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Revision History

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<th>Author(s)</th>
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<td>1.0</td>
<td>20.09.16</td>
<td>ES, MK</td>
<td>Initial Release</td>
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<td>GPS/Engineering Record Format</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>CPIES Data Record</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>PIES Data Record</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Data Format Identifiers</td>
<td>31</td>
</tr>
<tr>
<td>6</td>
<td>Number of PDS data records</td>
<td>31</td>
</tr>
<tr>
<td>7</td>
<td>PDS data record Parsed Fields</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>Mobile Terminated Command Messages</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>PDS Data Fields Output by sbd2popDat</td>
<td>33</td>
</tr>
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<td>10</td>
<td>PDS Output File Formats</td>
<td>34</td>
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1 Popeye Data Shuttle Overview

A data shuttle is a device that collects data while in one location, moves to a second location and passes those data on to yet another IT carrier. In the case of the Popeye Data Shuttle (PDS), the first location is the sea floor, the second location is the sea surface, and the subsequent IT carrier is the Iridium gateway to the internet.

The URI-GSO PDS carries out the task with the following enhancements:

- Multiple PDS capsules clustered around a “mother” seafloor data logger
- Micro-power, wireless, near-field magnetic broadcast link between “mother” and capsules
- Low-cost, expendable, corrosion-free glass capsule
- Deep ocean deployment capability (max: 6000 m depth)
- Deployment duration to 4 years
- Programmable, individual capsule release date/time
- Global Iridium satellite network (M2M gateway) access once capsule is on the surface
- Data from the seafloor site transferred as email or direct to any IP location

Note: The PDS is an add-on device designed (and described in this manual) for use with the URI-GSO Inverted Echo Sounder (IES). A full description of the IES can be found at: [http://www.po.gso.uri.edu/dynamics/IES/index.html](http://www.po.gso.uri.edu/dynamics/IES/index.html) (includes photos, project descriptions, and link to IES bibliography).

1.1 PDS AS A CPIES COMPANION

The PDS is not a stand-alone instrument. It employs a counterpart instrument from which to receive data. Its companion instrument must be equipped with a matching wireless magnetic link. The term Current and Pressure recording Inverted Echo Sounder (CPIES) refers to a version of the IES (refer to the above link) that is configured with a current meter sensor (hence the C) and a pressure sensor (hence the P). The CPIES system must be configured with the appropriate firmware and hardware (subsea magnetic transmitter and antenna). As of this writing, only IES models 6.2C and later can be fitted with the PDS feature. Refer to Section 2.3 for instructions on how to set up a properly equipped CPIES for PDS service.

1.2 SUBSEA NEAR-FIELD WIRELESS LINK

The subsea communications link between the bottom-moored Pressure recording Inverted Echo Sounder (PIES) or CPIES and a cluster of PDS capsules is a short-range (<2 meters), wireless technique that uses the magnetic induction principle as the applied science. When equipped with a PDS transmitter, the CPIES can generate a non-propagating magnetic field surrounding its housing...
as shown in Figure 1. The CPIES generates the magnetic field by driving a series-tuned ferrite coil antenna mounted inside the glass housing. Each PDS capsule is equipped with a magnetic field detector to convert the amplitude modulations of the field into digital signals.

![Figure 1: PDS Subsea Magnetic Link](image)

Data are broadcast from the CPIES to all PDS capsules in range as time-delay encoded amplitude modulations of the magnetic field. Broadcast and receiving antennas are designed as a narrow-band pair (high Q response), optimizing error-free reception. The received signals are decoded and logged to a memory card by the PDS controller. The goal here, for this deep-sea, interference and noise-free application, is one-way transmission (with error flagging) that will allow the PDS capsules to be simple (inexpensive and expendable) but highly reliable.

### 1.3 SEA SURFACE IRIDIUM LINK

Each PDS capsule is equipped with a Iridium Model 9602 transceiver configured to access the Iridium Short Burst Data (SBD) service once the capsule is on the surface.

The PDS controller will compose SBD messages from the onboard data file in a last-in-first-out (LIFO) sequence, i.e., the data will be sent in reverse order of when they were collected. The PDS controller will also aid the Iridium transceiver in detecting and managing transmission problems. Messages (data) will be sent as email attachments to as many as five email addresses. The PDS will attempt to send all data from the onboard collection file until the beginning of file is detected, the batteries are exhausted or the transceiver is commanded to stop by the Iridium SBD service. PDS capsules are designed to be expendable and will only be recovered if an opportunity presents itself, e.g., by chance discovery and return.
## 1.4 PDS MODEL 4 SPECIFICATIONS

### General

<table>
<thead>
<tr>
<th>Controller</th>
<th>STM32L0 Arm Cortex-M0+ MCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>+6Vdc</td>
</tr>
<tr>
<td>Current, active</td>
<td>&lt; 10 mA</td>
</tr>
<tr>
<td>Current, standby</td>
<td>&lt; 3 µA</td>
</tr>
<tr>
<td>Data capacity</td>
<td>2 Gbyte</td>
</tr>
<tr>
<td>System battery</td>
<td>4 stacks of 4 alkaline C cells, +6V, 14 Ahrs @25C</td>
</tr>
<tr>
<td>Release/Iridium battery</td>
<td>2 stacks of 8 alkaline C cells, +12V, 7 Ahrs @25C</td>
</tr>
<tr>
<td>Clock battery</td>
<td>lithium coin cell CR2477 +3V, 1000 mAhrs</td>
</tr>
<tr>
<td>Combined battery weight</td>
<td>1.73 kg (3.81 lbs)</td>
</tr>
</tbody>
</table>

### Subsea Magnetic Link

<table>
<thead>
<tr>
<th>CPIES Transmitter:</th>
<th>PIC16F1847</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>+5V</td>
</tr>
<tr>
<td>PA drive level</td>
<td>13Vdc</td>
</tr>
<tr>
<td>Current, transmit</td>
<td>peak: 250 mA</td>
</tr>
<tr>
<td>Current, standby</td>
<td>1 µA</td>
</tr>
<tr>
<td>CPIES record transmit time</td>
<td>15 sec (typical)</td>
</tr>
<tr>
<td>Transfer rate</td>
<td>10 bits/sec</td>
</tr>
<tr>
<td>Transfer protocol</td>
<td>fixed field, packed BCD</td>
</tr>
<tr>
<td>Range</td>
<td>2 m</td>
</tr>
<tr>
<td>Antenna</td>
<td>Series-tuned ferrite rod (77500Hz)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>PDS Receiver:</th>
<th>EM2S-DCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Volt</td>
<td>+3.3Vdc</td>
</tr>
<tr>
<td>Current, active</td>
<td>&lt; 1mA</td>
</tr>
<tr>
<td>Current, standby</td>
<td>&lt; 1 µA</td>
</tr>
<tr>
<td>Antenna</td>
<td>Parallel-tuned ferrite rod (77500Hz)</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>&lt; 750Hz, 77500 ± 300Hz</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>&gt; 8uV out with 100uV/m-1 field strength</td>
</tr>
</tbody>
</table>

