5947  +17.2958  +0000.850            │
│      +00.5946  +17.2948  +0000.840            │
└─────────────────────────────────────────────┘
```

Prompt for oxygen ─────→ (points to "Does this 41CP data file have oxygen?")

Figure 6-1: Data Offload Prompt for Oxygen in Data File

Removing the Flash Card

Follow the steps below to detach both end caps and remove the flash card.

1. From the firmware Main Menu, select <4> to put the ITP in 'Sleep' mode and then disconnect the COM cable from the ITP.

2. Remove the grey anodized plug from the CTD end cap.

Figure 6-2: Remove CTD End Cap Plug

3. Support the CTD sensor end cap and use a 3/16" hex driver to loosen the screw from the stud in the center of the connecting plate.
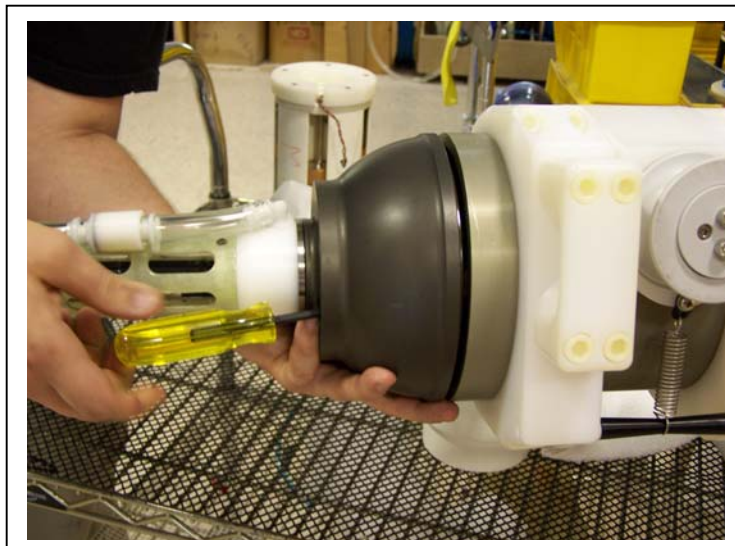
Figure 6-3: Unscrew the CTD Sensor End Cap

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4. Gently slide the chassis out of the controller housing.

Figure 6-4: Remove the Chassis

5. Slide out the CTD electronics and release the CTD connector.
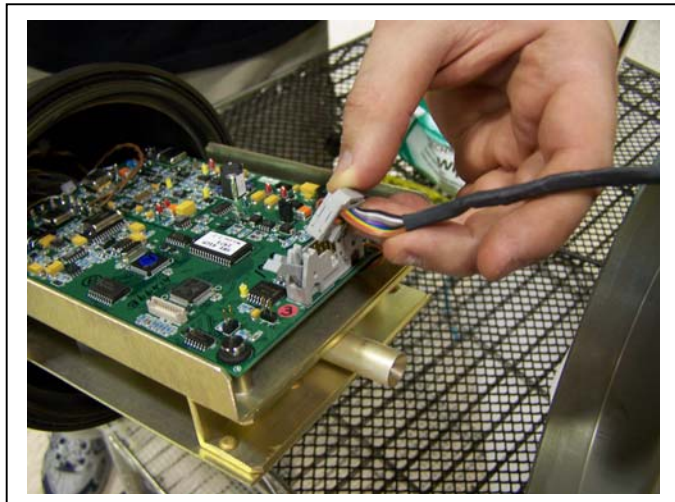
Figure 6-5: Release the CTD Connector

6. Remove the two ¼" top connecting plate screws using the long 3/16" hex driver and remove the connecting plate.

Figure 6-6: Remove the Top Connecting Plate Screws

7. On the bottom end cap, disconnect the UIM cable from the coil.

Figure 6-7: Disconnect the UIM Cable

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8. Remove the bottom plug from the end cap.

Figure 6-8: Remove the Bottom Plug

9. Support the bottom end cap, and using a ¼" hex driver, loosen the socket cap screw that secures the end cap to the body.

Figure 6-9: Loosen the Bottom End Cap Screw

10. Gently pull the bottom end cap off of the controller housing.

11. Remove the retaining ring from the bottom end of the controller housing.
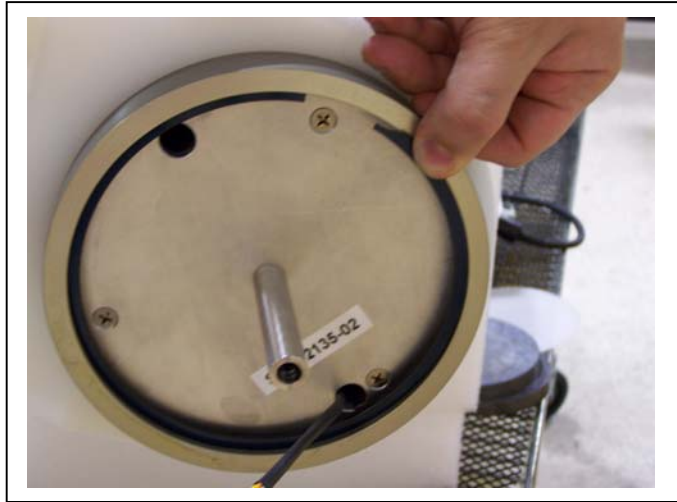
Figure 6-10: Remove the Retaining Ring

12. Slide the electronics chassis from the controller housing until the main electronics circuit board and the flash card are visible (disconnect the 2-pin drive motor connector if the chassis needs to slide out further to access the flash card).
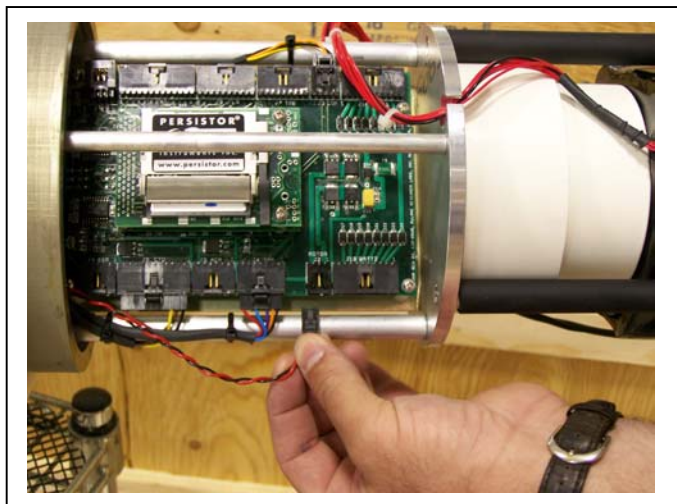
Figure 6-11: Disconnect Drive Motor if Necessary

13. Disconnect the battery.

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14. Push the release lever and remove the flashcard.
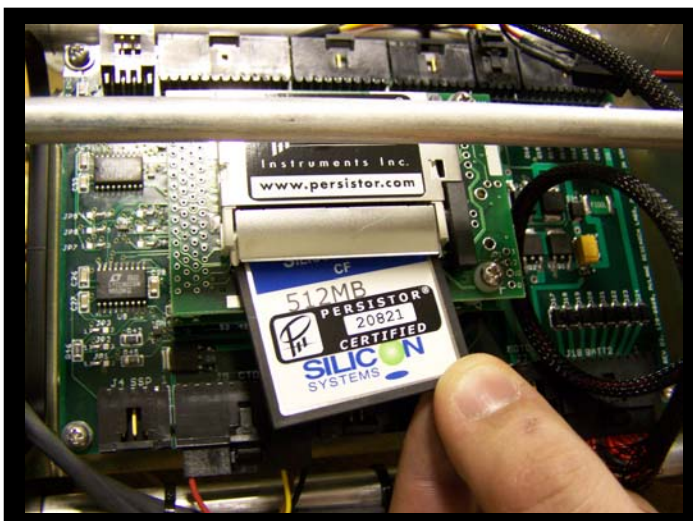
Figure 6-12: Flash Card Removal

15. Insert the flash card into a compact flash reader on a PC and copy the flash card contents to the PC hard drive (this procedure does not remove the data from the flash card).

Unpacking and Translating the Binary Data Files

Once the flash card is removed from the profiler and the binary data is copied to a directory on the PC, the Unpacker application can be used to unpack the binary deployment data files to ASCII text. See the "MMP Unpacker Application" section that follows, for detailed information about the Unpacker.

Optionally, advanced users can directly edit settings in the Unpacker initialization file (MMPUnpacker.INI) to bypass the step-by-step screens and control the unpacking process as a single step application. For example, to make the Unpacker compatible with a different firmware version, change the .INI *FirmwareVers* key (*FirmwareVers =4.05)*.
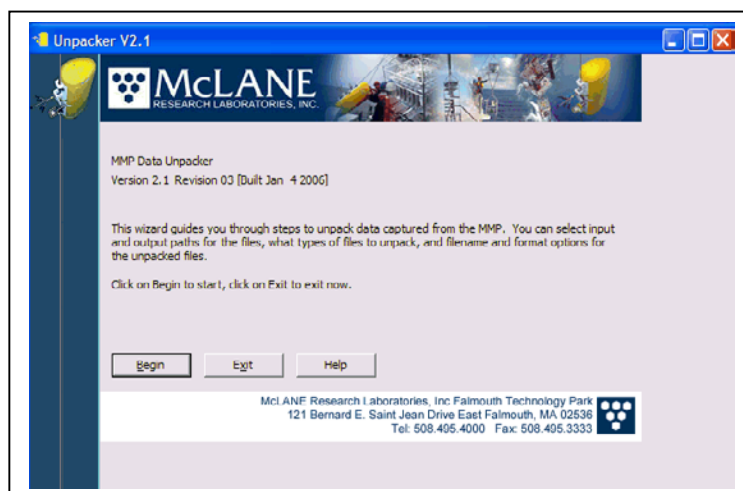
Figure 6-13: Unpacker Initial Display

MMP Unpacker Application

The Unpacker is a Windows application for MMP firmware versions 3.01 and higher that automatically unpacks binary data files. To use this application, copy Unpacker.exe from the CD in the toolkit onto a PC directory or download the most current Unpacker.zip file from www.mclanelabs.com. An overview of each Unpacker screen is included below.

IMPORTANT
Before unpacking, backup deployment data files on the PC directory where the binary data is copied from the flash card.

Unpacker – Step 1

Step 1 and Step 2 identify source and destination directories for the unpacked binary data files. Clicking 'Browse' begins Step 1. Once a folder with deployment data is selected, the Contents window displays the firmware version that created the file (or, Contents displays the detailed deployment files if the firmware already matches the version in the 'Unpack for firmware version' drop down).
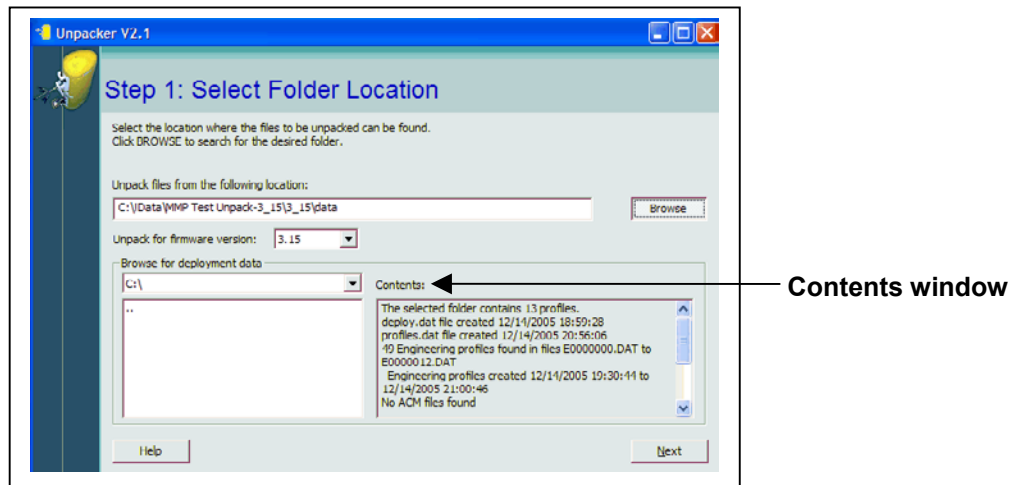
Figure 6-14: Step 1 Select Source Directory

Unpacker – Step 2

In Step 2, select a destination for the unpacked data, either in the default folder that displays or in a new folder. If the destination directory does not exist, the Unpacker prompts to create the directory.

NOTE
The Contents window in the lower right displays files that exist in the selected directory. If data is unpacked to a folder that contains files, the existing files will be overwritten.
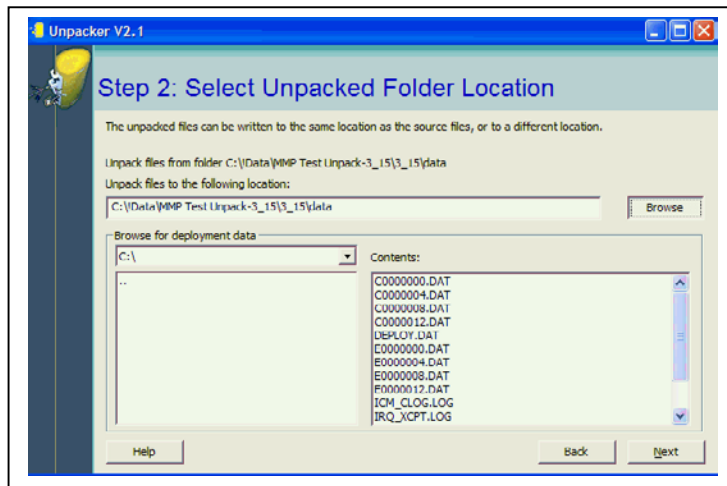
Figure 6-15: Step 2 Select Destination Directory

Unpacker – Step 3

Step 3 selects the data files to convert. Deselecting 'All Files for Entire Deployment' unlocks the other checkboxes to select specific log files and data files to unpack.

NOTE
If the selected firmware supports Inductive Charging, an Inductive Charging checkbox displays to unpack Profile.DAT files and an 'Inductive Charger Modem Communications Log' checkbox displays to unpack the log of communications between the instrument and an inductive charger.
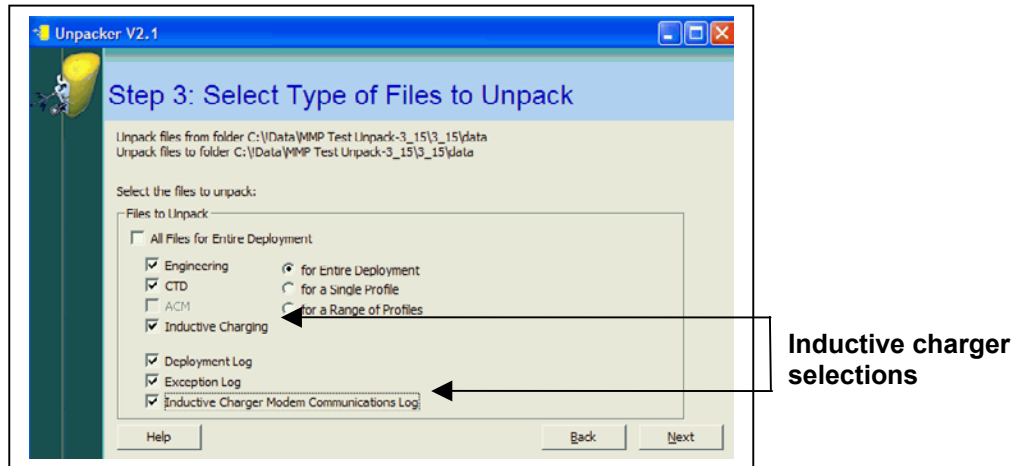
Figure 6-16: Step 3 Select Files to Unpack

NOTE
If the selected firmware supports the Deployment Planner (eg. version 4.20), a checkbox displays for step 3 to unpack the Deployment Schedule and/or Log (Deploy.DAT).
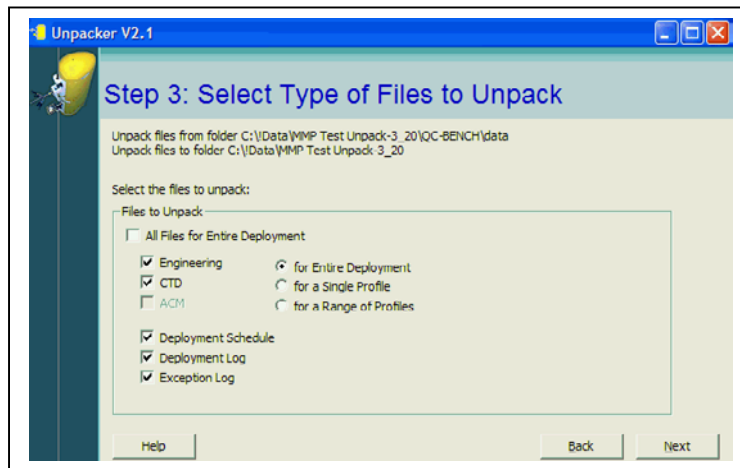
Figure 6-17: Step 3 Unpack Deployment Planner Files

Unpacker – Step 4

Step 4 optionally attaches a user-defined prefix to the unpacked data files so that the unpacked files from multiple deployments can be stored in the same directory and identified. In the following example, the first engineering file would be KN144_E0000000.TXT.
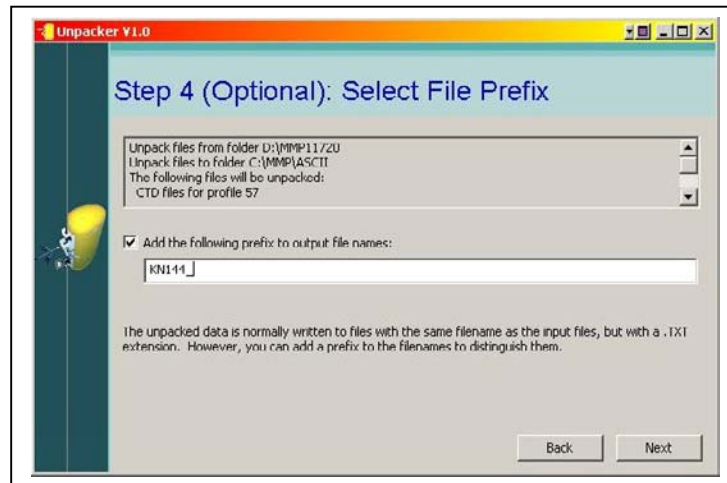
Figure 6-18: Step 4 Define Output File Prefix

Unpacker – Step 5

Step 5 optionally adds text headers to the converted files.
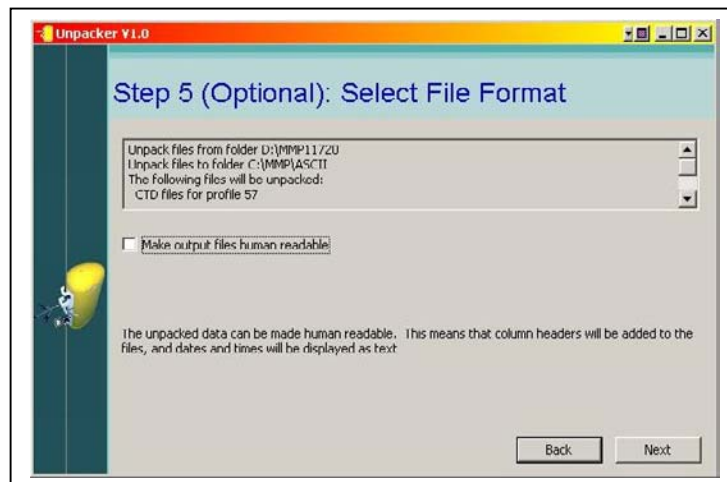
Figure 6-19: Step 5 Convert Files with Text Headers

NOTE

Adding text headers may complicate post processing by programs such as Excel and Matlab.

Unpacker – Step 6

Step 6 displays the unpacking options selected for verification. If the 'Show Details' box is checked, additional information is displayed.
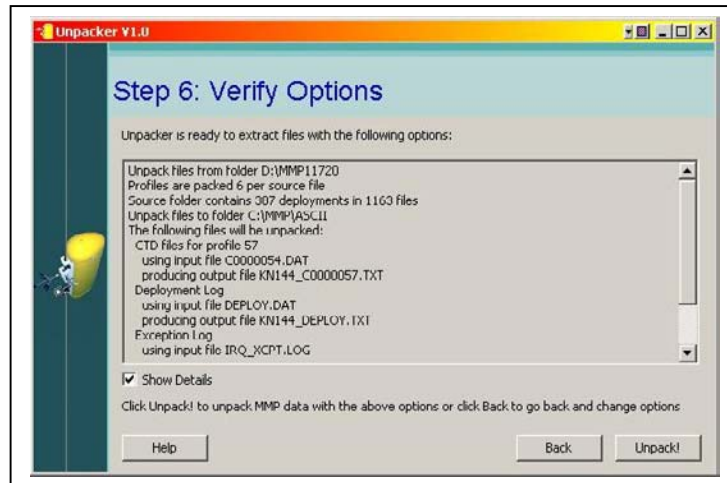
Figure 6-20: Step 6 Verify Selected Options

Unpacking progress displays in the status bar and any errors are reported in the Activity Log. Details of the unpacking process are saved in UNPACKER.LOG in the destination directory.
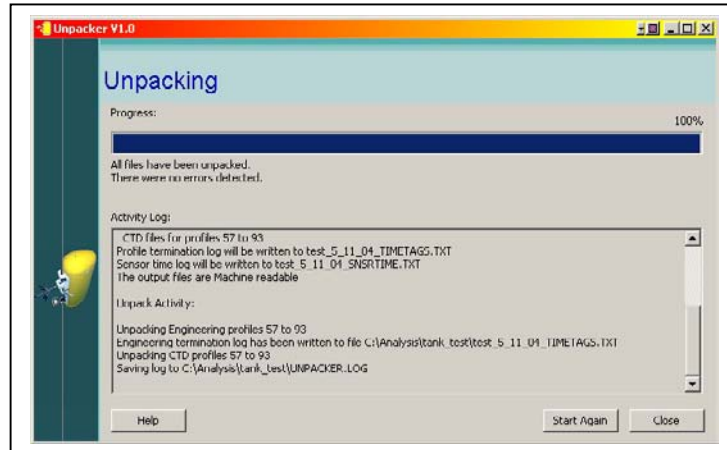
Figure 6-21: Unpacking Progress

NOTE

When the Unpacker encounters a missing data file, the file is skipped and unpacking continues. After unpacking is complete, any missing files are itemized in both the Unpacker Acitivity Log window and in the file UNPACKER.LOG.

NOTE

Converted DEPLOY.DAT information is written to a DEPLOY.TXT file and also saved in the destination directory. DEPLOY.DAT should be permanently archived with the data files as it is a record of the conditions under which the data was collected (deployment termination condition and time and the deployment definition information).

Unpacked Files

In addition to UNPACKER.LOG, and the unpacked CTD and Engineering files, other auxiliary text files are saved in the destination directory with the DEPLOY.TXT file. These files are IRQ_XCPT.TXT (displays the time tagged log of interrupt requests and exception)

SNSRTIME.TXT (a log of sensor power up and power down times), and TIMETAGS.TXT (contains each profile start and stop time).

Each line in TIMETAGS.TXT contains the profile number, sensor turn on date and time, motion start date and time, motion stop date and time, sensor turn off date and time and termination condition. Deployment termination conditions are also specified as listed below.

Code	Definition
0	SMOOTH RUNNING
1	MISSION COMPLETE
2	OPERATOR CTRL C
3	TT8 COMM FAILURE
4	CTD COMM FAILURE
5	ACM COMM FAILURE
6	TIMER EXPIRED
7	MIN BATTERY
8	AVG MOTOR CURRENT
9	MAX MOTOR CURRENT
10	SINGLE PRESSURE
11	AVG PRESSURE
12	AVG TEMPERATURE
13	TOP PRESSURE
14	BOTTOM PRESSURE
15	PRESSURE RATE ZERO
16	STOP NULL
17	FLASH CARD FULL
18	FILE SYSTEM FULL
19	TOO MANY OPEN FILES

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The unpacked files are assigned names with the form ENNNNNNN.DAT, CNNNNNNN.DAT, identifying the files as engineering (E) or CTD (C), with the profile number padded with leading zeros (0000000, 0000001, 0000002, …, etc.).

The converted DEPLOY.DAT file is written to a DEPLOY.TXT file and saved in a destination directory.

The profile count stored in PROFILES.DAT is the number of the last profile of the deployment. If the profile count is unavailable for some reason, the system uses the maximum number of files that the file system can accommodate.

Editing MMPUnpacker.INI

MMPUNPACKER.INI is a standard Windows INI file located in the Windows directory. This file is automatically created when the MMP Unpacker executes.

IMPORTANT
Editing the .INI file can affect the appearance and operation of the Unpacker and should be performed only by advanced users.

To edit MMPUNPACKER.INI, open the file in a text editor and use the table shown next as a guide to change default program values.

MMPUnpacker.INI Configuration Options		
Key	**Description**	**Default Value**
SrcDir	Source path for files to unpack.	C:\MMP
DstDir	Destination path for files to unpack.	C:\MMP
ProfileRange	Range of files to unpack (ALL, SINGLE or RANGE): 1 = unpack all profiles 2 = unpack single profile 3 = unpack range of profiles	1 (unpack all)
FirstProfile	If ProfileRange=2 (unpack single profile), this value is the profile to unpack; if ProfileRange=3 (unpack range of profiles), this value is the first profile in the range to unpack.	0
LastProfile	If ProfileRange=3 (unpack range of profiles), this value is the last profile in the range to unpack.	0
UnpackAll	Boolean value set to True (non-zero) if unpacking all files. Changing this value to 0 unlocks the Options values (see next Key description) so that specific files can be selected to unpack.	1 (TRUE)

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MMPUnpacker.INI Configuration Options		
Key	**Description**	**Default Value**

Options	Specifies the files to unpack. This number can be a combination of the following bitmask values:
	
	  1 = ENG files
	
	  2 = CTD files
	
	  4 = ACM files
	
	  8 = Deployment files
	
	 16 = Exception log
	
	For example, a value of 7 unpacks ENG, CTD and ACM files (2 + 4 + 1). A value of 31 (1 + 2 + 4 + 8 + 16) unpacks all files.
	
	If the default 0 remains in this Key, no files are unpacked.
		0

Prefix	Prefix string to pre-pend to output file names and uniquely tag each file so that unpacked files from multiple deployments can be stored in the same directory. For example, 'KN144' would display on the first engineering file as KN144_E0000000.TXT	NULL (no prefix string)
HumanReadible	Boolean value set to TRUE (non-zero) if output files are to be human readable.	0 (FALSE)
WindowX	Window X screen position.	default value
WindowY	Window Y screen position.	default value
WindowW	Window screen width.	default value
WindowH	Window screen height.	default value

NOTE
Unless necessary, leave the WindowX, WindowY, WindowW, and WindowH keys unchanged. Changes to these keys will affect screen position and appearance.

MMPUnpacker.INI Configuration Options		
LogLevel	Level of logging detail supported. This is a combination of any of the following bitmask values: 1 = log information 2 = log activity 4 = log warnings 8 = log errors 15 = log everything	15 (log everything) This key is never written back to the Unpacker code and will not permanently change the Unpacker Wizard.