### Sea Surface Iridium Link

<table>
<thead>
<tr>
<th>Transceiver:</th>
<th>Iridium Model 9602</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>1616-1626.5 MHz</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>+5Vdc</td>
</tr>
<tr>
<td>Current, active</td>
<td>1.5A peak, 45mA (avg)</td>
</tr>
<tr>
<td>SBD service</td>
<td>190mA (avg), average power = 1.0W</td>
</tr>
<tr>
<td>Standby</td>
<td>&lt; 1 µA</td>
</tr>
<tr>
<td>Antenna</td>
<td>Taoglas #IP.1621.25.4.A.02</td>
</tr>
<tr>
<td>Mount</td>
<td>URI PCB rev5.2</td>
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### GPS

<table>
<thead>
<tr>
<th>Model</th>
<th>Sierra Wireless XA1100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>1575.42 MHz</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>3.3V</td>
</tr>
<tr>
<td>Current, acquisition</td>
<td>21mA</td>
</tr>
<tr>
<td>Time to first fix</td>
<td>40 seconds (typ)</td>
</tr>
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### Spherical Glass Housing

<table>
<thead>
<tr>
<th>Type</th>
<th>low expansion boronicate</th>
</tr>
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<tbody>
<tr>
<td>OD</td>
<td>33.00 cm (13 in)</td>
</tr>
<tr>
<td>ID</td>
<td>30.5 cm (12 in)</td>
</tr>
<tr>
<td>Weight in air</td>
<td>11 kg (24 lbs)</td>
</tr>
<tr>
<td>Net buoyancy</td>
<td>10.6 kg (23 lbs)</td>
</tr>
<tr>
<td>Depth rating</td>
<td>7000 m (22,966 ft)</td>
</tr>
</tbody>
</table>

### Mechanical (complete PDS capsule assembly)

| Weight in air | 11.3 kg (25 lbs) with standard battery pack |
| Shipping container | cardboard box, 22 in x 22 in x 22 in |
| Total shipping weight | 18 kg (40 lbs) |
Figure 2: PDS Controller

Figure 3: GPS Bluetooth and Iridium module
2 Getting Started Configuring the PDS System

This chapter provides instructions on how to:

- Establish communications with the PDS capsule
- Use the PDS menus
- Use the IES menu to enable the PDS application

The PDS is shipped sealed, with its battery installed, ready to be turned ON, configured with its companion CPIES, and deployed. There are no internal or external switches on the PDS capsule; power is controlled through the Bluetooth communications port.

2.1 PDS BLUETOOTH PAIRING

Communications are established with the PDS via Bluetooth. The following instructions are for a Windows 10 Platform.

2.1.1 Power Up and Bluetooth LED Indicators:

There is a cutout in the top of the PDS hardhat (Figure 4). Place the magnet in the cutout (Figure 5) to power up the Bluetooth module. The red LED on the module should now be blinking at a 1Hz rate.

<table>
<thead>
<tr>
<th>Red LED Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toggle at 1 Hz</td>
<td>The module is discoverable and waiting for a connection</td>
</tr>
<tr>
<td>Toggle at 10 Hz</td>
<td>The module is in command mode</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Green LED Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>The module is connected to another device over Bluetooth</td>
</tr>
<tr>
<td>OFF</td>
<td>The module is not connected over Bluetooth</td>
</tr>
</tbody>
</table>

2.1.2 To add a Bluetooth enabled device to a Windows Computer

Once you’ve verified that a Bluetooth adapter is installed on your computer, and the device you want to connect with is discoverable, you can add most Bluetooth enabled devices to your computer. Here’s how:

1. In the Search Bar, type ‘Bluetooth & other devices settings’.
2. Open ‘Bluetooth & other devices settings’ application
3. Click ‘Add Bluetooth or other device (Figure 6). A new window pops up called ‘Add a device’ (Figure 7).
2.1 PDS BLUETOOTH PAIRING

Figure 4: Cutout in the top of the PDS hardhat.

4. Under ‘Choose the kind of device that you want to add’ choose ‘Bluetooth’ (Figure 7).

5. Click on the PDS Serial Number to add (Figure 8) and enter the pin code 1234 (Figure 9).

6. Click ‘Connect’. After a few moments, the PDS should be paired with the computer. Click ‘Done’ (Figure 10).

7. To find the Com Port number, click on the PDS that was paired. Go back to Bluetooth & other devices settings (Figure 11). On the right side of the window, click on ‘More Bluetooth Options’. A new window will pop up (Figure 12). Select the ‘Com Ports’ Tab. The correct Com Port number to use when connecting using TeraTerm has ‘RNI-SSP’ in the ‘Name’ column.

Tera Term is a terminal emulator that is used to communicate with the PDS over the Bluetooth radio. Tera Term is provided on the PDS User’s Disk and should be installed on the compter.

Open Tera Term, Select the Serial radio button (Figure 13) and choose the appropriate COM port that was created during the pairing process from the drop-down menu. Select ‘OK’.

After several seconds, the green LED on the Bluetooth module should now be illuminated. The New Connection window will automatically close and there will be a blank Tera Term session (Figure 14).

To configure the serial port (9600,8,N,1), select ‘Serial’ from the Setup menu (Figure ??). Once the setup is correct, select ‘OK’ to save the configuration and to close the window.

Setup the Terminal: Change New-Line Receive from CR to LF (Figure 16).

To Log the Tera Term session select ‘Log’ from the ‘File’ drop down menu (Figure 17). Save the log using a descriptive name with a txt file extension.
2.1 PDS BLUETOOTH PAIRING

Figure 5: Place the magnet in the cutout.

Figure 6: Bluetooth & other devices screen.
2.1 PDS BLUETOOTH PAIRING

Figure 7: Add a device popup window.

Figure 8: Click on PDS serial number to add.
2.1 PDS BLUETOOTH PAIRING

Figure 9: Enter the PIN for PDS serial number.

Figure 10: Add a device window after pairing successful.
2.1 PDS BLUETOOTH PAIRING

Figure 11: Update Bluetooth & other devices window.

Figure 12: Bluetooth Settings window.
2.1 PDS BLUETOOTH PAIRING

Figure 13: Tera Term New Connection Window

Figure 14: Blank Tera Term Session
2.1 PDS BLUETOOTH PAIRING

Figure 15: Tera Term Serial port setup

Figure 16: Tera Term Terminal setup
2.2 USER INTERFACE - MENU MODE

2.2.1 PDS Main Menu

When the PDS wakes the “Main Menu” is displayed (Figure 18). The options from the main menu are:

B — Memory Card Menu
Memory Card Menu allows the user to examine and offload the memory card test data files as well as prepare the card for a mission. Details of each memory card menu selection are provided in Section 2.2.2.

M — Mission Setup and START Menu
Mission Setup and START Menu is a list of programming options that MUST be selected prior to deploying the PDS. These selections determine the behavior of the instrument’s data acquisition system during the deployment. The valid ranges of selections are indicated. Invalid or conflicting operating parameters will not be accepted. Details of each selection are provided in Section 2.2.3.

O — Power OFF
Power OFF will force the PDS controller into suspend mode. Pressing any key will restart the controller from a power ON status.

T — Testing Toolbox Menu
Testing Toolbox Menu lists the PDS firmware self-test routines available. Details of each selection are provided in Section 2.2.4.