LogSize	Size of log.	32M This key is never written back to the Unpacker code and will not permanently change the Unpacker Wizard.
SaveLog	Set to TRUE (1) if log is saved to file for each unpack.	1 (TRUE) This key is never written back to the Unpacker code and will not permanently change the Unpacker Wizard.
LogName	Name of the log file.	Unpacker.log This key is never written back to the Unpacker code and will not permanently change the Unpacker Wizard.
HideAnimation	Set to 1 (TRUE) if animation is not shown.	0 (FALSE) This key is never written back to the Unpacker code and will not permanently change the Unpacker Wizard.

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MMPUnpacker.INI Configuration Options		
SkipToPreview	Set to 1 (TRUE) if NEXT button on initial screen goes directly to preview step and skips all the intermediate steps.	0 (FALSE) This key is never written back to the Unpacker code and will not permanently change the Unpacker Wizard.

Notes

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Appendix A
Operating Crosscut for Windows and Crosscut

McLane recommends using the file capture for all deployments. File Capture creates a log of operations, deployment settings, and recovery procedures. McLane recommends two standard file capture programs freely distributed by Onset Computer (www.onsetcomp.com) for TT8v2 communication. Crosscut for Win is Windows-based and Crosscut is a DOS-based program that runs on a PC.

NOTE
Download compressed archives of Crosscut for Win and Crosscut and software at the McLane website (www.mclanelabs.com).

Using Crosscut for Win

Crosscut for Win is a Windows-based program that runs on a PC. Crosscut for Win will run without modification or difficulty under all currently available versions of Windows, including 95, 98, Me, NT, 2000 and XP. Contact McLane or Onset Computer (www.onsetcomp.com) for additional information.

First-Time Crosscut for Win Use

To use Crosscut for Win for the first time, complete the following steps:

1. Create a Crosscut for Win directory and copy into it the two Crosscut for Win files from the disk provided in the tool kit.

2. Click on the Crosscut for Win icon to run the program. You may also choose to establish a short cut from your desktop. Do not connect the COM cable to the ITP yet.

3. Select 'CommPort' from the menu bar at the top of the Crosscut for Win window and then 'Setup' from the submenu.

4. Select the COM port you intend to use and set the port parameters to 9600 baud, 8 data bits, 1 stop bit, and no parity (9600, 8, N, 1).

5. Click 'OK'. The system stores these values and they will be used whenever Crosscut for Win is started in the future.

6. Connect the COM cable to the PC, then connect to the controller.

<u>Capturing Data Files with Crosscut for Win</u>

1. Start Crosscut for Win.

2. To capture a data file after a deployment select 'Terminal' from the menu bar and 'Capture Setup' from the submenu.

3. Enter a *Capture file name* in the box and select *Overwrite* or *Append*. Overwrite replaces any information in an existing log file. Append adds new information to an existing file (choose carefully!).

4. Click 'OK'.

5. Start 'File → Capture'. Everything that appears in the Crosscut for Win window is written to the file.

IMPORTANT
In Crosscut for Win, File→ Capture must be manually switched on using Step 5. Confirm that the 'Capture' box in the lower left of the Crosscut for Win display is 'on' and is highlighted in Yellow.

6. Toggle file logging by selecting 'File' and 'Capture' again.

7. To exit Crosscut for Win select 'File' from the menu bar and 'Exit' from the submenu.

The format of the captured data file is ASCII text (you should use the extension .TXT for the file name). ASCII text files can be read by word processors and text editors.

Crosscut for Win requires you to supply a name for the log file the first time the capture utility is called during a Crosscut for Win session. That name then becomes the default for the remainder of the session. The file can be renamed after capture on the hard disk of the PC.

Connecting the firmware to a PC

When connecting a DB-9 or DB-25 connector to the serial port of a PC, rocking the connector back and forth can cause a Comm Port Crash in the TT8v2. If a crash occurs, you must remove the connector and then restore power to recover control of the firmware. The crash is caused by signals or apparent signals on the receive pin of the communications port if they arrive

when the TT8v2 is in low power sleep and if the ground connection between the TT8v2 and the PC is intermittent.

To prevent a crash, boot the PC, start Crosscut, connect the cable to the PC, connect the cable to the ITP, and connect power to the ITP (in that order).

To connect and disconnect the communications cable complete the following steps:

1. Always boot the PC and start Crosscut before connecting the communications cable to the ITP.

2. Connect the communications cable first to the PC and then to the ITP.

3. Disconnect the communications cable first from the ITP and then from the PC.

4. Connect to and disconnect from the ITP as smoothly as possible. Try to prevent repeated intermittent contacts.

5. Leave the PC and Crosscut running until the COMM cable is disconnected from the ITP.

Using Crosscut

Crosscut is a DOS-based program that runs on a PC. Crosscut will run without modification or difficulty under DOS, Windows up to Windows 98, 1st edition, and Windows NT up to Version 4.0, Service Pack 5. Later releases of these operating systems commonly require a change to the registry of your PC to disable power management of the serial port. Modifications may also be required to enable the mouse. Detailed instructions for the registry change can be found below and at www.mclanelabs.com/laptops_and_crosscut.html. Contact McLane or Onset Computer (www.onsetcomp.com) for additional information.

First Time Crosscut Use

To use Crosscut for the first time, complete the following steps:

1. Place the six Crosscut files from the disk provided in the Toolkit into a directory that is on your path or create a new directory for them and add it to your path. Alternatively, create a Crosscut directory and place the six Crosscut files there. If you operate Crosscut from the directory that contains the files, changes to the path are unnecessary.

2. Type *crosscut* at the DOS prompt or click on the Crosscut icon to run the program (a short cut can also be created from the desktop). Do not connect the PC to the TT8v2 yet.

3. Select 'CommPort' from the menu bar at the top of the Crosscut window and then 'Port setup' from the submenu (use a mouse or the keyboard combination [ALT]-[P]).

4. Use the mouse or [TAB] and arrow keys to set the COM port being used to 9600 baud, 8 data bits, 1 stop bit, no handshaking, and no parity (9600, 8, N, 1). Crosscut should have these values preset.

5. Click 'OK' to store these values in the configuration files so they will be reused whenever Crosscut is started.

Editing the Registry to Enable Crosscut

1. On the desktop of a PC running a recent version of Windows, click START and select RUN from the pop up menu.

2. In the prompt box type *regedit* and click on OK to start the registry editor window.

3. The editor will display a Windows directory tree in the left half of the window and a folder contents display in the right half of the window. Click your way through the directory tree following this path:

    HKEY_LOCAL_MACHINE / SYSTEM / CurrentControlSet / Services / VxD / VCOMM

4. Click on the VCOMM folder and its contents will be displayed in the right half of the window.

5. Double-click on ENABLE POWER MANAGEMENT in the right half of the window and change its value from *01 00 00 00* to *00 00 00 00* using the editing tool that pops up.

6. After the value has been changed, work your way back out through the directory tree and exit the registry editor.

7. Exit all programs, restart your PC, and try Crosscut again.

Capturing Data Files Using Crosscut

Once steps are completed for first-time Crosscut use, follow the steps below to capture data files:

1. To start Crosscut type *crosscut* at a DOS prompt or click on the Crosscut icon (the Crosscut directory must be in the directory path when for this step).

2. To capture a data file after a deployment select 'CommPort' from the menu bar and 'Capture to File' from the submenu.

3. Select a directory and a name for the file.

4. The 'Open file' window that will appear in the Crosscut window. [ALT]-[Z] brings up the "Open file" window from the keyboard.

5. Type the path and name of the file in the *Name* field or use the [TAB] and [ENTER] keys to select the directory and enter the name in the *Name* field.

6. Once the capture is started, everything that appears in the Crosscut window, from both the instrument and the keyboard, is written to the file. Run the offload utility and the data unpacked from the flash card will be captured in the named log file. (Crosscut overwrites the information in an existing log file).

7. Terminate file logging by selecting 'CommPort' and 'Capture to File' again or by typing [ALT]-[Z].

8. To exit Crosscut select 'File' from the menu bar and 'Quit' from the submenu or type [ALT]-[Q].

The format of the captured data file is ASCII text (use the extension .TXT for the file name). ASCII text files can be loaded and edited by all of the common word and text processors.

Crosscut assigns a default file name of CAPTURE.TXT to log files. The operator can, as described above, change the name before logging begins. That name then becomes the default during that Crosscut session. Alternatively, the file can be renamed once captured to the hard disk of the PC. In either case, Crosscut does not append (each log file must eventually be given a unique name and path or it will be overwritten).

Connecting the COM Cable

Connecting a DB-9 or DB-25 connector to a PC serial port by rocking the connector back and forth can cause a Com Port Crash in the TT8v2. If a crash occurs, remove the connector and then cycle power to reset the TT8v2. The crash is caused by signals or apparent signals on the receive pin of the communications port if they arrive when the TT8v2 is in low power sleep and if the ground connection between the TT8v2 and the PC is intermittent.

To connect and disconnect the communications cable note the following guidelines:

1. Always boot the PC and start Crosscut before connecting the communications cable to the controller.

2. Connect the communications cable first to the PC and then to the instrument.

3. Disconnect the communications cable first from the controller and then from the PC.

4. Connect to and disconnect from the controller as smoothly as possible. Try to prevent repeated intermittent contacts.

5. Leave the PC and Crosscut running until the COM cable is disconnected from the controller.

Additional Documentation

A more detailed and complete description of Crosscut operations can be found in the file crosscut.doc, which is included with the Crosscut program. Crosscut for Win has a help utility which can be viewed by selecting 'Help' from the menu bar.

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Appendix B
Bench Top Deployment

Deployment planning requires the development of a sampling schedule targeted for the scientific goals. Programming a bench top deployment allows the operator to change schedule settings and provides an estimate of battery endurance. Appendix B shows a bench top deployment for an ITP with a 41CP CTD and explains how different settings affect endurance.

IMPORTANT
When performing a bench top deployment, use the Crosscut file capture utility to create a log.

The screens that follow show how the firmware recalculates the endurance estimate based on schedule settings.