X — RESET
RESET will restart the PDS controller computer module.
2.2 USER INTERFACE - MENU MODE

Figure 18: Start Menu’s Banner indicating model, firmware build date and Iridium IMEI

---

Popeye Data Shuttle – Model 4.0 Build Date: Jul 7 2020 12:59:57
PDS Serial No. 114 Iridium IMEI No.
Receive Sync Period: 60 minute(s).
Listening Timeout: 360 minutes(s).
Iridium Network Available Timeout: 1 minute(s).
GPS Fix Timeout: 2 minute(s).
Configured for IES type: CPIES

PopEye Data Shuttle has RESET 25 time(s) since Mission Setup

University of Rhode Island - Graduate School of Oceanography

System clock: Wed Sep 16 07:38:01 2020

Press the <space> key within the next 10 seconds to enter the Main Menu, otherwise data collection will start with the previous operating parameters.

---

************************************************** Main Menu **************************************************
B ----- Memory Card Menu
M ----- Mission Setup and START Menu
O ----- Power OFF — permanent suspend mode. Hold <space> key to wake
T ----- Testing Toolbox
X ----- SYSTEM RESET

* select =>*
2.2 USER INTERFACE - MENU MODE

Note: Menu Timeout: If the user does not make a menu selection for 10 minutes, the system will enter suspend mode. This will prevent the user from inadvertently leaving the system in menu mode (a relatively high current condition). Pressing and holding the ‘space’ key will return the user to the startup banner as above. This timeout will not interfere with any operations.

2.2.2 Memory Card Menu

From the PDS Main Menu select “B” to enter the Memory Card Menu. The following options are available (Figure 19):

A — Display memory card data directory
Display memory card directory displays the name, size and date of creation for each file in the memory card “/DATA” directory.

B — Read a file
Read a file displays the directory structure and prompts the user for the name of a file to read. When the file name is entered, the file contents will be displayed. This is the equivalent of the MS-DOS “TYPE” command. WARNING: DO NOT USE FILE EXTENSIONS (.DAT) HERE!! trying to keep it simple.

E — Erase ALL files
This menu option erases ALL files in the memory card “/DATA” directory. There is no recycle bin. When this operation is performed all data will be irrevocably lost! The user will be warned and asked to approve the operation. To approve the operation the user must enter an uppercase “Y”.

2.2.3 Mission Setup Menu

From the PDS Main Menu select “M” to enter the Mission Setup Menu (Figure 20). The menu provides an ordered list of operations required to configure the PDS for deployment. Perform mission setup no more than three hours before pairing a PDS with an IES, this will minimize the risk the PDS inadvertently assumes a communication timeout with the IES has occurred and triggering release.

A — Read/Set capsule date/time clock
2.2 USER INTERFACE - MENU MODE

Figure 20: PDS Mission Setup Menu

This menu option displays the current PDS date/time clock and allows the user to modify those values. To modify the time, enter a date/time that is slightly ahead of your timepiece and press <enter> when the times match the new time will be saved and will remain accurate even when the PDS is OFF. To confirm the correct time, select “A” while monitoring your timepiece and compare the times. After selecting “A”, simply pressing <enter> without entering a valid time will leave the clock unchanged.

B — Set capsule release date and hour
This menu option displays the current PDS release data and hour. Press <enter> to accept the value or enter a new time and hour (24 hour format) and then press <enter>. The new time will be saved in non-volatile memory. Watch for warning messages here regarding the correct format.

NOTE: the PDS will release if it does not get valid data from the IES for 6 hours. The release is based on time, not samples. In July 2020, a low battery abort feature was added to the PDS firmware. During subsea operations, if 12 consecutive hourly low battery conditions (voltage less than 4.0V) are observed, the PDS will abort the mission and proceed to release and surface operations.

E — Erase ALL DATA FILES
This menu option enables erasing ALL files in the memory card “/DATA” directory. There is no recycle bin. When this operation is performed all data will be irretrievably lost! The user will be warned and asked to approve the operation. To approve the operation the user must enter an uppercase “Y”.

I — Change host IES type
This menu option sets the IES type the PDS is paired to. IMPORTANT NOTE: As delivered to the end-user the PDS is in “CUSTOMER DELIVERY MODE”, this menu option must be used at least once to select and save the IES host type the PDS is paired to. This will ensure that the device is configured properly for the selected IES type.

S — Save mission configuration

G — GO - review/save configuration and START a new mission
This menu option displays a summary of all mission-significant operating parameters and asks the user to approve their use in a new mission. Any operating parameter incompatibilities will be displayed. REVIEW THIS SCREEN CAREFULLY Enter “N” to return to the setup menus or
“Y” to begin the mission sequence. Warning: A new mission will create a new POPMODEM.DAT file, any previous data will be overwritten.

Q — Return to the Main Menu

2.2.4 Testing Toolbox Menu

From the PDS Main Menu, select “T” to enter the Testing Toolbox Menu (Figure 21). Note: Menu item ‘A’ is for URI testing purposes only.

A — Enter modem AT commands & display reply
The modem will be turned ON and the user will be asked to enter an AT command. Replies to valid commands will be displayed. Invalid commands may take as long as 40 seconds to process. Be patient. After each command the user will be asked to enter another. If “N” the modem power will shut OFF and the user returned to Testing Toolbox.

B — Continuous magnetic link receive mode... no listening timeout
This mode is similar to starting a mission except that meta records are not written, the listening timeout is disabled and the capsule release and Iridium operations are suspended. This mode is used specifically to test the subsea magnetic link. The test files will automatically be enabled in this mode. The system will remain in receive mode until terminated by the user.

C — Create test pattern POPMODEM.DAT file
This will create a number of fixed-data records in a new POPMODEM.DAT file (old data will be overwritten). The test pattern format and fixed data values are outlined in Chapter 4.1. The user will be asked for how many records. A meta-record will be added to the request. Remember that there will be one Iridium SBD session for each 9 records for a CPIES.

D — Immediate SBD transmit of POPMODEM.DAT file
This will start an Iridium SBD session using the existing POPMODEM.DAT file. This function is used specifically to test the Iridium link prior to deployment. This test must be performed with an
unobstructed view of the sky.

**F — Iridium signal quality bar graph mode. . . press <space> to STOP**
This will continuously check and display the signal quality the modem is experiencing. When testing the modem prior deployment the signal quality can be affected by adjacent obstacles, resulting in the modem being unable to successfully transmit data.

**G — Release relay test. . . LEDs flash red for 5 seconds**
Latch the release relay ON for 5 seconds. Flash both LED indicators red during ON time. Display the status on the screen.

**L — Measure Vbatt**
This will measure the voltages of system and release batteries.
vBatt-HI - reserve battery: to power the GPS and Iridium modem. [~ 12Vdc]
vBatt-LO - system battery: to power the micro-controller for all operations. [~ 6Vdc]

**N — NMEA GPS Receive Test. . . press <space> to STOP**
The will turn on the GPS unit and continuously display records received from the GPS, encoded in NMEA format. This test must be performed with an unobstructed view of the sky.

**O — Generate GPS/Engineering Record**
This will return a GPS/Engineering record (Table 2) containing the current GPS location and device status information.