```
             ID        M| Mooring ID              = 001

             Start     Z| Countdown delay         =      00:05:00 [HH:MM:SS]
6 hour start
interval
between    ▶ Schedule  I| Profile start interval  = 000 06:00:00 [DDD HH:MM:SS]
profiles              R| Reference date/time     =   01/01/2001 00:00:00
                      B| Burst Interval          =      Disabled
                      N| Profiles per burst      =      Disabled
                      P| Paired profiles                Disabled
                      F| Profiles / file set     =             1

Profile between
5 and 1000   Stops     S| Shallow pressure        =           5.0 [dbar]
meters              ▶ D| Deep pressure           =        1000.0 [dbar]
                      H| Shallow error           =         500.0 [dbar]
Firmware              E| Deep error              =         500.0 [dbar]
calculates time    ▶ T| Profile time limit      =      01:37:55 [HH:MM:SS]
for a single         C| Stop check interval     =            30 [sec]
profile based        L| Fluorometer             =      Disabled
on Shallow and       O| OBS Turbidity           =      Disabled
Deep pressure

             Endurance  | Power for single profile =        315.1 [mAh]
755 profiles         | Total profiles/(240 Ah) =           755
estimated for      ▶ | Est. battery expiration = 03/11/2008 08:53:10
these settings  Deploy  V| Verify and Proceed
```

Figure B-1: Profile Between 5 and 1000 Meters, every 6 Hours

In Figure B-2, Profile Start Interval is increased to 12 hours. The recalculated endurance estimate has the same power for a single profile and new total profiles and battery expiration date.

```
ID          M| Mooring ID                = 001

 Start      Z| Countdown delay           =     00:05:00 [HH:MM:SS]

 Schedule   I| Profile start interval    = 000 12:00:00 [DDD
HH:MM:SS]
            R| Reference date/time        =    01/01/2001 00:00:00
            B| Burst Interval             =       Disabled
            N| Profiles per burst         =       Disabled
            P| Paired profiles                    Disabled
            F| Profiles / file set        =              1

 Stops      S| Shallow pressure           =          5.0 [dbar]
            D| Deep pressure              =       1000.0 [dbar]
            H| Shallow error              =        500.0 [dbar]
            E| Deep error                 =        500.0 [dbar]
            T| Profile time limit         =     01:37:55 [HH:MM:SS]
            C| Stop check interval        =           30 [sec]
            L| Fluorometer                =       Disabled
            O| OBS Turbidity              =       Disabled

 Endurance  | Power for single profile   =        315.1 [mAh]
            | Total profiles/(240 Ah)    =          748
            | Est. battery expiration    =  09/12/2008 14:53:29

 Deploy     V| Verify and Proceed
```

12 hour start interval between profiles → (Schedule)

Time for a single profile unchanged → (Profile time limit)

748 profiles estimated for these settings → (Total profiles)

Figure B-2: Profile Between 5 and 1000 Meters, every 12 Hours

In Figure B-3, Profile Start Interval is decreased to 4 hours. The recalculated endurance estimate has the same power for a single profile and new total profiles and battery expiration date.

```
ID          M| Mooring ID                = 001

 Start      Z| Countdown delay           =     00:05:00 [HH:MM:SS]

 Schedule   I| Profile start interval    = 000 04:00:00 [DDD
HH:MM:SS]
            R| Reference date/time        =    01/01/2001 00:00:00
            B| Burst Interval             =       Disabled
            N| Profiles per burst         =       Disabled
            P| Paired profiles                    Disabled
            F| Profiles / file set        =              1

 Stops      S| Shallow pressure           =          5.0 [dbar]
            D| Deep pressure              =       1000.0 [dbar]
            H| Shallow error              =        500.0 [dbar]
            E| Deep error                 =        500.0 [dbar]
            T| Profile time limit         =     01:37:55 [HH:MM:SS]
            C| Stop check interval        =           30 [sec]
            L| Fluorometer                =       Disabled
            O| OBS Turbidity              =       Disabled

 Endurance  | Power for single profile   =        315.1 [mAh]
            | Total profiles/(240 Ah)    =          758
            | Est. battery expiration    =  01/08/2008 23:11:03
 Deploy     V| Verify and Proceed
```

4 hour start interval between profiles → (Schedule)

Time for a single profile unchanged → (Profile time limit)

758 profiles estimated for these settings → (Total profiles)

Figure B-3: Profile Between 5 and 1000 Meters, every 4 Hours

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In Figure B-4, Shallow Pressure is changed from 5 to 500 meters. The recalculated endurance estimate shows less power for a single profile and new total profiles and battery expiration date.

```
ID          M| Mooring ID             = 001

 Start      Z| Countdown delay        =     00:05:00 [HH:MM:SS]

 Schedule   I| Profile start interval = 000 06:00:00 [DDD
 HH:MM:SS]
            R| Reference date/time     =   01/01/2001 00:00:00
            B| Burst Interval          =     Disabled
            N| Profiles per burst      =     Disabled
            P| Paired profiles               Disabled
            F| Profiles / file set     =            1

 Stops      S| Shallow pressure        =        500.0 [dbar]
            D| Deep pressure           =       1000.0 [dbar]
            H| Shallow error           =        500.0 [dbar]
            E| Deep error              =        500.0 [dbar]
            T| Profile time limit      =     00:56:40 [HH:MM:SS]
            C| Stop check interval     =           30 [sec]
            L| Fluorometer             =     Disabled
            O| OBS Turbidity           =     Disabled

 Endurance   | Power for single profile =      159.5 [mAh]
             | Total profiles/(240 Ah)  =       1479
             | Est. battery expiration  = 09/08/2008 08:38:35

 Deploy     V| Verify and Proceed

            Selection  ? v
```

Labels (left margin, pointing into figure):
- **6 hour start interval** → Schedule
- **Profile between 500 and 1000 meters** → Stops
- **Firmware recalculates time limit** → Stop check interval
- **1479 profiles estimated for these settings** →

Figure B-4: Profile Between 500 and 1000 Meters. Every 6 Hours

Full Bench Top Deployment Example

The next section shows a full bench top deployment for an ITP with the 41CP CTD and explains the settings that display.

To shorten the bench test, the profile time limit can be set to 1 minute to end downward profiles (because the ambient pressure on the bench remains near zero, a longer bench test would result if the time limit were set long enough to allow a zero pressure rate detection). The shallow pressure limit can be set to 0 dbars to end upward profiles based on ambient pressure.

For this bench test example, the deployment was manually stopped after Profile 0.

NOTE
During deployment initialization, a message displays to leave the communications cable in place to observe initialization and respond to any problems that arise. After initialization is complete, a reminder to disconnect the communications cable displays, but this message can be ignored.

IMPORTANT
The flash card is reformatted during deployment initialization to remove data files from previous deployments. MMP-N_NN.RUN, AUTOEXEC.BAT and other required files are preserved in TT8v2 RAM and restored to the flash card when reformatting is complete. Deleted data files are not recoverable.

Short Circuit of Tubing ————▶

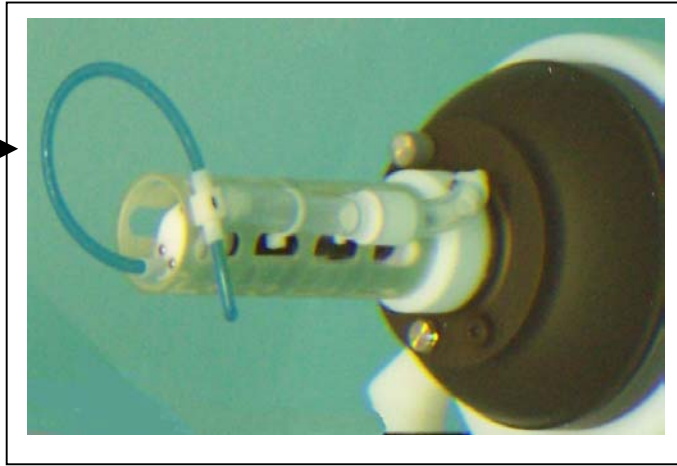*Figure B-5: Short Circuit of Tubing*

```
                   McLane Research Laboratories, USA
                        McLane Moored Profiler
                   Version: MMP-4_05  S/N: ML12000-000
                 ┌────────────────────────────────────┐
                 │              Main Menu               │
                 └────────────────────────────────────┘
                         Fri Apr 20 07:18:41 2007

                 <1> Set Time          <5> Bench Test
                 <2> Diagnostics       <6> Deploy Profiler
                 <3> Flash Card Ops    <7> Offload Deployment Data
                 <4> Sleep             <8> Contacting McLane
                 <C> Configure
                   Selection  ? 6

         Clock reads 04/20/2007 07:18:51
         Change time & date (Yes/No) [N] ?

         Setting watchdog clock . . . done.

         Profiling history:
           Total motor hours:                   1.94 hours
           Total meters traveled:                  0 meters

         Verification of sensor settings
         <A> Automated (standard settings only)
         <M> Manual    (operator controlled)
         <S> Skip Verification

         Selection  ? a

          Automated verification of sensor settings.

          Applying power to CTD . . .
          SBE 41CP McLane V 2.2
         S>

          Sending command  initprofile

         S>
          Expected response received.
          Proceeding to next command.
          Sending command  ds

         SBE 41CP McLane V 2.2  SERIAL NO. 1948
         stop profile when pressure is less than = -100.0 decibars
         automatic bin averaging when p < -100.0 disabled

         number of samples = 0
         number of bins = 0
         top bin interval = 10
         top bin size = 10
         top bin max = 100
         middle bin interval = 50
         middle bin size = 50
         middle bin max = 1000
         bottom bin interval = 100
         bottom bin size = 100
         do not include two transition bins
         S>

          Expected response received.
          Standard CTD settings verified.
         Sensor suite initialized and ready for deployment.

          Press any key to continue.
```

Start deployment → Selection ? 6

Automated 41CP CTD sensor verification → Selection ? a

Figure B-6: Bench top Deployment Example (screen 1 of 5)

```
ID        M| Mooring ID            = 001

Start     Z| Countdown delay       =     00:05:00 [HH:MM:SS]

Schedule  I| Profile start interval = 000 00:30:00 [DDD
HH:MM:SS]
          R| Reference date/time    =    01/01/2001 00:00:00
          B| Burst Interval         =      Disabled
          N| Profiles per burst     =      Disabled
          P| Paired profiles               Disabled
          F| Profiles / file set    =             1

Stops     S| Shallow pressure      =          0.0 [dbar]
          D| Deep pressure         =         60.0 [dbar]
          H| Shallow error         =        500.0 [dbar]
          E| Deep error            =        500.0 [dbar]
          T| Profile time limit    =     00:01:00 [HH:MM:SS]
          C| Stop check interval   =           15 [sec]
          L| Fluorometer           =      Disabled
          O| OBS Turbidity         =      Disabled

Endurance | Power for single profile =       21.2 [mAh]
          | Total profiles/(240 Ah)  =      11230
          | Est. battery expiration  =   12/10/2007 06:24:25

Deploy    V| Verify and Proceed


Selection  ? v

 Checking entries . . . done.
 All entries are within allowed ranges.

 Checking profile schedule . . . done.
 Calculated minimum profile duration:          00:23:48
 Profile schedule selections are consistent.

 Checking burst schedule . . . done.
 Burst mode disabled.

 >>>>> WARNING: Flash card file limit will be reached
               before the battery expires.

 Accept and store schedule selections (Yes/No) [Y] ?

 Storing deployment definition parameters . . . done.


 WARNING:  If you have not already done so,

           REMOVE the flow path CAPS from the CTD NOW.

           Failure to remove the caps will prevent proper
           CTD operation during the deployment and may
           cause permanent damage to the sensor.

           After removing the caps, press any key
           to continue.

 CAUTION:  Deployment will erase all data
           files stored on the flash card
```

Shallow pressure 0 dbar for bench test →

Profile time limit 1 minute for bench test →

Check schedule consistency →

Figure B-7: Bench top Deployment Example (screen 2 of 5)

```
System status:

 RTC: 04/20/2007 07:19:47   WDC: 04/20/2007 07:19:46   11.6 Vb
0 mA


Proceed with the deployment (Yes/No) [N] ? y


 >>> Initializing autonomous operation <<<

 Do NOT remove the communication cable
    until initialization is complete.

Setting motor to Free Wheel during launch . . . done.

Powering on the UIM . . .done.

Initializing data pointers and status flags . . . done.

Initializing flash card . . .
   Deleting all previous data files
      (process may take several minutes) . . . .

Deleting all files                                    . . .
   Initializing flash pointers . . .
   Creating DEPLOY.DAT . . .
   Creating PROFILES.DAT . . .
   Creating IRQ_XCPT.LOG . . .
   Creating LASTSENT.DAT . . .
Flash card initialization complete.

04/20/2007 07:20:01

Sensor warm-up will begin at           04/20/2007 07:23:01
Initial dive to bottom stop will begin at  04/20/2007 07:25:01.


System is ready to deploy.

Remove communication cable, apply dummy
plug to communications port, and attach
faired bottom cap to vehicle.
```

Committing to the deployment

Instruction to keep COM cable in place

UIM powers on for operator status request (only occurs before Dive 0)

Flash card is reformatted

Remove the COM cable when deploying (Ignore this message for bench test)

Figure B-8: Bench top Deployment Example (screen 3 of 5)

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```
                         04/20/2007 07:20:03 Sleeping  until 04/20/2007 07:23:01 . . .
Sensor warmup
at 07:23:01
(2 minutes          Powering off the UIM before dive 0
before Dive 0)

UIM powers off      04/20/2007 07:23:01
before Dive 0

                    Initializing CTD logging pointers . . .
CTD powers on,
2 minute            SBE 41CP McLane V 2.2
warmup
                    S>

                     Sending command  startprofile


                    profile started, pump delay = 0 seconds

                    S>

                     Expected response received.

                     CTD logging pointers initialized.

                     04/20/2007 07:23:10

                     Continuing 120 second sensor warm-up.
                     Initial dive to bottom stop will begin at  04/20/2007 07:25:01.

Start Profile 0      04/20/2007 07:23:12 Sleeping  until 04/20/2007 07:25:01 . . .
at 07:25:01         04/20/2007 07:25:01

                     Opening file E0000000.dat for storage of
                     profile 0 engineering data.

Motion begins,      Beginning profile 0
velocity ramp       Full speed reached.  Setting low power run mode.
complete             16 mA   11.5 V

Stop check           Checking for stop . . .
                     Current pressure    0.110 dbar
                     04/20/2007 07:25:33 Sleeping  until 04/20/2007 07:25:45 . . .

                      16 mA   11.5 V
Stop check           Checking for stop . . .
                     Current pressure    0.100 dbar
                     Current speed       0.001 dbar/s
                     04/20/2007 07:25:47 Sleeping  until 04/20/2007 07:26:00 . . .

                      16 mA   11.5 V
Stop check           Checking for stop . . .
                     Current pressure    0.120 dbar
                     Current speed       0.000 dbar/s

Found stop           04/20/2007 07:26:02 Sleeping  until 04/20/2007 07:26:15 . . .
(programmed 1
minute profile        15 mA   11.5 V
time limit)         Checking for stop . . . found stop.

                     Profile timer expired at 04/20/2007 07:26:15

                     04/20/2007 07:26:16
2 minute
sensor warm
down begins         Programmed pause to provide sensor data for
                    a post deployment sensor bias check, 120 seconds

                     04/20/2007 07:26:18 Sleeping  until 04/20/2007 07:28:16 . . .
```

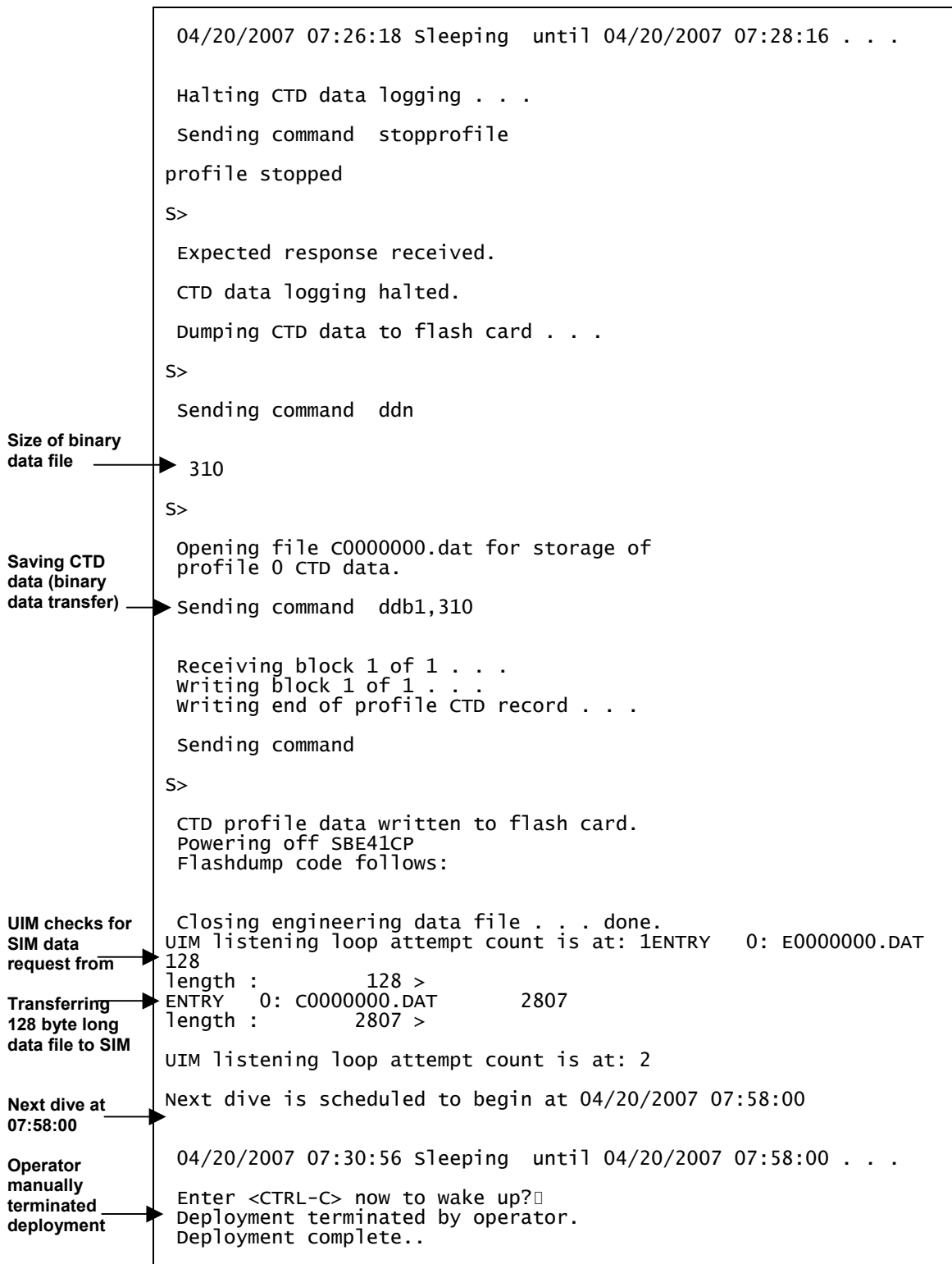*Figure B-9: Bench top Deployment Example (screen 4 of 5)*

```
   04/20/2007 07:26:18 Sleeping  until 04/20/2007 07:28:16 . . .

 Halting CTD data logging . . .

 Sending command  stopprofile

profile stopped

S>

 Expected response received.

 CTD data logging halted.

 Dumping CTD data to flash card . . .

S>

 Sending command  ddn


 310

S>

 Opening file C0000000.dat for storage of
 profile 0 CTD data.

Sending command  ddb1,310


 Receiving block 1 of 1 . . .
 Writing block 1 of 1 . . .
 Writing end of profile CTD record . . .

 Sending command

S>

 CTD profile data written to flash card.
 Powering off SBE41CP
 Flashdump code follows:


 Closing engineering data file . . . done.
UIM listening loop attempt count is at: 1ENTRY   0: E0000000.DAT
128
length :        128 >
ENTRY   0: C0000000.DAT      2807
length :       2807 >

UIM listening loop attempt count is at: 2

Next dive is scheduled to begin at 04/20/2007 07:58:00


 04/20/2007 07:30:56 Sleeping  until 04/20/2007 07:58:00 . . .

 Enter <CTRL-C> now to wake up?
 Deployment terminated by operator.
 Deployment complete..
```

Size of binary data file —▶ (points to `310`)

Saving CTD data (binary data transfer) —▶ (points to `Sending command  ddb1,310`)

UIM checks for SIM data request from ▶ (points to `UIM listening loop attempt count is at: 1ENTRY`)

Transferring 128 byte long data file to SIM ▶ (points to `ENTRY   0: C0000000.DAT`)

Next dive at 07:58:00 ▶ (points to `Next dive is scheduled to begin...`)

Operator manually terminated deployment ▶ (points to `Deployment terminated by operator.`)

Figure B-10: Bench top Deployment Example (screen 5 of 5)

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Appendix C
System Architecture

This Appendix explains the firmware architecture in detail beginning with the deployment process.

Starting a Deployment

1. Deployment parameters are programmed and the autonomous portion of a deployment is initiated.

2. The firmware places the TT8v2 into Low Power Sleep (LPS) for a user-specified interval, while the profiler is launched.

3. The TT8v2 wakes from LPS (based on an alarm signal set by the firmware, the programmed schedule, or when commanded to wake-up by an operator).

4. The system conducts Profile 0 to move the profiler to the bottom of the programmed range. Subsequent profiles are numbered 1, 2, 3, … and are conducted following the programmed schedule (odd numbered profiles go from the bottom of the programmed range to the top and even numbered profiles go from top to bottom).

5. The sensors turn on and begin logging data two minutes before the scheduled start time of each profile.

6. Profiler motion begins at the scheduled start time. During the profile, the sensors log data autonomously and the profiler records engineering and status information. Also during a profile the firmware queries the CTD for real-time depth (pressure) measurements. The information is used to determine when the end of a profile has been reached or an obstruction has been encountered.

7. The sensors continue to log internally for two minutes.

8. The firmware stops the sensors and transfers all CTD sensor data (conductivity, temperature, depth and oxygen if applicable) to the flash card (a profile is complete when the sensor and engineering files have been closed).

9. The system enters LPS again and waits for the next scheduled profile. The interval of sensor logging between motion start and stop provides data for use during post-processing to correct for sensor drift. Other conditions, such as an obstacle blocking the mooring cable, can be detected during a profile and may trigger changes in profiling action.

10. The system continues to conduct profiles until the deployment is terminated.

Ending a Deployment

1. The system terminates a deployment if the termination menu option is selected, the battery falls below 7.5 V, or the flash card is full.

2. After terminating a deployment the firmware places the TT8v2 in low power sleep (LPS).

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The firmware operating system programs include:

- Communications and control routines for system components.
- Logical structure that guides a deployment based on the deployment definition parameters supplied by the operator (the installed version of the code is stored on the flash card and loaded into the RAM whenever power is applied or the system is otherwise rebooted). The code executes in RAM, and accesses information stored in the flash memory, in the serial EEPROM, and on the flash card.

The serial EEPROM stores:

- The serial number of each unit.
- Motor hours and estimated meters traveled.
- Profile termination log.
- Termination time and condition.
- A copy of the deployment definition parameters (an additional copy of the deployment definition parameters is stored on the flash card so that copies travel with both the system and the data). The deployment definition parameters stored in the serial EEPROM contain the last settings programmed by the operator.

MMP Unpacker Program

The MMP Unpacker application (for firmware versions 3.01 and higher) can be used to unpack the binary deployment data files to ASCII text. For information about the Unpacker, see the section "Unpacking and Translating the Binary Data Files" in this User Manual.

Files Stored On the Flash Card

During each profile, the firmware creates and stores data files on the flash card (one for the CTD and one for the engineering data which includes all of a profile's time tags). The data is stored as scaled integers to minimize storage requirements. Each of the values (C, T, D, and O, if applicable) in a CTD record requires 3 bytes (9 bytes/record). The binary data processors provided with the firmware translate data using these specific scaling and offset values.

Time tags in the engineering data file record the start and stop times for sensor data collection, profiler motion, battery voltage, motor current, ambient pressure, and termination condition. The information is stored in a coded binary form to reduce file size. These data files are described in more detail in Chapter 3, "ITP User Interface" in the section titled "<7> Offload Deployment Data", and in Chapter 6, Data "Offload, Processing, and Interpretation".

The flash card also contains a system file called IRQ_XCPT.LOG, which records a time history of interrupt requests (IRQs) and other exceptions sent to or detected by the TT8v2 during the deployment. Other logged exceptions include the creation time of the file, critical handler faults (low level problems detectable by the 68332 CPU, the critical handler places the system in a controlled low power state until it is rebooted by the watchdog), and unattended resets (a reboot by the watchdog after the 68332 CPU crashes and fails to acknowledge a watchdog IRQ).

The remaining files stored on the flash card are AUTOEXEC.BAT, the firmware (MMP-N_NN.RUN) DEPLOY.DAT (deployment settings), PROFILES.DAT (profile count, which is the number of the last profile of the deployment) and LASTSENT.DAT (used with the Underwater Inductive Modem option). SCHEDULE.DPL must also be on the flash card if using the Deployment Planner.

AUTOEXEC.BAT is automatically executed by PicoDOS when power is applied to the system or a reboot is executed. The MMP AUTOEXEC.BAT file calls the firmware, triggering the transfer to RAM and subsequent execution of the program.

For the firmware, MMP-N_NN.RUN, N_NN is the version number, e.g., MMP-4_03.RUN.

IMPORTANT
Archive AUTOEXEC.BAT and MMP-N_NN.RUN onto a PC hard drive and bring copies to every deployment. If either of these files is inadvertently removed from the flash card the profiler will be inoperable. A backup of each program is provided with the profiler.

To install AUTOEXEC.BAT and the MMP-N_NN.RUN backup programs, insert the flash card to a PC and copy the files from the flash card to the PC using standard DOS or Windows commands.

IMPORTANT
Before copying the files, archive all data files, create a backup and then reformat the flash card to avoid fragmenting the file structure on the card.

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When the system switches on, the screen displays the total data files that the flash card can accommodate. The firmware reserves space for 16 data files. This number is subtracted from the flash card to obtain the file system accommodation number

```
File system can accommodate  4080 data files
```

Profiles/File Set

The 'Profiles/file set' option allows more profiles to be conducted by storing multiple profiles as a single data file. The maximum profiles per file set is affected by the configuration of the instrument. And is described in Chapter 3, "ITP User Interface".

Electronics

The controller is a three board stack mounted on the chassis plate between the controller housing end cap and the main battery cage.
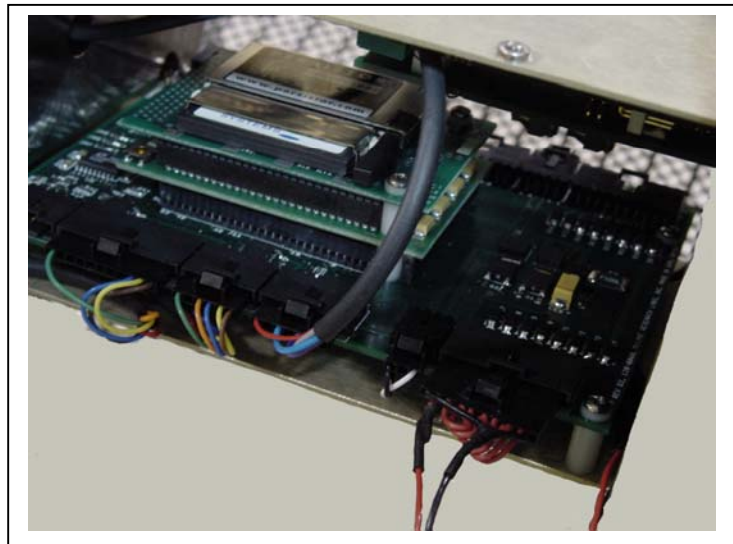
Figure C-1: Controller Stack

IMPORTANT
MMP v4.01 (and higher) operate only on the Rev D board.   The firmware displays an error if installed onto a Rev A, B, or C controller board. Use standard electrostatic discharge (ESD) precautions when handling electronics.

Tattletale 8v2 Micro-Controller

The Tattletale 8 version 2 (TT8v2) is the physical brain of the profiler and is a single-board micro-controller with significant computational and I/O capabilities. The main processor is a Motorola 68332, a 68000 family CPU with multiple co-processors and I/O modules on a single IC. In addition to the 68332, the TT8v2 includes a PIC micro-controller serving as a boot manager and programmable real-time clock (RTC), 256 Kbytes of flash memory, 1 Mbyte of RAM, an 8 Kbyte serial EEPROM, two RS-232 serial communication ports, many flexibly programmable digital I/O channels, and a 12-bit, 8-channel successive approximation analog-to-digital converter. A TT8v2 manual with a complete description can be downloaded from the Onset Computer web site, www.onsetcomp.com.

Two programs, the TOM8 and PicoDOS, are stored in non-volatile flash memory, which retains information when power is removed. The TOM8 (Tiny Onset Monitor for the TT8v2) is a mini-monitor that oversees the loading and running of firmware. PicoDOS links the TT8v2 to the AT8 board and the 512MB PCMCIA flash card and provides access to the file system.

NOTE
Download PicoDOS user manuals at www.persistor.com.

AT8 Board and Flash Card

The AT8 board and the DOS/Windows compatible flash card are the physical components of the file system. The flash card plugs into a PCMCIA connector on the AT8 board, which is connected directly to the address, data, and control bus of the TT8v2. After a deployment, the flash card can be removed from the ITP and plugged into to a PC to transfer the binary data files.

IMPORTANT
Remove or install the flash card only when the system is off, or by using the "hot swap" utility.

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As shown in the schematic in Figure C-2, sensors each have dedicated switched power connectors. The SPARE CONNECTOR has an RS-232 Electronic Industries Alliance (EIA) or a 5v Complementary Metal Oxide Semiconductor (CMOS), a dedicated switched power output, three analog inputs, two digital outputs and a user interrupt input. The SPARE SERIAL PORT has an RS-232 (EIA or 5VCMOS) and a dedicated switched power output. The Rev D board supports two full size batteries.
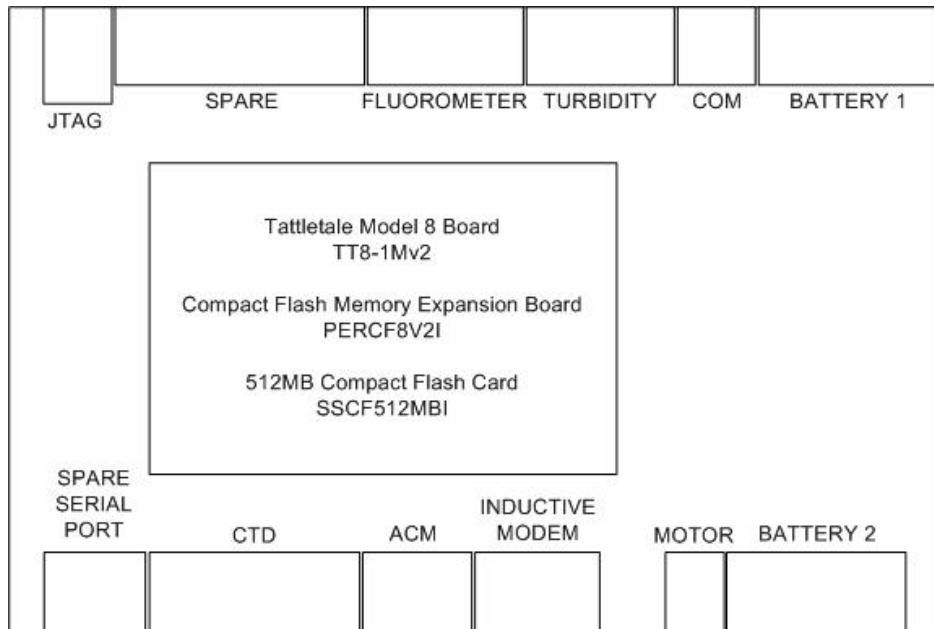

Figure C-2: Electronics Schematic

The controller board has a single CPLD (Complex Programmable Logic Device) that can be programmed through the JTAG CONNECTOR. A temperature-compensated crystal oscillator (TCXO) provides highly reliable time-keeping in the system watchdog clock.

The top circuit board in the controller is a Persistor CF (Compact Flash) memory expansion board that holds a 512MB compact flash card.

NOTE
McLane uses a flashcard certified by Persistor Instruments, Inc. (www.persistor.com).

The middle circuit board is a TattleTale 8 (TT8v2) microcontroller manufactured by Onset Computer Corporation (www.onsetcomp.com). The TT8v2 controls power and communications for the MMP hardware.

The bottom circuit board is the motherboard of the ITP controller. Peripheral components like the motor and sensors connect to the controller through the black edge connectors. This bottom circuit board also supports power distribution and an independent watchdog circuit. The watchdog is described in more detail in this Appendix.

Over time, a layer of particles and oils may accumulate on the connector contact surfaces, producing an oxide layer which interferes with electrical operation. Remove the particles by disconnecting and reinserting the connectors or using cleaning spray for electrical contacts.

NOTE
Before a deployment, manually verify that the connectors are fully inserted and locked.

The MOTOR connector on the bottom circuit board is the output of a standard H-bridge and provides a directional drive voltage to the DC brushless motor. The drive circuit is designed to protect against the back EMF voltages that are generated when the motor is driven by the mooring during launch and recovery operations or if the profiler encounters an obstruction during a profile.

Motherboard

The motherboard contains the interface circuits that translate the signals and commands passing between the TT8v2, the peripheral components of the system, the system watchdog circuit and its independent power supply.

The interface circuits protect the system from electrical damage. The eight independent voltage taps of the main lithium battery pack are diode isolated on the motherboard. Each cell in the battery pack is internally fused for 3 A. There is an accessible, single-use, 2 A fuse in the common return of the battery pack. That fuse is physically attached to the pack. Self-resetting positive temperature coefficient (PTC) "fuses" isolate the three branches of the power distribution network - (1) the TT8v2, AT8, and motherboard, (2) the sensor suite, and (3) the drive motor. The branch supplying the drive motor is designed to protect the rest of the power distribution network from the back EMF voltages that are generated when the motor is driven by the mooring. This may occur during launch and recovery operations. Wave induced mooring motions, particularly during storms, may also produce strong, transient, back EMFs. The generated

electrical currents are absorbed through voltage limiting shunt components that can dissipate several watts.