Table 2: GPS/Engineering Record.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDS_date</td>
<td>Internal real time clock (RTC) Date; format: “ymmd”</td>
</tr>
<tr>
<td>PDS_time</td>
<td>Internal RTC Time; format: “hhmmss”</td>
</tr>
<tr>
<td>GPS_time</td>
<td>GPS Time; format: “hhmmss”</td>
</tr>
<tr>
<td>Latitude</td>
<td>GPS Latitude; format: “+/- decimal degrees”</td>
</tr>
<tr>
<td>Longitude</td>
<td>GPS Longitude; format: “+/- decimal degrees”</td>
</tr>
<tr>
<td>SOG</td>
<td>GPS speed over ground</td>
</tr>
<tr>
<td>COG</td>
<td>GPS course over ground</td>
</tr>
<tr>
<td>PTW_seconds</td>
<td>Number of seconds sending SBD messages for most recent file transfer</td>
</tr>
<tr>
<td>PTW_retries</td>
<td>Number of retries sending SBD messages for most recent file transfer.</td>
</tr>
<tr>
<td>vBatt_HI</td>
<td>Battery voltage - HI</td>
</tr>
<tr>
<td>vBatt_LO</td>
<td>Battery voltage - LO</td>
</tr>
<tr>
<td>n_resets</td>
<td>Number of PDS device resets since initialization.</td>
</tr>
<tr>
<td>n_sent</td>
<td>Number of times POPMODEM.DAT has been successfully transmitted.</td>
</tr>
<tr>
<td>GPS_wake</td>
<td>Repeat interval to send GPS/Engineering records.</td>
</tr>
<tr>
<td>wake_units</td>
<td>Time interval units; format: “H” (hours); “M” (minutes).</td>
</tr>
</tbody>
</table>

**Q — Return to the Main Menu**
2.3 IES USER INTERFACE - PDS ENABLE

All that has to be done to an IES with PDS application firmware installed is enable data shuttle reporting. From the IES Main Menu, navigate to the IES Mission Setup Menu (Figure 22). If an IES has PDS application firmware installed, Option ‘P’ will be listed under Optional Sensors. Select ‘P’ and follow the prompts to enable data shuttle reporting to the PDS capsules (Figure 23). Check “Enable Data Shuttle Reporting” on the IES Pre-Launch Prep Checklist (Appendix B).

IES typically allow 1, 2, 3 or 6 samples per hour for pressure/temperature (P/T) and current measurements. P/T and current sampling schedules are independent. Note that due to the format of PDS data payload (see Section 3.2), three samples per hour (20 minute sampling) is not a valid sampling schedule for P/T or currents for a PDS-enabled CPIES: choose 1, 2 or 6 samples per hour.
2.3 IES USER INTERFACE - PDS ENABLE

Figure 23: IES Mission Setup Menu for an IES with PDS application firmware installed, Option ‘P’
3 Mission Planning and Predeployment Testing

This chapter provides information on:

- Mission planning
- Data payload
- Energy vs. deployment time
- Mission setup & testing procedures

3.1 MISSION PLANNING

Designing a PDS mission involves answering the following two questions: 1) what are the data to be transferred and, 2) how often will the data be transferred. The answers to both of these questions will determine the energy (battery) required to complete the mission. At this writing, the answers to these questions are already set for the CPIES/PDS application. The following sections outline the data payload and energy budget for a CPIES/PDS mission.

3.2 DATA PAYLOAD

The CPIES (PIES) logger will be programmed to make the measurements listed in Table 3 (Table 4) every hour. The logger will compose and broadcast the data record to all PDS capsules in range at the end of each hour. For more details on the data record compression formatting refer to Chapter 4.

If one pressure measurement per hour is selected in the IES mission, then the two pressure measurements reported to the PDS will be the same. If one DCS measurement per hour is selected in the IES mission, then the two current speeds and headings reported to the PDS will be the same.

<table>
<thead>
<tr>
<th>Field</th>
<th>#hex chars</th>
<th>transmitted to PDS</th>
<th>stored in PDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour number (since 1 Jan 1970)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tau (hourly average of 24 or 96 measurements)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Pressure (2 measurements, 30 minutes apart)</td>
<td>6x2</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Current speed (2 measurements, 30 minutes apart)</td>
<td>3x2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Heading (2 measurements, 30 minutes apart)</td>
<td>3x2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>32-bit checksum calculation</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37 hex chars/record</strong></td>
<td><strong>35 bytes/record</strong></td>
<td></td>
</tr>
</tbody>
</table>

The subsea near-field link transfers data as nibble (hex) characters but they will be stored in the PDS capsule as bytes as follows: 35 bytes/record (with 3 nibble checksum converted to 1 byte):
Table 4: PIES Data Record

<table>
<thead>
<tr>
<th>Field</th>
<th>#hex chars</th>
<th>transmitted to PDS</th>
<th>stored in PDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour number (since 1 Jan 1970)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tau (hourly average of 24 or 96 measurements)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Pressure (2 measurements, 30 minutes apart)</td>
<td>6x2</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>32-bit checksum calculation</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>25 hex chars/record</td>
<td>23 bytes/record</td>
</tr>
</tbody>
</table>

‘Y’ or ‘N’. The total CPIES payload for a year is then 35 bytes/record x 24 records/day x 365 days = 307 Kbytes/year. The total PIES payload for a year is then 23 bytes/record x 24 records/day x 365 days = 197 Kbytes/year.

The standard PDS controller has a 2 GB micro SD memory card, so its data capacity is not a limiting factor. The total data payload needs to be calculated because of its influence on the receive and transmit energy budgets. See next section.
3.3 ENERGY VS. DEPLOYMENT TIME

Battery life curves are included here for a ZPULSE Doppler Current Sensor (DCS) (Figure 24) and 3820 DCS (Figure 25). These curves are based on the PDS adding 0.75 mA/hr average current drain. Battery drain does not increase with the number of PDSs. The PIES has one added Poplink transmitter, which simply broadcasts at the same power, and any number of PDS can receive it.

Figure 24: IES Sampling Life for 240 AmpHour System Battery with Zpulse DCS
3.3 ENERGY VS. DEPLOYMENT TIME

IES Sampling Life for 240 AmpHour System Battery, (24 Tau + DCS + 6 P+T)/hr with PDS

Figure 25: IES Sampling Life for 240 AmpHour System Battery with 3820 DCS
3.4 MISSION SETUP & TESTING PROCEDURES

Refer to the PDS Model 4.1 Checkout Testing & Mission Setup Sheet in Appendix A.

- Connect to the PDS via Bluetooth through Tera Term, wake the PDS and enter the Main Menu (Figure 18).

- **Note:** Log the Tera Term session for future reference

- Select ‘T’ from the Main Menu to enter the Testing Toolbox

- Select ‘L to measure the battery voltages. VbattHI is nominally 12V and VbattLO is nominally 6V. Record these voltages.

- Fit the Release Test Clip (Figure 26) over the outside of the release (cathode). Connect the negative lead of a voltmeter to the Release Test Clip. Connect the positive lead of a voltmeter to the small loop in the middle of the release (anode). The release voltage should be 0V.

- Select ‘G (Figure 27) to activate the release test for 5 seconds. During this time the release voltage should be $\sim 12V$. Confirm the release voltage is $\sim 0V$ after the test has concluded.

- **Note:** The following Iridium and GPS tests must be performed with an unobstructed view of the sky.