Digital I/O (DIO) pins, serial communication lines, and analog channels are all protected from voltage surges by high/low pairs of shunt diodes. DIO lines can be used as either inputs or outputs. Some can be programmed for special, time dependent, input or output behaviors. In all cases they can have only two values, 0 V or 5 V, a Logic 0 or a Logic 1. Analog channels measure analog voltages. The measurement is passed to the micro-processor in digital form and a dedicated analog channel is used to monitor the voltage of the main lithium battery.

PC and Communications Software

The firmware controls system testing, deployment programming, and data recovery. The operator enters instructions on the keyboard of a PC running terminal emulation software and the firmware executes the commands and displays status information and data on the PC screen.

Laptop and desktop PCs running DOS and Windows are the recommended operating systems. Handheld PDA's and PCs with other operating systems can also be used.

The communications link between the profiler and a PC is a standard, 3-wire, full duplex, RS-232 Electronic Industries Alliance (EIA) connection passing primarily ASCII text bytes. The communications cable and the terminal emulation software are included in the tool kit. Crosscut for Win is a Windows program and Crosscut is DOS-based. Instructions for installing and operating these emulators are provided in Appendix A, "Operating Crosscut for Windows and Crosscut".

Drive Motor

The drive motor control interface is composed of three DIO lines. One of the lines can be programmed to output a pulse train with a variable duty cycle. A dedicated analog channel measures motor current during deployments and diagnostic testing. Current is steered through the DC brush motor with a standard HEXFET H-bridge. A logic network controlled by the DIO lines drives the switch. Unregulated battery voltage is applied directly to the motor through the H-switch to minimize losses that would reduce the endurance of the system.

One of the DIO lines sets the motor direction for upward or downward profiling. The second line enables or disables the motor and applies a dynamic brake. The dynamic brake can support several pounds of positive or negative buoyancy and is set electronically by grounding both terminals of the motor through the lower legs of the H-bridge. The third DIO line is programmable to enable the motor to free wheel or send the motor in a specified direction during

a profile. In free wheel mode, the motor is not driven by the battery and offers no resistance (other than friction) to external torque. The motor is automatically set to free wheel during launch to reduce slip related wear of the drive wheel.

IMPORTANT
Do not attempt to accelerate the profiler too rapidly. Any sudden transition in the voltage applied across the motor can spike motor current and torque causing the drive wheel to slip against the cable.

Based on testing at McLane, the applied motor voltage is ramped up linearly over a 30 second period to start each profile. Pulse width modulation (PWM) is used to accomplish this without sacrificing efficiency in the drive train. The programmable DIO pin is set to produce a 20 KHz pulse train and the drive voltage is varied by changing the duty cycle from 0 % at the beginning of the ramp to 100 % at its end. It is the reactance of the motor inductance and a parallel capacitor that filter the pulse train and produce a smooth average drive voltage from the pulse train. Once the duty cycle reaches 100 %, the pulse train is turned off to reduce processor overhead and the DIO pin is simply set to the run state.

Independent Watchdog

The system watchdog circuit is mounted on the motherboard and is composed of a DS1306 real-time clock chip, which sends periodic interrupt requests to the TT8v2, and a hardware counter, which can restart the TT8v2 if the IRQ from the DS1306 is not acknowledged.

The watchdog circuit receives power from the main lithium battery. However, if the power supply is interrupted, the watchdog continues to function with an independent back-up power supply in the form of a "super cap", a large capacity capacitor that functions like a rechargeable battery. The super cap, once fully charged, can keep the watchdog active for several days in the absence of power from the main lithium battery.

The DS1306 chip operates autonomously. The TT8v2 and the DS1306 communicate through a SPI (Serial Peripheral Interface) port and an IRQ (interrupt request) line. Whenever the operator sets the TT8v2's Real-time Clock (RTC), the DS1306 RTC is automatically set by the system. To avoid confusion, the watchdog clock is referred to as the WDC and RTC is reserved to denote the TT8v2 real-time clock. The RTC is accurate to approximately 1 second per day (1 minute per month). The WDC has a temperature compensated crystal oscillator (TCXO) as its source and is accurate to ±1.5 minutes per year (worst case). To take advantage of the improved

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time keeping, the RTC is updated with the WDC time at the beginning of every profile. In addition to maintaining an independent real-time clock, the DS1306 steers a small current (≤1 mA) into the super capacitor whenever the main lithium battery is connected. The trickle of charge assures that the independent power supply will be ready if needed.

NOTE

The watchdog circuit produces a small current drain compared to the maximum charging current (the initial current into an uncharged capacitor is limited to approximately 1 mA, which decreases as the voltage across the capacitor increases from zero).

The hardware counter is driven by a 32.768 kHz square wave generated by the DS1306. Once reset to zero by the TT8v2, the counter will "roll over" after about 68 minutes. The roll-over forces the master clear signal to remain low until the TT8v2 performs a hardware reset and forces the TT8v2 to reboot.

When power is first applied to the profiler, the firmware performs a number of initialization procedures. Among these tasks, the watchdog counter is reset to zero and the DS1306 is programmed to send an interrupt request to the TT8v2 at one minute after the hour during every hour of operation. When the TT8v2 receives this interrupt, the TT8v2 acknowledges and clears the request by communicating with the DS1306. Then the TT8v2 resets the 68 minute counter to zero, logs the IRQ if a deployment is in progress, and goes on with whatever operation was being conducted when the interrupt was received. These actions indicate the TT8v2 is smoothly running the firmware. As long as the TT8Vv2 is operating properly, the counter never rolls over and the TT8V2 is never rebooted.

URAO Operation

In the (unlikely) event of a processor crash, the watchdog circuit triggers the Unattended Reset, Autonomous Operation (URAO) feature of the firmware. URAO autonomously resets the system, loads the correct time from the DS1306, recovers the deployment parameters programmed by the operator, and restarts the deployment already in progress. URAO also functions in the event of a transient loss of the main power supply. URAO is described in more detail in Chapter 3, "ITP User Interface".

If the TT8v2 crashes, it is no longer running the firmware or has been put to sleep by the critical handler after a detectable fault. The watchdog continues to operate autonomously and sends a scheduled IRQ to the TT8v2. The unresponsive TT8v2 ignores the interrupt and, in

consequence, the counter, which has counted 60 minutes of its 68 minute period, is not reset. Approximately eight minutes later the counter rolls over and triggers a TT8v2 master clear. The system reinitializes, detects the absence of an operator and starts the URAO feature.

Sensors

The TT8v2 communicates with the ITP sensors through a dedicated RS-232 serial port. The sensors are turned on and start logging internally at the beginning of each profile. At CTD power on, data in the CTD Header indicates whether the Integrated Dissolved Oxygen (IDO) sensor is installed. The firmware uses the CTD depth parameter to control profiler movement. When the profile is completed, logging stops and the sensor data is transferred to the flash card.

CTD Measurements

The CTD logs one measurement each of conductivity, temperature, depth, and oxygen (if applicable) in each record and acquires records at a nominal rate of 1.85 Hz. Each datum is stored as a scaled integer in three bytes. There are, therefore, nine bytes in a CTD record that does not contain oxygen data. At this size, the CTD can log records internally for approximately 8.75 hours before filling its 512 Kbyte data memory. The measured current drain of the CTD is 12.5 mA while logging internally (profiling) and 30 mA while moving data onto the flash card. The duration of the data transfer is 10% - 15% of the elapsed profile time.

NOTE
The sensors do not log time tags with their measurements; all time tags are recorded in the engineering files.

A 1000 meter profile with a 41CP CTD requires approximately 4.5 KB of engineering data storage, and approximately 75 KB of CTD data storage. As a result, a 512 MB compact flash card can store more than 6,400 profiles without exceeding the flash card size limit. Additionally, the flash card file limitation is further managed by using file deletion after transferring files via inductive modem.

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The on-board offload utility and the high-speed MMP Unpacker application cannot support non-standard sensor settings. Processing binary data files collected with non-standard sensor settings is the responsibility of the operator. The firmware can automatically verify standard sensor settings at the beginning of a deployment or allow the operator to manually program the sensors. Contact McLane if programming non-standard sensor settings is required for a deployment.

Other Sensors

Integrating sensors with the ITP requires a partnership with McLane.

Notes

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Appendix D
Underwater Inductive Modem (UIM)

Version 3.10 (and higher) of the firmware supports a real-time communication option between the profiler and a surface buoy, currently via a SeaBird inductive modem link (this configuration option also requires a SeaBird inductive coupler). For the inductive modem interface, the profiler electronics stack contains a SeaBird UIM (Underwater Inductive Modem) board (SBE44 V1.8) with an inductive coupler around the mooring wire (a surface inductive modem and surface controller are also required for this option).

This appendix describes the communications sequence between the profiler and the UIM. A detailed description of SIM/UIM protocols is also provided.

Transmission Communication Sequence – Overview

Below is a process overview of the communication sequence between the Surface Inductive Modem (SIM), the Underwater Inductive Modem (UIM) and the profiler. A complete listing of file transmission protocols is provided on page C-7.

1. The sequence begins with the SIM powered off.

2. At the completion of a profile, the ITP firmware powers on the UIM.

3. The UIM sends a tone detect to wake the SIM.

4. The ITP firmware listens for commands transmitted by the SIM as the SIM performs a Cyclic Redundancy Check (CRC) to ensure that data transmitted is valid. If the CRC confirms valid data, the SIM sends the ITP firmware a command to 'send the next piece of data'. If the CRC detects invalid data, the SIM sends the ITP firmware a 'resend data' command.

NOTE
The CRC calculated is a 16bit CCITT standard CRC.

5. The ITP firmware sends a null record after the last group of data to tell the SIM that the 'end of the data' has been reached.

6. The ITP firmware powers off the UIM and waits to perform the next profile.

IMPORTANT
When data transmission is complete, the SIM must be powered off before the next tone detect is sent; otherwise, both the surface modem and the inductive modem will be in 'listening mode' simultaneously and cannot perform the communication sequence.

Transmission Communication Sequence – Technical Details

The next section describes technical details of the communication sequence including command and transmission sequences, data formats and file transmission protocols.

UIM data is sent in packets requiring the surface to acknowledge the receipt of each packet. If the surface controller does not acknowledge receipt of a packet within 55 seconds the firmware will go back to the main listening loop and wait for a command (for example, REQNEW).

<u>Command Sequences</u>

At the completion of a profile, the ITP firmware powers on the UIM and begins a transmission session by listening for one of the following command sequences: REQNEW, REQDIR, REQFIL, REQEOD. Each command sequence is described below.

Command Sequence	Action
REQNEW	ITP firmware sends the next file in the list of files collected since the last successful transmission.
REQFIL filename.ext	ITP firmware sends the requested file.
REQDIR	ITP firmware sends a full listing of all files on the flash card.
REQEOD	ITP firmware powers off the UIM.

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Command Sequence	Action
REQACK (sent as a binary command)	The ITP firmware interprets this command as an acknowledgement that the last data packet sent was received successfully. The ITP firmware will transmit the next data packet.
REQNAK (sent as a binary command)	The ITP firmware interprets this command as a failure for the last data packet sent. The ITP firmware will resend the data packet.

Commands sent through the SIM/UIM system always take one of two forms: #nnCOMMAND or bnnCOMMAND.

The nn is the UIM identification and is used by the UIM to identify whether a command is directed toward it. If the command is meant to be handled by the UIM, the COMMAND portion is relayed to the serial instrument (in this case the ITP).

- The '#', indicates that the SIM and UIM are awaiting ascii data terminated with a pre-defined termination character.

- The 'b', indicates that the SIM and UIM are awaiting binary data terminated by a transmission gap.

The timeouts are different for the two cases and are explained in the SeaBird documentation.

Transmission Sequence Scenario

This section provides a sample transmission sequence session. For detailed descriptions of file transmission protocols, see page D-6.

> **NOTE**
>
> To confirm the communications link, the UIM initially powers 'on' after 'V' (Verify and Proceed) is selected from the Deployment menu. The UIM remains on until profile 0 (the initial profiler dive) begins, then powers off and remains off until the next scheduled transmission session. This is a verification feature only. The firmware itself remains in Low Power Sleep (LPS) and does not listen or respond to the UIM until the scheduled transmission session.

1. The 'Tone detect' board attached to the SIM receives a tone and responds by setting its detect line (JP4 pin 2) low. If the ITP firmware does not receive a response from the surface within 40 seconds, the tone will be sent again a maximum of two more times (spaced 40 seconds apart).

> **NOTE**
>
> The ITP firmware sends tones twice spaced 40 seconds apart, as a backup. The UIM should automatically generate a 4800 Hz tone for 2.5 seconds detectable by the Tone Detect board on the SIM. In some instances the UIM tone is not sent (this occurs because the the SBE44 was not specifically designed for the profiler inductive modem interface). The ITP firmware initiates the wake-up tone to ensure that the SIM detect line is properly set.

2. The surface controller (SC) monitors the 'Tone detect' board tone detect line. Receipt of a tone indicates that the ITP firmware is ready to transmit data. The SC powers on the SIM and sends the necessary commands to upload the data.

3. The ITP firmware listens for 3 intervals of 40 seconds each for one of the recognized data upload commands.

4. When power is applied to the SIM board, the board sends a wake-up signal down the mooring wire (if the UIM is up and running the wake-up signal is ignored). If the UIM is not ready, this wake-up activates the UIM.

5. A transmit-receive-acknowledge sequence proceeds as follows until the ITP firmware has sent the entire file:

   - If the SC requires the newest data it relays a #nnREQNEW command to the ITP firmware (eg. #01REQNEW). The '#' defines the request to the UIM to transmit

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ascii data with a termination character, configured as '>'; nn is the ID of the UIM attached to the profiler; REQNEW is the command relayed by the UIM to the ITP firmware. Everything after the nn ID is relayed verbatim to the UIM, including the filename in the case of REQFIL.

- The ITP firmware responds by sending the next file available from the files collected since the last successful transmission. If the operator has chosen to keep a limited number of files and there is trouble transmitting, the oldest files may be deleted before they are transmitted. This risks the loss of the oldest data, but does not interfere with the algorithm which sends the next available data. The data is sent in packets (defined in the 'Data Format' section of this appendix) and the transaction process requires the surface to acknowledge receipt of each packet.

6. After the ITP firmware sends the entire data file, a CRC packet is sent that contains only a packet header (no data content).

NOTE
If required, the SC can request transmission of a particular file by sending #nnREQFIL filename.ext (where filename.ext conforms to the 8.3 format). The ITP firmware will send the requested file (DOS) with the same protocol used to answer REQNEW.

7. If the SC requests a full directory listing of files on the flash card, (by sending a #nnREQDIR command) the ITP firmware responds by sending a listing of file names and file sizes as described in the 'File Transfer Protocol' section of this document.

8. If the ITP firmware has no data to offer it will reply with an EOD packet and wait for a command. The ITP firmware will terminate communications if a termination command is sent by the surface. The SC maintains primary control of the communication. Time-out thresholds are used as a backup. If no command is received the ITP firmware will time out after the third 40 second session.

9. If the SC is finished requesting data, and sends a #nnREQEOD command, the ITP firmware powers off the UIM and continues with the programmed deployment.

Control of Communication Session

Noise on the mooring cable could falsely trigger the Tone Detect board attached to the SIM (however, the UIM is powered on only during the communication transaction period at the

end of a profile). The ITP/UIM pair exclusively initiate a communication session. Once the session starts, the SC controls data transmission and the end of the communication session. The communication session will timeout in the absence of surface controller response.

Data Format

When a file or combination of files is requested, the ITP firmware first sends the metadata for the next file to be transmitted.

NOTE
Mooring ID (a three position numeric identifier) is defined from the Deployment Menu and embedded in the metadata to identify files from multiple profilers on the same mooring line.

The metadata structure is as follows:

```
typedef struct
{
  char    fileName[13];        // filename.ext - followed by white space
  char    profileEndTime[20]; // mm dd yyyy hh mm ss - followed "
  char    mooringID[4];        // ### - followed by "
  char    byteCount[12];        // ###### - followed by "
  char    term[2];
} metaDataStruct;
```

Each character field is terminated by a white space, rather than a null. The metadata for a single file is followed by a series of data packets and ends with an EOD packet. Each packet is prefaced with the packet header:

```
typedef struct
{
  char  dataHdr[4];    // "DAT", "CRC"
  short byteCount; // of whole pkt 8 + pktdatasize
  short CRC;        // CRC
} packetHeader;
```

The character field dataHdr is terminated by a white space. Immediately after the packet header, the packet content is transmitted. A "DAT" packet will contain up to 4KB of data; a "CRC" packet will indicate that there are no more packets to be sent. There is no content for the CRC packet. The CRC value reported in this packet is the value for the entire file.

File Transmission Protocol

The data files that the ITP firmware sends to the surface will adhere to the protocol described in the table shown next.

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File Transmission Protocol	
REQNEW	ITP firmware transmits next data file(s) in list of those collected since the last successful transmission and the following occurs: • ITP firmware answers with a metaDataStruct, then waits for acknowledgement. • SC acknowledges receipt with bnnREQACK. • ITP firmware answers with first data packet. • ITP firmware packet/SC acknowledgement (positive or negative) continues until the ITP firmware reaches end of file. If three consecutive negative acknowledgements are received the ITP firmware returns to listening mode and waits for a command. • ITP firmware answers with CRC packet. • SC responds with further commands.
REQDIR	ITP firmware sends a listing of file names and sizes according to the following structure: <code>typedef struct { char name[12]; char lenstr[11]; char zterm; } DirStrEntry</code>
REQFIL	ITP firmware sends a single file as described above in the REQNEW section of this document.
REQEOD	ITP firmware powers off the UIM and continues with the programmed deployment.
REQDCN	ITP firmware transmits decimated ACM and CTD data files (only decimation of ACM and CTD data is allowed). REQDCN sends a full engineering file, a CTD file decimated with a preset value of 2, and an ACM file decimated with a preset value of 100.
REQDCF	Allows the operator to request a file with a specific decimation Nth line value between 1 and 998 (the Nth scan of data is sent with no bin averaging or alias checks).
REQFDR filename.ext	ITP firmware sends a flash card directory listing of the file indicated.

SeaBird Firmware and Settings for 4K Packets

SIM V2.8 (or later) and the UIM, SBE44 V1.9 (or later) support binary relay commands. The binary relay command works like the standard relay command except that all characters received by the SBE44 are relayed to the SIM and the relay termination character is ignored.

Settings for 4K Packets

The SIM and UIM settings in the transmission sequence scenario described in this Appendix are shown next. These settings were designed to coordinate the communications relay and data packet transmission between the ITP, SIM and UIM. Guidelines are below.

- The UIM terminates Relay when the time since the last character the SBE44 receives exceeds the time specified by the RTERMMAX command (55000 msec default) or the time specified by the RTOTALMAX command (600 sec default).

- Relay is terminated by the SIM when the time since the last character received by the SIM is greater than the time specified by the BINARYGAP command (5000MSEC default) or the total time specified by the RELAYMAX command (600 SEC default) is exceeded.

- UIM command RTERMMAX must be greater than SIM command BINARYGAP.

- Setting the PONTONE command to 'Yes' should cause the UIM to send a wake up tone to the SIM upon power-up. If the wake-up tone is not sent, the ITP firmware forces a tone detect that wakes up the SIM after 40 seconds.

<u>SIM Settings</u>

```
SBE 37 SURFACE MODEM V 2.8
wait time for dataNN response = 1000 msec
wait time for relay command response = 600 seconds  ◄─── RELAYMAX=600
binary relay character timeout = 5000 msec  ◄──────── BINARYGAP=5000
echo = yes
execute pwron command on powerup = no
```

<u>UIM Settings</u>

```
SBE 44 UNDERWATER MODEM V 1.9
sensor baud rate = 9600
break character length = 1000 milliseconds
time out after 30 seconds without receiving a valid command ◄─── !01TIMEOUT=30
termination character is 62, char = >
Relay Command Settings:
   relay termination characters = <CR><LF>
   total time for response = 600 seconds ◄──────── !01RTOTALMAX=600
   wait 0 milliseconds before sending the command
   halt relay after a gap of 5500 milliseconds between characters ◄───!01RTERMMAX=5500
GDATA Command Settings:
   total time for response = 30 seconds
   wait 0 milliseconds before sending the command
   halt acquisition after a gap of 1000 milliseconds between characters ◄─!01GTERMMAX=1000
   GDATA command string = NO STRING
include gdata reply delay in datann reply
do not enable control line on power up
disable control line logic for relayed commands
disable control line logic for GDATA command
do not switch power to sensor on power up
disable switch power logic for relayed commands
disable switch power logic for GDATA command
     send tone on powerup ◄─── !01PONTONE=Y
```

File Deletion

Through the ITP firmware, the operator can select to keep a limited number of deployment data files on the flash card. The number of files stored on the flash card are predefined and when that number is reached, the oldest profile (which has already been transferred via the UIM) is deleted.

The file deletion capability (which is disabled by default) and the maximum number of profiles to store before the oldest profile is deleted, can be changed in the firmware System Configuration menu.

To enable file deletion and define the maximum number of stored profiles, complete the following steps:

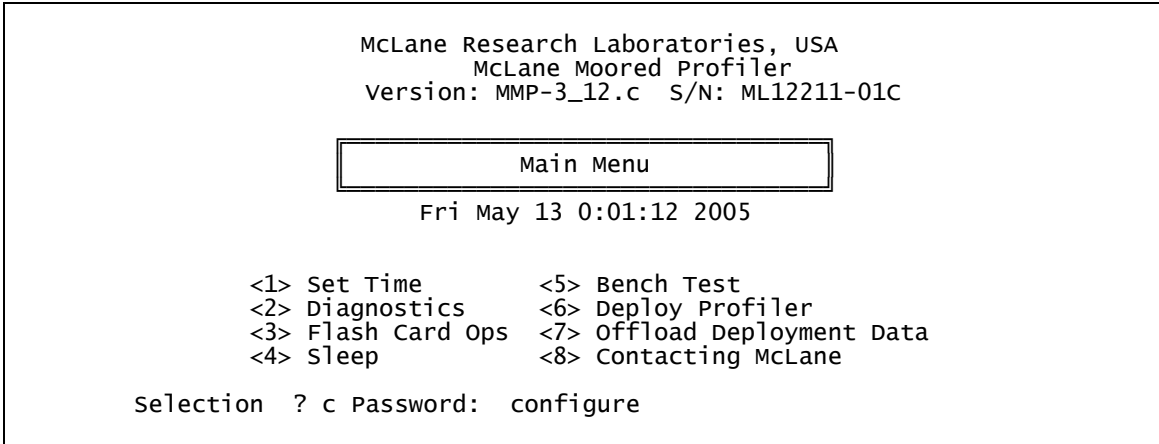1. From the Main Menu type 'c' and enter the password 'configure'.

```
                McLane Research Laboratories, USA
                      McLane Moored Profiler
                 Version: MMP-3_12.c  S/N: ML12211-01C

               ┌────────────────────────────────────────┐
               │                Main Menu                 │
               └────────────────────────────────────────┘
                      Fri May 13 0:01:12 2005


            <1> Set Time        <5> Bench Test
            <2> Diagnostics     <6> Deploy Profiler
            <3> Flash Card Ops  <7> Offload Deployment Data
            <4> Sleep           <8> Contacting McLane

        Selection  ? c Password:  configure
```

Figure D-1: Configuration Menu

2. Select <F> 'File Deletion'.

```
             ┌─────────────────────────────────────┐
             │         System Configuration        │
             └─────────────────────────────────────┘

        System Parameters:
          <E> Nominal Endurance          240 Ah
          <I> Inductive Telemetry        Enabled
          <T> Acoustic Transponder       Disabled
          <C> Inductive Charger Modem    Disabled
          <F> File Deletion              Enabled, size= 60

        Sensor Suite:
          <1> FSI EM         CTD         Disabled
          <2> SeaBird 41CP   CTD         Enabled
          <3> SeaBird 52MP   CTD         Disabled
          <4> FSI 2D         ACM         Disabled
          <5> Nobska MAVS    ACM         Disabled
          <6> SeaPoint       Fluorometer Disabled   (Chlorophyll à)
          <7> Wetlabs        Fluorometer Disabled
          <8> SeaPoint       Turbidity   Disabled   (IR)
          <9> Aanderaa Optode            Disabled

          Selection  ? f
 Enable file deletion  (Yes/No) [N] ? y
 Enter maximum number of profiles to store:  ( 0 to 60) ? 60
Selection  ? x
Storing system configuration changes . . . done.
```

Figure D-2: Enabling File Deletion

3. Type 'y' to enable file deletion

4. Enter the number of profiles to store (up to 60).

5. Type 'x' to exit and save changes.

Deployment settings including file deletion and number of stored profiles can be viewed in DEPLOY.DAT . For more information, see the section "<7> Offload Deployment Data" in this User Manual.

```
DEPLOYMENT PARAMETERS
─────────────────────
Countdown delay                00:05:00 [HH:MM:SS]
Profile start interval     000 02:00:00 [DDD HH:MM:SS]
Reference date/time         01/01/2006 00:00:00
Burst interval             010 00:00:00 [DDD HH:MM:SS]
Profiles per burst             Disabled
Paired profiles                Disabled
Profiles / file set                   2
Shallow pressure                  100.0 [dbar]
Deep pressure                    1100.0 [dbar]
Shallow error                     500.0 [dbar]
Deep error                        500.0 [dbar]
Profile time limit             01:30:00 [HH:MM:SS]
Stop check interval                   5 [sec]

SYSTEM CONFIGURATION
─────────────────────
Nominal Battery Life                240 Ah
Inductive Telemetry            Disabled
Acoustic Transponder           Disabled
Inductive Charger Modem        Disabled
FSI EM        CTD              Enabled
SeaBird 41CP  CTD              Disabled
SeaBird 52MP  CTD              Disabled
FSI 2D        ACM              Disabled
Nobska MAVS3  ACM              Disabled
SeaPoint      Fluorometer      Disabled
              AutoGain         True
              Current Gain            1
              Sample/avg =            5
Wetlabs       Fluorometer      Disabled
              Sample/avg =            5
SeaPoint      Turbidity        Disabled (IR)
              AutoGain         True
              Current Gain            1
              Sample/avg =            5
File Deletion                  Disabled  with profiles stored = 30
INTERNAL PARAMETERS
─────────────────────
FullSpeed                         0.250 [dbar/sec]
PR_Threshold                      0.045 [dbar/sec]
PR_TimeThreshold                    180 [sec]
sensor_warmup                       120 [sec]
sensor_warmdown                     120 [sec]
InfiniteDeployment             Enabled


PR_Threshold for Inductive Charger                    0.045 [dbar/sec]
PR_TimeThreshold for Inductive Charger                   30 [sec]
```

Figure D-3: Deploy.DAT

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Profiles/File Set

To support the UIM interface (in ITP firmware version 3.10 and higher), the maximum allowed value for Profiles / file set is predefined as '1'. If using the UIM interface, multiple profiles per file set are not allowed as each profile file must be completely closed at the end of a profile for real time transmission.

```
DEPLOYMENT PARAMETERS
_____
  Countdown delay              00:10:00 [HH:MM:SS]
  Profile start interval   000 00:10:00 [DDD HH:MM:SS]
  Reference date/time      04/28/2004 10:50:00
  Burst interval           010 00:00:00 [DDD HH:MM:SS]
  Profiles per burst           Disabled
  Paired profiles              Disabled
  Profiles / file set                 1
  Shallow pressure                  0.0 [dbar]
  Deep pressure                     5.0 [dbar]
  Shallow error                   500.0 [dbar]
  Deep error                      500.0 [dbar]
  Profile time limit           00:30:10 [HH:MM:SS]
  Stop check interval                 5 [sec]
  Transmission duration              30 [min]
```

Figure D-4: Profiles/File Set

Notes

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Appendix E
SBE 41CP CTD with Integrated Dissolved Oxygen

This appendix provides steps for configuring the firmware and verifying settings for the Sea-Bird 41CP CTD and SBE-55 integrated dissolved oxygen (IDO). Additional notes about the sensors are also included.

NOTE
For additional information about the 41CP CTD or the SBE-55 Integrated Dissolved Oxygen sensor, refer to the Sea-Bird Electronics website (www.seabird.com) or contact Sea-Bird.

41CP CTD

SBE 55 IDO

Figure E-1: 41CP CTD with SBE-55 IDO

Configuring the Firmware to Use a Sea-Bird CTD with IDO

The System Configuration menu specifies which sensors are enabled. If the firmware is configured for the 41CP CTD, it is unnecessary to change the configuration for the SeaBird 41CP CTD with IDO.

During a profile, the firmware uses only the depth parameter from the CTD data stream to determine profiler movement. Motion stops when the end of the programmed profiling range is detected. The firmware stops the sensor and requests the remaining CTD parameters (including Oxygen data), saving them to the ITP flashcard.

To enable a Sea-Bird 41CP, complete the following steps:

4. From the Main Menu type 'c' and enter the password 'configure'.

5. Select <2> for the 41CP CTD and then select 'Y' to enable the sensor.

6. Select [X] to exit and save the entry.

```
c    Password:  configure

 Synchronizing system configuration files . . . done.


        ┌──────────────────────────────────┐
        │        System Configuration      │
        └──────────────────────────────────┘

     System Parameters:
       <E> Nominal Endurance         240 Ah
       <I> Inductive Telemetry       Enabled
       <T> Acoustic Transponder      Disabled
       <C> Inductive Charger Modem   Disabled
       <F> File Deletion             Enabled, size= 60

     Sensor Suite:
       <1> FSI EM        CTD         Disabled
       <2> SeaBird 41CP  CTD         Enabled
       <3> SeaBird 52MP  CTD         Disabled
       <4> FSI 2D        ACM         Disabled
       <5> Nobska MAVS   ACM         Disabled
       <6> SeaPoint      Fluorometer Disabled   (Chlorophyll à)
       <7> Wetlabs       Fluorometer Disabled
       <8> SeaPoint      Turbidity   Disabled   (IR)
       <9> Aanderaa Optode           Disabled
```

Figure E-2: System Configuration Menu with Sensor Selections

NOTE

Configuring the 41CP CTD with IDO is the same as the 41CP CTD. At CTD power-on, data in the CTD Header indicates whether IDO is installed.

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Offloading Data

In the Data Offload option as shown in Figure E-3, the firmware prompts for whether or not oxygen is installed and displays oxygen data accordingly, in hz.

```
                    ╔═══════════════════════════════════╗
                    ║     Serial Dump Files From FLASH  ║
                    ╚═══════════════════════════════════╝
                         Sun Jun 17 16:53:49 2007

           Stream serial data from:
               <D> Deployment
               <S> Single profile
               <R> Range of profiles

               <L> Logging files

           Exit to:
               <M> Main menu

          Selection  ? s
           Select data files to download:
          <1> All data files
          <2> Engineering data files only
          <3> CTD data files only
          <4> ACM data files only

           Exit to:
           <P> Previous menu
           <M> Main menu

                 Selection  ? 3

           Enter ID# of profile to be read: (0 to 419) ? 10

          Processing profile.
```

Prompt for oxygen ►

```
          Does this 41CP data file have oxygen?  (Yes/No) [N] ? y

           Profile 10

            mmho/cm   Celsius     dbars      hz

           +00.6001  +17.2978   +0000.850   19164
           +00.5958  +17.2989   +0000.840   18921
           +00.5950  +17.2976   +0000.850   18674
           +00.5947  +17.2958   +0000.850   18466
           +00.5946  +17.2948   +0000.840   18368
```

Figure E-3: Data Offload Prompt for Oxygen in Data File

Verifying 41CP CTD-IDO Settings

The 41CP-IDO CTD settings can be verified from the firmware in the Bench Test menu. To display and verify settings, complete the following steps:

1. From the Bench Test option on the Main Menu, select <1> CTD Communications. The system shows the following display and prompt (S>).

```
SBE 41CP-IDO McLane V 2.0
S>
```

Figure E-4: 41CP-IDO CTD Settings

2. Type 'ds' at the prompt to display and verify the CTD settings as shown in Figure E-#.

```
S>ds
SBE 41CP-IDO McLane V 2.0  SERIAL NO. 1948

stop profile when pressure is less than = -100.0 decibars

automatic bin averaging when p < -100.0 disabled

number of samples = 249

number of bins = 0

top bin interval = 10

top bin size = 10

top bin max = 100

middle bin interval = 50

middle bin size = 50

middle bin max = 1000

bottom bin interval = 100

bottom bin size = 100

do not include two transition bins

do not include samples per bin

oxygen frequency multiplier = 1.00
S>
```

Figure E-5: Verifying 41CP-IDO CTD Settings

3. At the next S>prompt, type [CTRL]-[C] to power off the CTD.

4. Type <CR> to return to the Bench Test Menu.

Additional Notes

This section provides some additional notes about using the 41CP CTD with IDO.

NOTE
For more in-depth information, refer to the Sea-Bird Electronics website (www.seabird.com) or contact Sea-Bird.

IMPORTANT
The Sea-Bird 41CP CTD is integrated with the ITP end cap and cannot be removed. Consult Sea-Bird before disassembling any of the CTD electrical or mechanical components.

- Remove the three protective caps (the red plastic cap covers the water intake port and two translucent caps cover the T-shaped water outlet) before operating the CTD in water. The caps protect the cell from contamination by airborne particulates that could coat the cell walls and change sensor calibration.

- The red cap is attached to a TC Duct which ensures that the water sensed by the temperature sensor is the same water that passes through the cell. The effect optimizes the coordination of the T and C measurements so that salinity and density can be correctly determined.

- Test the CTD sensors with a closed loop of tubing connecting the intake and exhaust ports.

- Sensor orientation is important. The 41CP is deployed with the sensor pointing upward to ensure that the U-shaped water path can fill with water.

Flush the cell before and after deployment with a dilute solution of Triton X-100 (approximately 1 part Triton to 50 parts deionized water) to help keep the cell clean and facilitate wetting of the conductivity cell electrodes.

Notes

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Appendix F
Puck and Par Sensors

This appendix provides information for using the ITP with the Biospherical Instruments Inc QSP-2300 Par and the WetLabs ECO-Triplet Puck sensors. For more information about ITP firmware and these sensors, refer to the MMP v4.20 Release Notes.

Figure F-1: ITP with Puck and Par Sensors
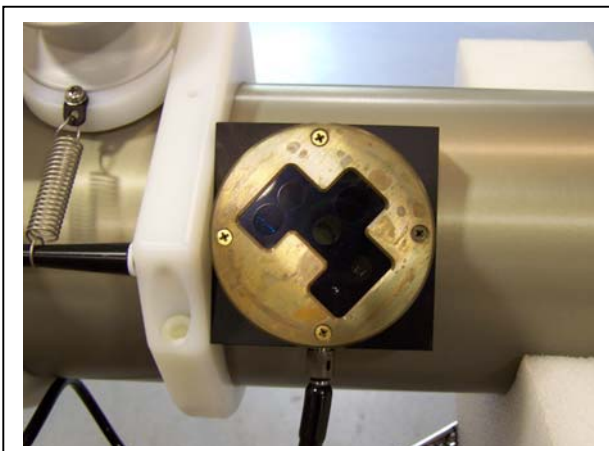
Figure F-2: Puck Sensor
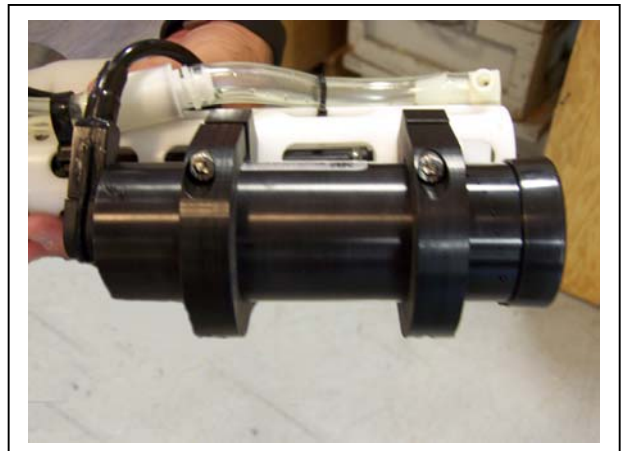
Figure F-3: Par Sensor

Assembling the ITP with Par and Puck Sensors

Predeployment assembly instructions provided in Chapter 2 of this User Manual also apply to the ITP with Par and Puck sensors (sensors are shown in Figures F-2 and F-3). This Appendix shows connecting the electronics and sealing the top end cap when the Par and Puck are installed.