- Select ‘C to create a sample POPMODEM.DAT file. The user must choose how many hourly records to generate. For a CPIES, there are 9 hourly records transmitted per SBD message. To calculate how many sample records are required for a desired number of SBD messages use the following calculation:

  - $\text{NumberSampleRecords} = (\text{NumberSBDMessages} * 9) - 1$
  - Ex. Desired to send 4 sample CPIES data SBD Messages
  - $\text{NumberSampleRecords} = (4 \text{ SBD} * 9 \text{ CPIES Records/SBD}) - 1 = 35$
  - (Typically, URI-GSO sends 4 SBD messages when testing)

- Select ‘D to transmit the contents of the POPMODEM.DAT file via Iridium

- Verify that the messages were received in email account.

- Select ‘O to acquire a GPS location. This may take 45-60 seconds.

- **PDS Near-Field Transmit Test**

  - Place the PDS within 1 m of the transmitting IES
  - From the IES Self-Test Menu select ‘P’, PopEye Data Shuttle Reporting Test
  - Select the interval to send the test pattern (Figure 28).
  - Select ‘G’ to start the continuous loop.
  - From the PDS Testing Toolbox, select ‘B’, Continuous magnetic link receive mode
3.4 MISSION SETUP & TESTING PROCEDURES

– The PDS will now be listening for a simulated data stream from the IES. The RED LED on the PDS Controller board will be illuminated. Several seconds after the IES begins to transmit the data stream, the RED LED will disappear and the GREEN LED will be illuminated and will stay on until the end of the transmission. The GREEN LED will flash if the data was received without error. If there was an error in the reception, the RED LED will flash. Once a single transmission has been received the PDS will return to the Testing Toolbox.

– Note: To cancel the magnetic link receive test without receiving a transmission from the IES press the space bar on the PDS twice within 1 second. This will reset the PDS and the user will have the opportunity to enter the main menu. The user may wish to activate the receive test again while the IES is still in a transmission loop. If the testing is complete, the user should end the transmission on the IES by going to the Motocross Transfer Menu and selecting ‘Send Break’. This will end the transmission loop.

• Note: If not proceeding directly on to the Mission Setup and Start, return to the Main Menu and select O to power down the PDS.

Setting up and starting the Mission

• Select ‘M’ on the Main Menu to enter the Mission Setup Menu

• Select ‘A’ to set the PDS Clock to UTC. Confirm that the time is set correctly by selecting ‘A’ again and comparing the PDS Time against UTC. Hit the enter key to cancel the date/time entry.

• Select ‘B’ to set the PDS release date and hour.

• Select ‘E’ to Erase ALL DATA FILES. There is no recycle bin so this action is permanent.

• Select ‘I’ to set the IES Host Type Submenu. PIES or CPIES are the two options.

• Select ‘Q’ to return to the Mission Setup Menu

• Select ‘S’ to save the Mission Configuration.

• Select ‘G’ to start the mission. Verify all configuration settings. Select ‘Y’ to confirm the start of the mission or ‘N’ to abort the mission start to go back and adjust the configuration.

• Log the Mission Start Time and cancel the Tera Term Logging. From the Tera Term file menu, select ‘Disconnect. The red LED will now be blinking. Remove the magnet. From the Tera Term file menu, select ‘Show Log Dialog and select ‘PAUSE. The Tera Term Log window can now be closed.

Once the PDS mission has been started, it will enter sub-sea operations. The mission can only be interrupted when the PDS is in ‘Listening Mode. During the first six hours of operation, the PDS will illuminate a red LED on the controller board to indicate that the PDS is in Listening Mode. After a period of six hours, LED indicators are disabled to conserve power. This feature allows the user to go back and change the mission configuration without having to press a reset button which is not possible when the PDS is sealed in the sphere. If the PDS is in release mode or
Figure 26: PDS Release Test Clip

Figure 27: PDS Testing Toolbox Menu, Option ‘G’, Release relay test
sea-surface operations (Iridium Transmission), it is only possible to break the operations for brief periods at certain times.

**Important Note:** The PDS will listen for up to six (6) hours for a transmission from the (C)PIES. If a transmission is not received within six hours, the PDS will automatically enter release mode. During setup operations, the user must ensure that the PDS receives transmissions within the six-hour limit.
4 Data Recovery and Analysis

PDS-enabled CPIES encode and transmit hourly data records to PDS. The data are converted to packed BCD format and sent to the CPIES AUX port. These data are also stored in the CPIES in the file PDS.DAT. The data are received by the PDS and stored locally in a file named POPMODEM.DAT. The contents of POPMODEM.DAT are transmitted as Iridium Short Burst Data (SBD) message attachments. This chapter provides instructions on how to:

- recover data as Iridium SBD message attachments
- understand record formats
- use the Matlab program `sbd2popDat.m` to concatenate email message attachments from a PDS deployment and write a data file

4.1 DATA RECOVERY

Upon surfacing, PDS are programmed to automatically transmit the POPMODEM.DAT data file to the Iridium Service Provider one time. If you want the PDS to “STOP” sending the ‘POPMODEM.DAT file, or to “SEND” the file again you can send commands to the PDS using Iridium Mobile Terminated (MT) Messages, see Section 4.2.2

During pre-deployment testing and after deployment PDS data are available as Iridium Short Burst Data (SBD) message attachments. Record format details are presented below.

4.1.1 Download from Iridium Service Provider

Contact your Iridium Service Provider to determine the best way to download the SBD messages to your computer. URI-GSO uses Mail Attachment Downloader v3.2 by GearMage. Store the messages in folders according to International Mobile Equipment Identity (IMEI).

Message attachments will be downloaded with filenames: IMEI_MOMSN.sbd if MetOcean Telematics is used as the Iridium service provider or IMEI-MOMSN.bin for RockBLOCK. IMEI is the International Mobile Equipment Identity of the PDS’s Iridium 9602 Modem and MOMSN is the Mobile Originated (MO) Message Number that was used during the SBD session.

4.2 EMAIL DATA

4.2.1 Message Types

SBD message attachments contain a single hexadecimal character string comprised of hourly data records. A two character format identifier (Table 5) is included at the beginning of each SBD message. This format field is used to indicate to `sbd2popDat.m` (see Section 4.2.3) how to unpack and decode the data in the remainder of the SBD message. M1, M2 and M3 records do not require decoding.
4.2 EMAIL DATA

An Iridium SBD session is limited to 340 characters. The number of discrete IES data records contained in an SBD message will vary depending on the type of IES the PDS is used with. Table 6 lists the available options. Following the data records will be a “$” delimiter followed by a fixed number of characters (10 characters) providing Iridium diagnostics.

An example message attachment is shown below. This is an attachment to the second message sent from Iridium modem IMEI 300234065035670 (PDS SN 31). Note: The first line (in bold) is the attachment name. It is not part of the attachment text. This PDS was used with a CPIES (format “02”, see Table 6).

300234065035670_000002.sbd
02662701863C180F53022500180F4202847AY6626F1863C180F5F022375180F5B02640EY
6626E1863C180F56015276180F5E01B4D8Y6626D1863C180F490351C1180F53030232Y
6626C1863C180F310162E2180F3D021DF6Y6626B1863C180F1B00EB12180F2800ED93Y
6626A1863C180F08016791180F0D01DC0CY662691863C180F0201F9ED180F0500CA1EY
662681863C180F000000000

There are 9 IES data records in the example attachment. Each data record includes tau, pressure, current speed and direction. For example, the first data record in the SBD message shown above will be parsed as follows:

PDS data record: 662701863C180F53022500180F4202847AY

Separating the fixed-size hex character fields: 66270 1863C 180F53 022 500 180F42 028 47A Y

IES Hours is the number of hours elapsed since 1–Jan–1970. It is the top of the hour in which measurements were made. Current direction increases clockwise (0-359) from north. At the end of each hour, the IES transmits a processed tau value to the PDS. For bad tau data, the transmitted processed value depends on whether the IES measured 24 or 96 taus per hour. For 24 taus/hours (standard IES) the bad data value is 0. For 96 taus/hour (Fast Tau) the bad value is 9.9999.