Connecting the Par and Puck Sensors

Connecting the sensor electronics and Top End Cap

After the battery is connected, the electronics chassis and battery holder must be installed into the controller housing. The drive motor is also connected while sliding the electronics into the controller housing. To install the electronics chassis and connect the motor and sensor cables, complete the following steps:

1. Confirm that the desiccant packet is in place to absorb moisture near the plastic spacer, just below the battery and battery holder rods.

Figure F-4: Desiccant Packet

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2. Position the connecting rods on opposite sides of the drive motor and when the wires are within reach, plug the 2-pin drive motor connector into the main circuit board.
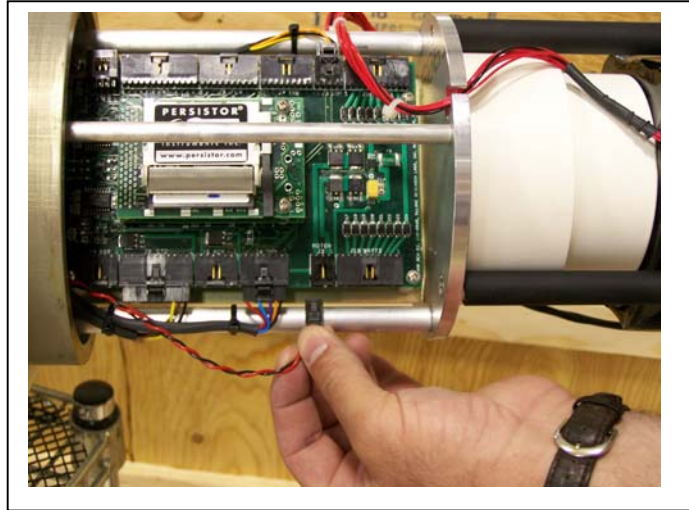
Figure F-5: Connect 2-Pin Drive Motor

Figure F-6: Slide in Electronics Chassis

Figure F-7: Secure Retaining Ring

3. Slide the electronics all the way into the housing and secure the retaining ring.

4. Thread the sensor cables through the top connecting plate and secure with two ¼-20 socket cap screws.
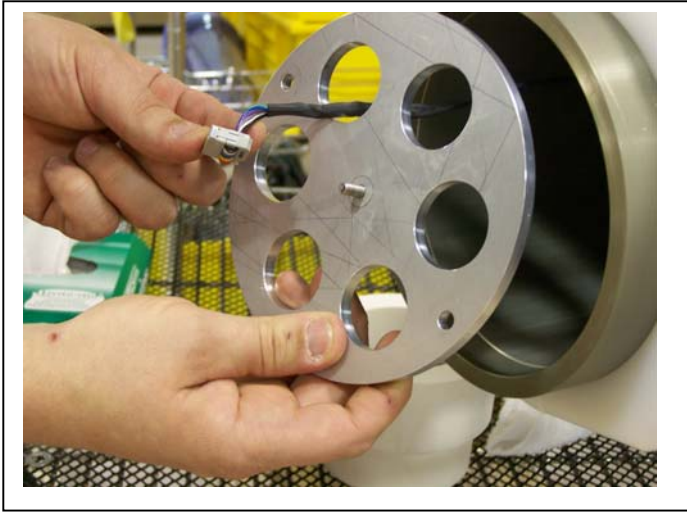
Figure F-8: Thread Sensor Cables

Figure F-9: Secure Top Connecting Plate

5. Check the seal on the sensor cap.

6. Press the CTD cable onto the connector on the CTD circuit board (the side clips will 'close').

7. Connect the Par and Puck cables to the connectors on the sensor end cap.
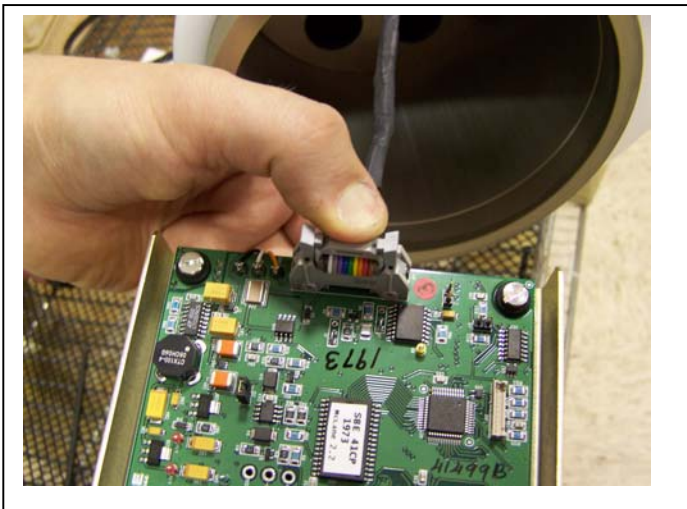
Figure F-10: Connect CTD Cable
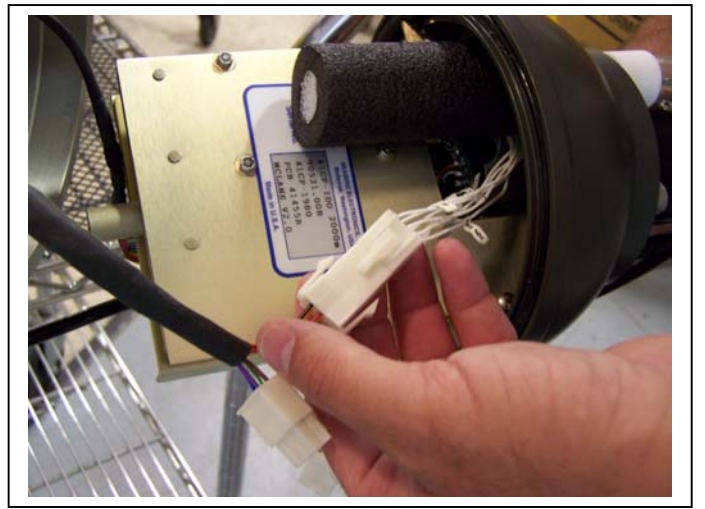
Figure F-11: Connect Par and Puck Cables

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8. Slide the sensor electronics into the controller housing.

Figure F-12: Slide in Sensor Electronics

Figure F-13: Tighten Cap into Stud

9. Center the end cap in the housing opening, and use a 3/16" long hex driver to secure the cap onto the stud in the center of the connecting plate.

Figure F-14: Install Both Top Plugs

10. Install the end cap plugs.

11. Align the Puck cable and screw the cable onto the connector.
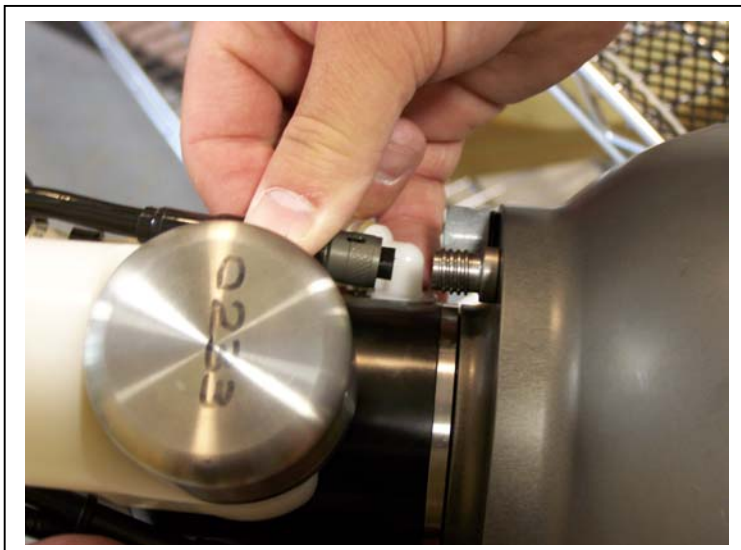
Figure F-15: Connecting the Puck Cable
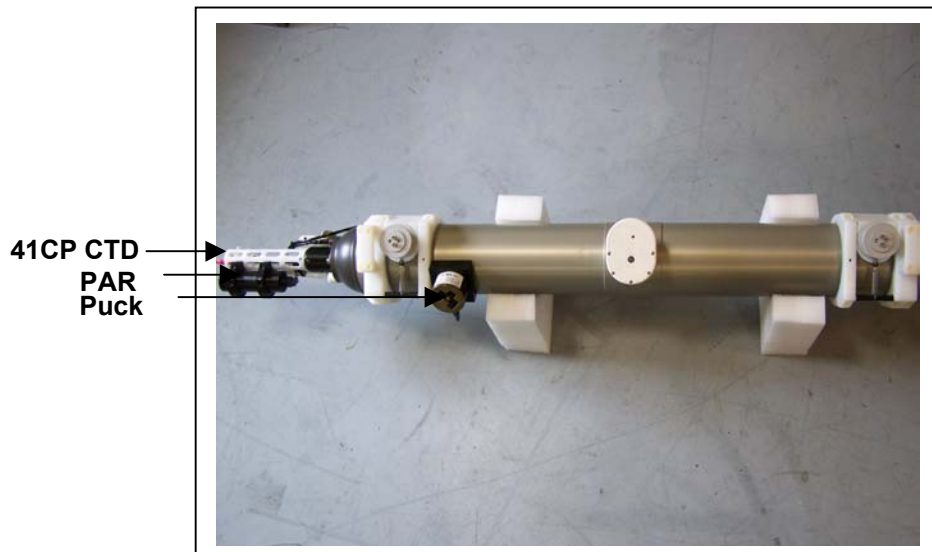
Figure F-16: Assembled ITP with Par and Puck Sensors

Calibration Sheets

The Par and Puck data is recorded as counts. To calculate Irradiance, Scatter, Chlorophyll, and CDOM factors, requires using the Calibration sheets provided with each sensor. A copy of each sheet is included in the section that follows for reference.

PO Box 518
620 Applegate St.
Philomath, OR 97370
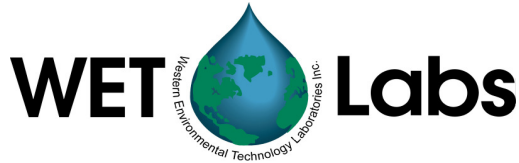
(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

WET ● Labs

Western Environmental Technology Laboratories Inc.

ECO CDOM Fluorometer Characterization Sheet

Date: 6/4/2007   Customer: McLane Research Laboratories, Inc.

Job #: 704034   SO #: 1127   S/N:# BBFL2BIPX-377

CDOM concentration expressed in ppb can be derived using the equation:

CDOM (ppb) = Scale Factor * (Output - Dark Counts)

	Digital	
Dark Counts	46	counts
Scale Factor (SF)	0.0964	ppb/count
Maximum Output	4121	counts
Resolution	0.5	counts
Ambient temperature during characterization	21.5	°C

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = $x \div$ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

WET ⬤ Labs

Western Environmental Technology Laboratories Inc.

Scattering Meter Calibration Sheet

5/25/2007	Customer: McLane Research Laboratories, Inc.	SO #: 1127
Wavelength:660	S/N#: BBFL2BIPX-377 Job #: 704034	Tech: K.C.

Use the following equation to obtain "scaled" output values:

$\beta(\theta c)$ m^{-1} sr^{-1} = **Scale Factor** x (Output - Dark Counts)

- **Scale Factor for 660 nm** = 5.353E-06 (counts)
- **Output** = meter reading (counts)
- **Dark Counts** = 45 (counts)

Instrument Resolution = 0.9 (counts) 4.73E-06 (m^{-1} sr^{-1})

Definitions:

- **Scale Factor**: Calibration scale factor, $\beta(\theta c)$/counts. Refer to User's Guide for derivation.
- **Output**: Measured signal output of the scattering meter.
- **Dark Counts**: Signal obtained by covering detector with black tape and submersing sensor in water.

Instrument Resolution: Standard deviation of 1 minute of collected data.

WET Labs
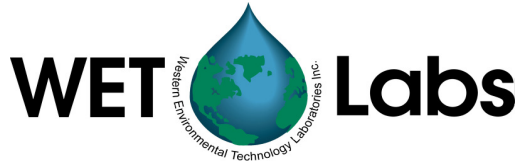
ECO Chlorophyll Fluorometer Characterization Sheet

Date: 6/4/2007   Customer: McLane Research Laboratories, Inc.

Job #: 704034   SO #: 1127   S/N:# BBFL2BIPX-377

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark counts)

	Digital
Dark counts	51 counts
Scale Factor (SF)	0.0129 µg/l/count
Maximum Output	4121 counts
Resolution	1.1 counts
Ambient temperature during characterization	21.5 °C

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations in-situ is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (Thalassiosira weissflogii). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

Notes

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Appendix G
Using the Deployment Planner

The Deployment Planner Windows application creates deployment schedules with profile patterns. Dive 0 time, profiles, patterns, and shallow/deep errors are all entered in the Deployment Planner. The final step in the Deployment Planner saves the schedule in a file called SCHEDULE.DPL, which must be on the flashcard to run the deployment.

NOTE
Up to 25 individual profiles can be defined in a project. A deployment schedule can have a maximum of 12 patterns and up to 100 profiles per pattern.

IMPORTANT
Inductive Telemetry is enabled on the Project tab in the Deployment Planner and then set for each individual profile.

Creating a Deployment Plan

1. On the Initial screen (see Figure E-1), select a project or click 'Create a New Project.'
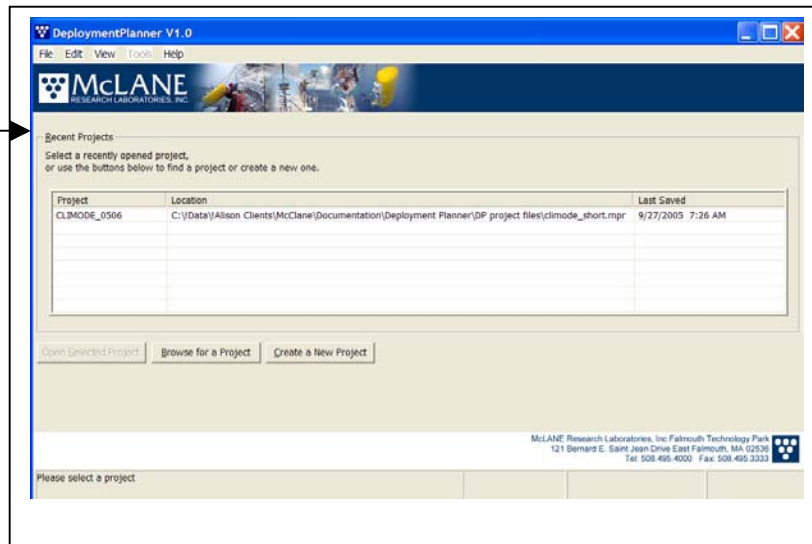
Figure G-1: Deployment Planner Initial Screen display

1. On the Project Tab (see Figure E-2), enter Dive 0 (the start of the initial MMP dive to the bottom). Use the calendar icon or type the date and time directly.

NOTE
Project Settings show the project name and description, number of profiles and patterns, and when SCHEDULE.DPL was initially created and last created.
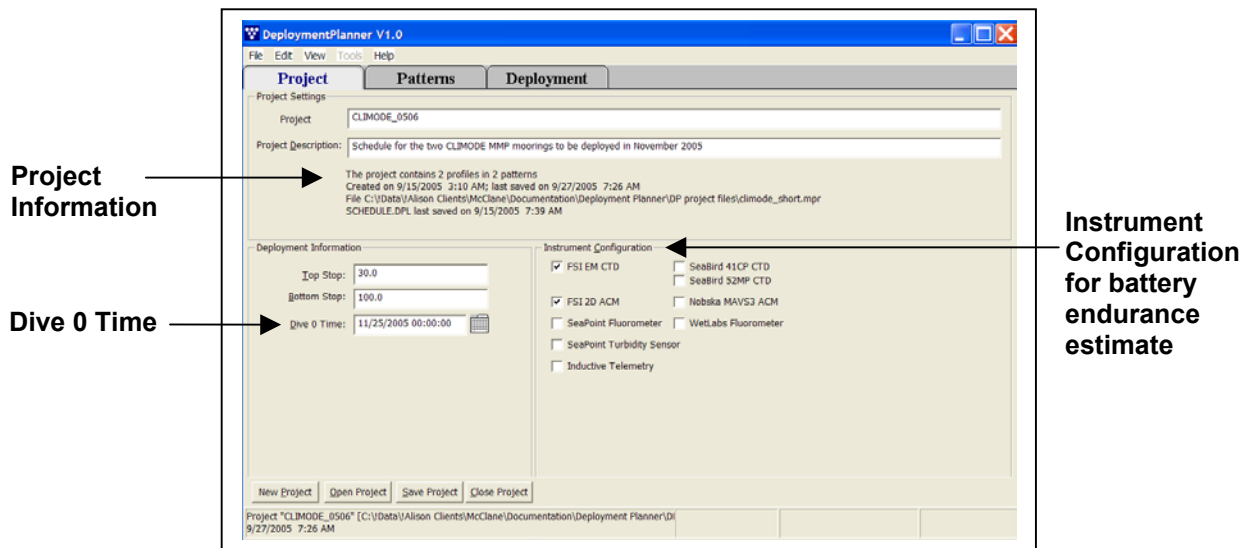
Figure G-2: Deployment Planner Project Tab display

2. Select the Instrument Configuration.

IMPORTANT
Instrument Configuration is used only to calculate estimated battery endurance in the Deployment Planner. Actual deployment sensors must be configured in the MMP firmware.