4.2.2 Send Commands to PDS

The PDS is programmed to accept four basic commands that can alter its pre-programmed behavior. These commands are communicated to the PDS using Iridium SBD Mobile Terminated (MT) Messages.

The PDS will automatically download any queued MT messages during SBD data transmission. Additionally, once the initial file transmission has completed the PDS is programmed to “wake” each day at 23:59 GMT and check for any queued MT messages at the Iridium Service Provider. It then immediately implements the command received in the MT message in the order received, in case there are multiple commands in the queue. The PDS will continue to check for messages each day until the battery dies. The “mission” never ends for a PDS while there is battery power. The following descriptions are respective to our Iridium Service Provider, you should consult your Iridium Service Provider’s documentation to determine the appropriate method to send Mobile Terminated (MT) messages for your deployment.
Table 5: Data Format Identifiers. TPOP data (formats 04 - 07) are described in a separate manual.

<table>
<thead>
<tr>
<th>Format Identifier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>GPS/Engineering Record transmitted at the start of a data session</td>
</tr>
<tr>
<td>M2</td>
<td>GPS/Engineering Record transmitted at the end of a data session</td>
</tr>
<tr>
<td>M3</td>
<td>GPS/Engineering Record transmitted at the user’s request</td>
</tr>
<tr>
<td>00</td>
<td>Non-valid format</td>
</tr>
<tr>
<td>01</td>
<td>PIES Data</td>
</tr>
<tr>
<td>02</td>
<td>CPIES Data</td>
</tr>
<tr>
<td>03</td>
<td>Dual-Pressure CPIES Data</td>
</tr>
<tr>
<td>04</td>
<td>TPOP Data - 1 sample/hr</td>
</tr>
<tr>
<td>05</td>
<td>TPOP Data - 2 sample/hr</td>
</tr>
<tr>
<td>06</td>
<td>TPOP Data - 3 sample/hr</td>
</tr>
<tr>
<td>07</td>
<td>TPOP Data - 6 sample/hr</td>
</tr>
</tbody>
</table>

Table 6: Number of PDS data records.

<table>
<thead>
<tr>
<th>Format Identifier</th>
<th>Type of IES</th>
<th>Number of data records per SBD message</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>PIES</td>
<td>14</td>
</tr>
<tr>
<td>02</td>
<td>CPIES</td>
<td>9</td>
</tr>
<tr>
<td>03</td>
<td>Dual-Pressure CPIES</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 7: Example: PDS data record Parsed Fields

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Packed BCD</th>
<th>Unpacked decimal</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IES Hours</td>
<td>66270</td>
<td>418416</td>
<td>hours</td>
</tr>
<tr>
<td>Tau (hourly average)</td>
<td>1863C</td>
<td>99900</td>
<td>s * 10000</td>
</tr>
<tr>
<td>Pressure</td>
<td>180F53</td>
<td>1576787</td>
<td>dbar * 1000</td>
</tr>
<tr>
<td>Current speed</td>
<td>022</td>
<td>34</td>
<td>cm s(^{-1}) * 10</td>
</tr>
<tr>
<td>Current direction</td>
<td>500</td>
<td>1280</td>
<td>degrees * 10</td>
</tr>
<tr>
<td>Pressure</td>
<td>180F42</td>
<td>1576770</td>
<td>dbar * 1000</td>
</tr>
<tr>
<td>Current speed</td>
<td>028</td>
<td>40</td>
<td>cm s(^{-1}) * 10</td>
</tr>
<tr>
<td>Current direction</td>
<td>47A</td>
<td>1146</td>
<td>degrees * 10</td>
</tr>
<tr>
<td>Checksum</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For our Iridium Service Provider, to send a Mobile Terminated (MT) message to an IMEI requires sending an email message to our provider’s SBD gateway “(i.e. data@sbd.iridium.com)” with only the IMEI number of the modem you want to send the MT message to in the “Subject” line. The MT message itself must be contained in a separate file you make an attachment to the email message, the attached file requires the “.sbd” extension. The attachment is then queued by the service provider for retrieval by the IMEI. Our service provider will retain the queued MT message for 72 hours, if the MT message has not been retrieved by the modem within that time period the MT message will be removed from the MT message queue. It is the responsibility of the end-user to be aware of this constraint, and to take the steps necessary to recognize if your MT messages have been retrieved and implemented by the PDS.

Table 8: PDS Commands available as SBD Mobile Terminated Messages

<table>
<thead>
<tr>
<th>PDS Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOP</td>
<td>Stop transmission of the POPMODEM.DAT file.</td>
</tr>
<tr>
<td>SEND</td>
<td>Send the POPMODEM.DAT file.</td>
</tr>
<tr>
<td>GPSM:x</td>
<td>Send GPS/Engineering record every “x” minutes, modulo from the top-of-the-hour. Valid values are 0,10,15,20,30 minutes; will remain in effect until a new value is received. “0” value instructs PDS to stop sending GPS/Engineering records, default setting.</td>
</tr>
<tr>
<td>GPSH:x</td>
<td>Send GPS/Engineering record at the top of every “x” hours. Valid values are 0,1,2,...,336 hours; will remain in effect until new value is received. “0” value instructs PDS to stop sending GPS/Engineering records, default setting.</td>
</tr>
</tbody>
</table>

4.2.3 Matlab Program

A Matlab program (sbd2popDat.m) has been developed to concatenate SBD message attachments from a PDS, convert them to data units and parse the decoded messages to a data file (IMEI.dat), an engineering file (IMEI_eng.dat), a diagnostic file (IMEI_diag.dat), and an undecoded raw data file (IMEI_raw.dat). sbd2popDat.m will first look for filenames with extension ‘.sbd’ (MetOcean naming convention). If none are found, it will then search for filenames with extension ‘.bin’ (RockBLOCK naming convention). Note, sbd2popDat.m flips the order in which messages are processed since the most recently acquired PDS data is transmitted first.

Usage:
sbd2popDat(IMEI,projDir)

Inputs:
IMEI: IMEI file prefix either as a string or double
projDir: Subdirectory of the current working directory that the sbd files are located in, if left empty sbd2popDat will look in the current working directory
usage example 1:
the sbd files are located in a subdirectory to sbd2popDat
sbd2popDat(300234065035670,'PDS031')

usage example 2:
The sbd files are located in the same directory as sbd2popDat
sbd2popDat(300234065035670)

4.3 RECORD TYPES and FORMATS

Table 9 lists the fields, including the maximum value, that are written to the IMEI.dat file output by `sbd2popDat.m` and Table 10 lists the format of the IMEI.dat file. For PDS format ‘02’, the CPIES sampling schedule determines what is written to the output file. For one sample per hour, P1 is repeated for P2. For two samples per hour, P1 corresponds to time 0 and P2 corresponds to 30 minutes after the hour. Three samples per hour is not a valid sampling schedule for PDS-enabled PIES. For six samples per hour, the measurements at 0 and 30 are written for P1 and P2. The measurements at 10, 20, 40, and 50 minutes are ignored but will be saved in the IES’s PXXX_.#.DAT file.

The Iridium diagnostic values following the “$” delimiter in the SBD message attachment (see Section 4.2.1) are written to IMEI_diag.dat

Table 9: PDS Fields Output by sbd2popDat

<table>
<thead>
<tr>
<th>Data type</th>
<th>fixed field</th>
<th>max value</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOMSN</td>
<td>hhhhh</td>
<td>10485876</td>
<td>hours</td>
</tr>
<tr>
<td>iesHRS</td>
<td>hhhhh</td>
<td>1048576</td>
<td>s * 10000</td>
</tr>
<tr>
<td>TAU</td>
<td>hhhhh</td>
<td>16777216</td>
<td>dbar * 1000</td>
</tr>
<tr>
<td>P1,P2</td>
<td>hhh</td>
<td>4096</td>
<td>cm s⁻¹</td>
</tr>
<tr>
<td>S1,S2</td>
<td>hhh</td>
<td>4096</td>
<td>degrees</td>
</tr>
<tr>
<td>H1,H2</td>
<td>hhh</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>sosP1,sosP2</td>
<td>hhh</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>sosT1,sosT2</td>
<td>hhh</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>sosR1,sosR2</td>
<td>hhh</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>hhh</td>
<td>4096</td>
<td></td>
</tr>
</tbody>
</table>
### 4.3 RECORD TYPES and FORMATS

Table 10: PDS Output Data File Formats

<table>
<thead>
<tr>
<th>PDS Fmt.</th>
<th>Output File Format</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>MOMSN iesHRS TAU P1 P2</td>
<td>CS</td>
</tr>
<tr>
<td>02</td>
<td>MOMSN iesHRS TAU P1 S1 H1 P2 S2 H2</td>
<td>CS</td>
</tr>
<tr>
<td>03</td>
<td>MOMSN iesHRS TAU P1 T1 sosP1 sosT1 sosR1 S1 H1 P2 T2 sosP2 sosT2 sosR2 S2 H2</td>
<td>CS</td>
</tr>
</tbody>
</table>
5 PDS Assembly Instructions

5.1 ATTACH THE PDS TO THE ANCHOR STAND

Modifications to the PIES anchor stand and a PDS adapter are required to use PDS with PIES/CPIES.

5.1.1 PIES Anchor Stand Modifications

The standard URI/GSO PIES anchor stand has the following modifications for use with Popeyes Data Shuttles (PDS):

- 4 chain links (outer dimensions: 3/8 inch thick, 1 1/2 inch wide, 2 3/8 inch high) have been welded to the bottom ring of the PIES anchor stand (Figure 29a).

- 4 PDS adapter ring stops (1 inch diameter hot rolled steel 1 inch long pieces, Figure 29b) have been welded to the PIES anchor stand, one stop on each leg, 10.625 inches from the top of the anchor stand to the middle of the ring stop, along the anchor stand leg (labeled on the drawing in Figure 30).
5.1 ATTACH THE PDS TO THE ANCHOR STAND

(a) Chain link welded to bottom ring of PIES anchor stand

(b) Adapter ring stops along anchor stand legs, to support adapter ring

Figure 29: PIES anchor stand modifications
5.1 ATTACH THE PDS TO THE ANCHOR STAND

Figure 30: PIES Mooring Stand with PDS Adapter Ring Stops
5.1 ATTACH THE PDS TO THE ANCHOR STAND

5.1.2 PDS Adapter Ring

- The 30 inch PDS adapter ring can have from 1 to 4 baskets. Figure 31a shows the specifications for the 1-basket version.

- The PDS adapter ring is located at the same level as the PDS transmit and receive antennas. After each basket is welded to the PDS adapter ring, to increase signal strength, cut a 2 inch section out of the ring (Figure 31b) centered on the center line of the basket.
5.1 ATTACH THE PDS TO THE ANCHOR STAND

Shown:
Single Basket at 0 deg.

Not Shown:
Two Baskets - 0 deg & 180 deg.
Three Baskets - 0 deg, 90 deg, 180 deg.
Four Baskets - 0 deg, 90 deg, 180 deg, 270 deg.

15.25

2.00

18.18

Note 1: After welding basket, cut a two-inch section out of the inner ring centered on the center line of the basket.

(a) Drawing

(b) Cuts are centered on inner ring for each basket

Figure 31: PDS Adapter Ring
5.1 ATTACH THE PDS TO THE ANCHOR STAND

5.1.3 Rigging

- Anchor stand should be rigged with DCS/cable leading aft, on the fantail side of the ship.
- Raise the anchor stand approximately 1.5 inches off the deck by putting wood or other material under the bottom ring. This leaves open space under the bottom ring below each welded chain link.
- Put the PIES in the anchor stand and rig the 50 lb anchor weights in the standard configuration using the line stops at the bottom of the anchor stand (Figure 32).
- Place the 10 lb weights over the welded chain links. Feed U-bolts up from the bottom ring through holes in the 10 lb weights (Figure 33). The size of U-bolts changes if you use an anchor stand with a single- or double- bottom ring, as follows:
  - for the standard one bottom ring anchor stand: 2 U-bolts (McMaster P/N 2936T73 1/4"-20, 1 3/4" ID)
  - or for the double bottom ring anchor stand: 2 large U-bolts (McMaster P/N 2936T91 3/8"-16, 3 1/2" ID).
- Secure the clasp on each side of the U-bolt with 2 nuts (McMaster P/N 90371A031). Apply liquid threadlocker (‘Loctite’) to the nuts.
- Place the PDS adapter ring on the PIES anchor stand. Center the PDS baskets over the chain links located on the bottom ring of the PIES anchor stand (Figure 34).
- Secure the PDS adapter ring to the PIES anchor stand with U-bolts (McMaster P/N 2936T74 1/4"-20, 2" ID), threaded ends inward, at the 4 adapter ring stops (Figure 35). Secure the clasp on each side of bolt with 2 nuts (McMaster P/N 90371A029). Apply liquid threadlocker (‘Loctite’) to the nuts.
- Place the PDSs in the baskets oriented as shown in Figure 36. The green arrow side of the PDS (containing the antenna) should be closest to the PIES.
- Attach the fluorocarbon fishing line (400 lb breaking strength) from the PDS release to the chain link below it on the anchor stand using a heavy duty cable-tie (McMaster-Carr P/N 80005K54). Pull cable-tie tight and pinch its loop together, to restrict vertical movement, and secure the end of cable tie with electrical tape (Figure 37).
- Attach the CPIES lifting loop (= lifting line) if it had not been attached previously (Figure 38). If there is only one PDS basket, attach the lifting loop on the PDS basket side.

The fully rigged anchor stand with PDS Adapter is shown in Figure 39.
5.1 ATTACH THE PDS TO THE ANCHOR STAND

Figure 32: Standard anchor weight rigging

Figure 33: 10 lb weight secured to anchor stand with U-bolts
5.1 ATTACH THE PDS TO THE ANCHOR STAND

Figure 34: PDS adapter ring placement. Center the PDS baskets over the chain links on the bottom ring. Note the 2” opens sections (see Figure 31b) will be cut prior to deployment.
5.1 ATTACH THE PDS TO THE ANCHOR STAND

Figure 35: U-bolt placement to secure PDS adapter to PIES anchor stand.