NOTE
Inductive Telemetry must be selected if inductive telemetry profiles will be defined.

3. Click the Patterns tab to continue.

4. On the Patterns tab (see Figure E-3), clicking the down arrow lists the patterns in the project (clicking 'New' creates a new pattern). When a pattern is selected, the Profiles are listed in the Pattern Contents window.
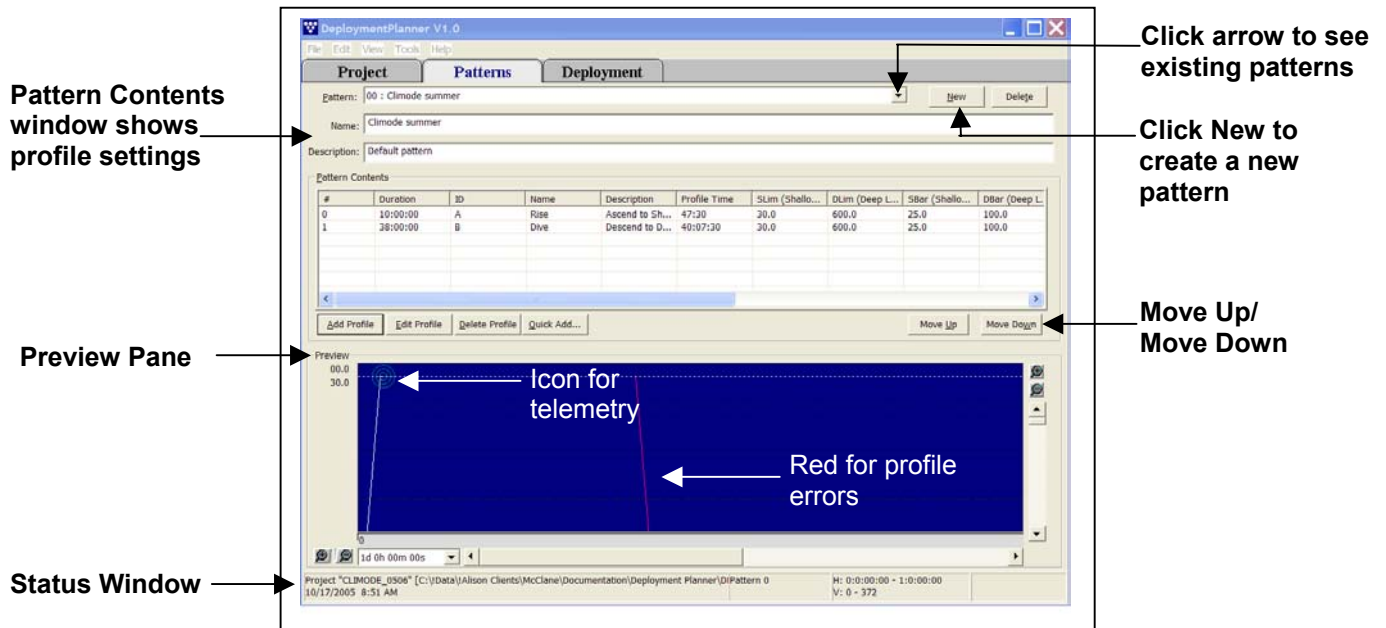
Figure G-3: Deployment Planner Patterns Tab display

5. Optionally, use 'Move Up' or 'Move Down' to reorder profiles.

- View →Preview Pane from the top menu bar hides or displays the Preview pane. View →Profile List displays profile details.

- Zoom in [+], zoom out [-] and the scroll bars change the view (the selected profile is shaded light blue and highlighted in the Pattern Contents list).

6. Select from additional options to add or change profiles in the pattern.

IMPORTANT
Profile changes are global. Except for the 'Duration for this profile in the pattern' setting, changes to a profile affect every pattern that uses the profile.

- 'Delete Profile' removes the profile selected in the Pattern Contents window (deleted profiles are removed from the pattern but remain in the profile catalog).

- Edit→Copy, Edit→Paste (or CTRL C, CTRL V) adds another instance of a profile. All profile settings are copied.

- 'Quick Add' allows profiles to be added to the pattern by typing (A,B,A,D).

- Clicking 'Add Profile' or 'Edit Profile' displays the Profile Editor.

7. If using the Profile Editor, (see Figure E-4) refer to the section that follows for additional information, otherwise, skip to Step 8.

NOTE

The Profile Editor adds or changes profiles. To add an identical copy of a profile, see Step 6. In edit mode, change Profile Name or Profile Description. Profile letter cannot change.

IMPORTANT

Self-logging sensors such as the ACM and CTD have a maximum internal memory of approximately 8 hours of data. Therefore, the maximum Profile Time is 8 hours.

Profile Preview

Profile Direction or Stationary

Profile Time

Shallow Range, Deep Range, Check Stop

Total Dive Time

Duration
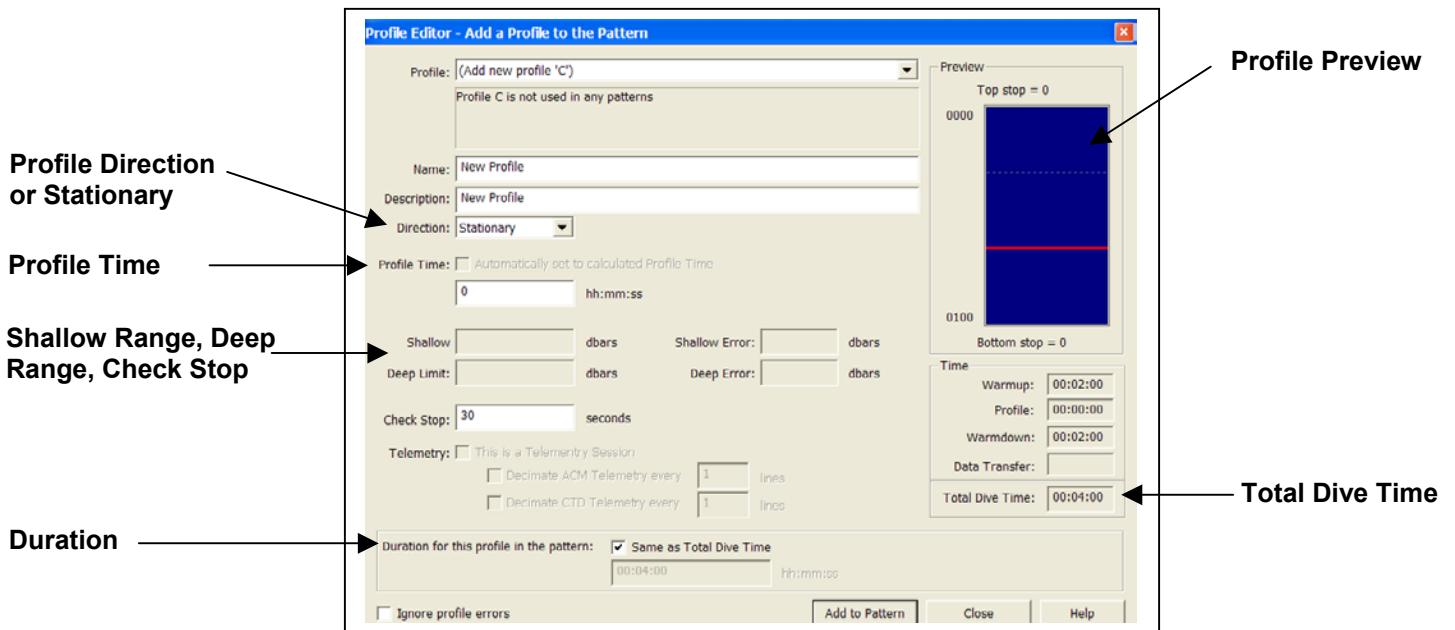
Figure G-4: Profile Editor – Add Mode display

Using the Profile Editor

Profile Time	Profile Time is data collection time, (moving or stationary). When the profile time elapses, the profile 'times out' – the profile is terminated and the sensor warm down begins.
Duration 'Same as Total Dive Time' is Default, or Duration can be manually entered.	The amount of time between the start of one profile and the start of the next. The MMP sleeps in the time between the end of the current profile and the beginning of the next.
Total Dive Time System estimate – cannot be changed.	Total Dive Time is the estimated time for managing a profile (sensor warm up + profile time + sensor warm down + data collection). Total Dive Time is automatically calculated based on profile settings.
Shallow Pressure	The 'top' of the profiling range. The MMP stops profiling on an 'up' profile when the ambient pressure drops to below the shallow pressure limit.
Deep Limit	The 'bottom' of the profiling range. The MMP stops profiling on a 'down' profile when the ambient pressure rises to more than the deep pressure limit.
Shallow Error	Relative pressure deeper than the shallow pressure stop.
Deep Error	Relative pressure above the deep pressure stop.
Ignore Profile Errors checkbox	If 'Ignore Profile Errors' is checked, the pop-up error box will not display when the Deployment Planner detects a profile with errors. McLane recommends that 'Ignore Profile Errors' remains unchecked.

8. Click the Deployment tab (see Figure E-5) to verify patterns and profiles and make any changes. The lower right corner displays the estimate for the number of days, profiles, total meters, and files on the flash card at battery expiration.
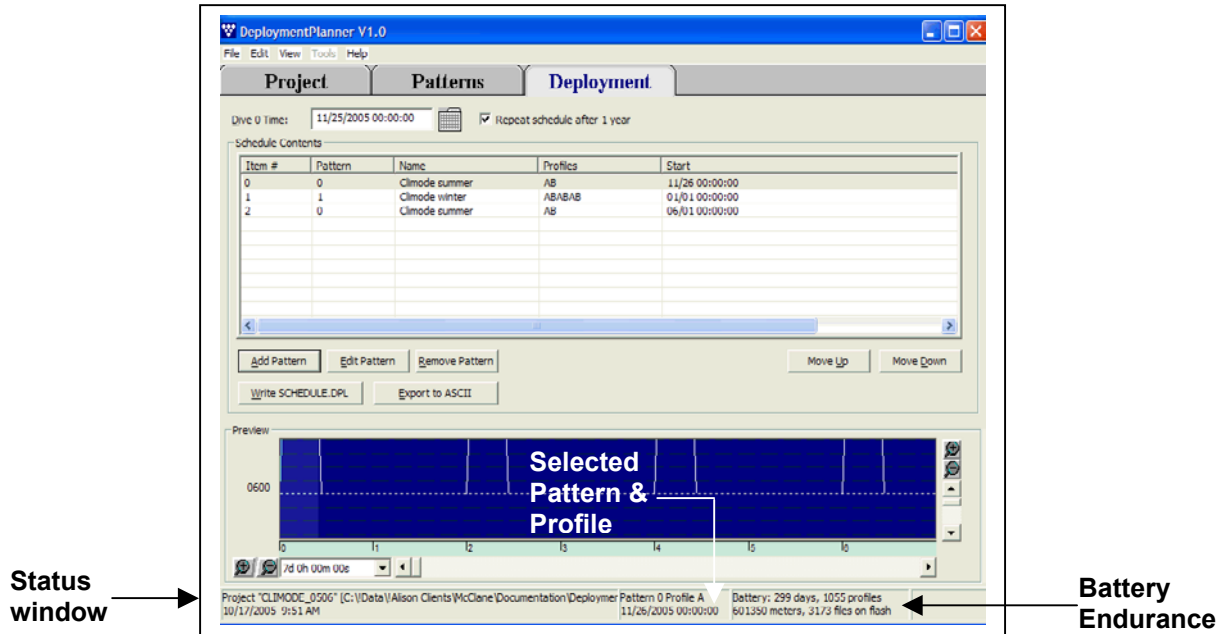

Figure G-5: Deployment Planner Deployment Tab display

9. On the Deployment Tab, use Move Up and Move Down to reorder patterns or click Add, Edit or Delete to change patterns in the deployment.

NOTE
Changing Dive 0 time on the Deployment tab changes the initial MMP dive to the bottom.

- The Status window indicates the pattern and profile that are selected in the Preview pane.
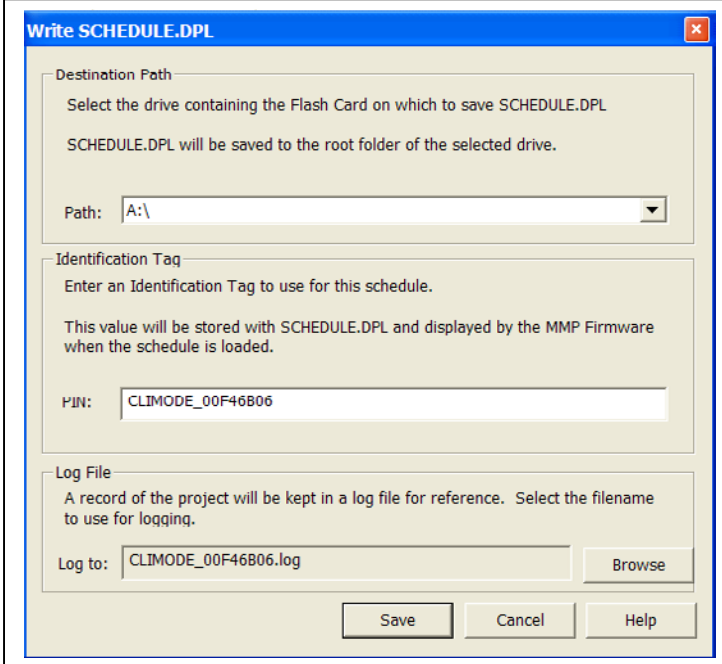
10. Click 'Write SCHEDULE.DPL' to save the deployment schedule in flashcard format.

IMPORTANT
The SCHEDULE.DPL file must be on the MMP flashcard to run the deployment.

Write SCHEDULE.DPL

Write SCHEDULE.DPL saves the deployment schedule. Since the Deployment Planner can use the same profiles in other deployment schedules, the PIN is generated to uniquely identify a deployment schedule.

Figure G-6: Write SCHEDULE.DPL display

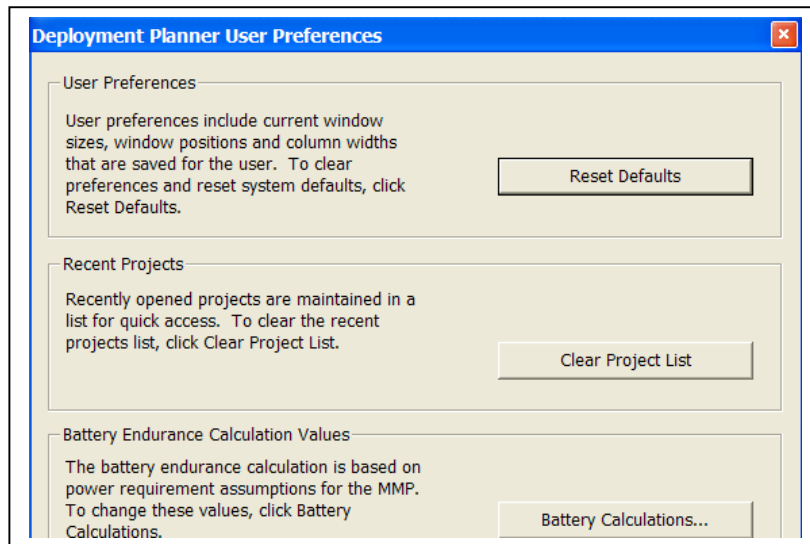| NOTE |
| --- |
| PIN is automatically generated but can be changed. |

Figure G-7: Reset User Preferences display

- A log file is also generated and saved by default in the project directory (click Browse to choose a different directory for the log file).

- Optionally, click 'Export to ASCII' to create a text file with project, pattern, and profile data.

- Copy the SCHEDULE.DPL file onto a flashcard and load into the MMP firmware for the deployment.

Changing User Preferences

From the Initial screen Deployment Planner screen (see Figure E-1), the User Preferences menu provides options that reset defaults including changing the battery endurance calculation. Clearing the Recent Projects list removes the projects that are listed on the initial Deployment Planner screen.

Modifying Battery Endurance Values

The Battery Endurance Calculation dialog displays the default current draw (in mAh) for each sensor selected on the Project Tab. Changing the default affects the battery estimate
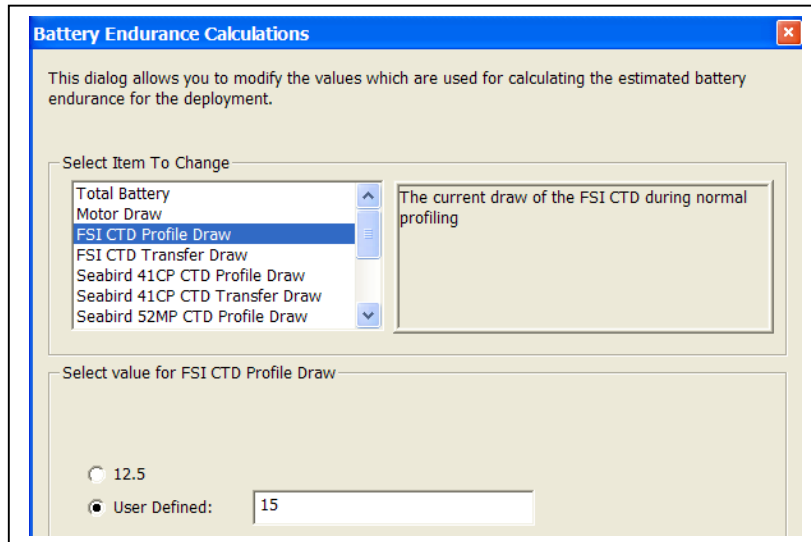

Figure G-8: Change Battery Endurance Calc display

Notes

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