Figure 36: Green arrow side should be closest to PIES.
Figure 37: Line from PDS release to PIES anchor stand.

Figure 38: Lifting line placement on anchor stand.
5.1 ATTACH THE PDS TO THE ANCHOR STAND

Figure 39: Fully rigged PIES with 4 PDSs.
A Appendix A: Checkout Testing & Mission Setup Sheet
PDS Paired with IES SN______.

Power Up and Bluetooth Pairing:
Place a magnet near the Bluetooth board to power up the Bluetooth module. The red LED on the module should now be blinking. Pair the Bluetooth module with a computer, if not already. Connect to the PDS using TeraTerm (9600,8,N,1). The green LED should now be illuminated. Hold the space bar until the PDS wakes. Press the space bar again to enter the main menu.

Log the TeraTerm session and save file as ____________________.log (ex. PDS010_1.log)
Record the Iridium Modem IMEI: _______________________________________.

Hardware Testing:
1. From the Testing Toolbox select ‘L’
   1.1. VbattHI ________Vdc  ~ 12Vdc
   1.2. VbattLO________Vdc  ~ 6Vdc
2. Release Relay Test
   2.1. From the Testing Toolbox select ‘G’
   2.2. Release Voltage ________Vdc  ~ 12Vdc
   2.3. Release Relay Set/Reset okay? …
   2.4. Confirm 0V at release after the release relay is reset…

GPS and Iridium Testing:
   Note: The following tests must be performed with an unobstructed view of the sky.
3. From the Testing Toolbox select ‘C’ and create a popmodem.dat file with ____ records…
   4.1. Iridium SBD transmission okay? …
   4.2. Verify that the SBD session was successfully completed by checking iridium email account…
5. From the Testing Toolbox select ‘O’. Wait about 45-60 seconds for a fix. GPS Fix Okay? …

Perform the following steps no more than 3 hours before pairing the PDS with an IES.

Mission Setup (Select ‘M’ from the Main Menu):
6. Select ‘A’ and set the PDS clock to UTC. Confirm that it is keeping time…
7. Select ‘B’ and set the capsule release date / hour…
8. Select ‘E’ to Erase ALL DATA FILES…
9. Select ‘F’ to set the IES Host Type: PIES… CPIES…
10. Select ‘Q’ to return to the Mission Setup Menu.
11. Select ‘S’ to save the Mission Configuration…
12. Select ‘G’ to start the mission. Verify all configuration settings. Select ‘Y’ to confirm the start…
13. Log Mission Start Time _____________________________…
14. Cancel Tera Term Logging…

NOTES:
B Appendix B: IES Pre-Launch Prep Checklist

B Appendix B: IES Pre-Launch Prep Checklist
IES – Pre-Launch Prep Checklist

S/N_________  Date:_________________
Tester: _____  Revised February 24, 2020

1. Motocross, capture text, start filename: SN___________.txt, attach RS232 cable

2. Altimeter Reading: ________________  Ambient Temperature:______________

3. Grease Red & Yellow plugs…☐  Red plug ON, ping…☐

4. Red plug OFF/ON…☐ <spacebar> within 10 sec, banner on screen has SN_______ and firmware version:
   For:  IES…☐  PIES…☐  C-PIES…☐  Rapid-PIES…☐

5. <A>to SelfTest, Echobox @_________sec, <B> 12.0kHz TT test, reports TT=___________sec
   (if IES model 6.2 or later):  <F> 12.5kHz TT test, reports TT=___________sec

6. PIES orientation: X-ducer UP…☐  X-ducer down…☐
   From Self-Test Menu, <D> P/T test
   Internal temp = ____________˚C.
   Paros Temp = ____________˚C
   Paros Pressure = ____________ psia

7. <G> Output Power Test, For level 197dB, output power = ____________ Watts

8. <S> System Refresh & Test: PASS…☐
   Charge Time: _________secs (~2.5secs)

9. If C-PIES: connect DCS head SN _________________
   From the Self-Test Menu select <E> to initiate a DCS measurement and verify communications. …☐

   Attach Aanderaa calibration test head on horizontal plane and align the notch with 45 degree heading.
   From Self Test Menu <E> initiate a DCS measurement and verify nominal values; [speed = 2.83 m/s]
   Ns: Speed: ____________
   Es: Direction: ____________
   Temperature: ____________
   Sig strength: ____________
   Compass dir: ____________
   North tilt: ____________
   East tilt: ____________
   ping count: ____________

10. ACS tests:
    CLEAR _____ 2 pings…☐ ACS replies @_________ kHz
    XPND _____ 2 pings…☐ 12.5int / 12.0 reply…☐ & after CLR, no reply…☐
    RELEASE _____ 6 pings…☐ Vrel =____, polarity ok…☐, button ➔ 4sec pings…☐
    RELOC…INVERT PIES… Radio on…☐  Flasher on…☐

11. Navigate to Mission Setup Menu and select <R> Reset Release Relay…☐
    a. Confirm by measuring the Release Block Voltage (~0V) …☐
12. <Q> back to Main Menu, <B> to Memory Card, <E> Erase all memory files…<Y>… □

13. <Q> back to Main Menu, <C> to Mission Setup,

☐ <A> set GMT time ________________________ <A> verify time set… □

14. <B> Set Up Tau Sampling Rate

☐ __________ pings per __________ minutes

15. <D> set depth for site name __________

☐ Depth: __________ m
☐ Lock Out: __________ secs
☐ Output Level: __________ dB

16. <E> Set timed release TR= __________________________

17. <F> Enable the Telemetry File … □

18. <H> Enter a mission statement __________________________

19. <J> Pressure Sensor Set Up Menu

☐ <A> P & T Measurement every __________ minutes
☐ <C> Enable the Raw Data File

If C-PIES…

20. <K> Current Sensor Set Up Menu

☐ <A> DCS Measurement every __________ minutes
☐ Configured for DCS Model & Firmware Version (choose one):
  ☐ DCS 3820R
  ☐ ZPulse 4930R firmware ver. 11.0.15

21. <P> Enable/Disable Data Shuttle Reporting

Choose One of the following:
☐ <0> Disable Data Shuttle Reporting
☐ <1> Enable Data Shuttle Reporting

22. <S> SAVE, <G> go, review setup…(really review), if okay <Y>, note if SAVED?… □

a. Tzero = __________˚C  Pzero = ______________ psia

23. Log Mission Start Time ___________________________ GMT… □

24. Stop capture, disconnect RS232, file saved as ________________.

25. Confirm that 1st ping of burst is on schedule prior to launch… □

Notes:
Acronyms

CPIES  Current and Pressure recording Inverted Echo Sounder. 1
DCS  Doppler Current Sensor. 23
IES  Inverted Echo Sounder. 1
IMEI  International Mobile Equipment Identity. 29
LIFO  last-in-first-out. 2
MT  Mobile Terminated. 30
PDS  Popeye Data Shuttle. 1
PIES  Pressure recording Inverted Echo Sounder. 1
RTC  real time clock. 18
SBD  Short Burst Data. 2
PDS
User’s Manual

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