PopotoModem

# User’s Guide for PMM5544 M2000/M6000 DB100-55

delResearch LLC

**Document Versions**

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# 1 Getting Started

## 1.1 Introduction

This section provides an overview of the various ways your Popoto Modem can be delivered and how to start using it. Each delivery option is tailored to different usage scenarios, from development and testing environments to ready-to-deploy applications.

## 1.2 Delivery Options

### 1.2.1 OEM Boardset

The OEM Boardset is designed for developers and manufacturers who wish to integrate the Popoto Modem into their own products or solutions. This option offers the most flexibility for custom applications. For detailed cabling and setup instructions, please refer to Chapter 2.

### 1.2.2 Lab Evaluation Platform

This delivery option includes an OEM Boardset mounted on a Lab Evaluation Platform, complete with a battery, a transducer, and an interface board for connection to a personal computer. It's ideal for quick testing and development. For setup details, see Chapter 3.

### 1.2.3 Enclosed Modem

The Enclosed Modem is housed in a depth-tolerant, waterproof enclosure, making it suitable for direct deployment in marine environments. Connectivity is provided through a wet-mate subsea connector. Cabling and operation information can be found in Chapter 5.

### 1.2.4 Deckbox

A complete modem solution housed in a Pelican case, the Deckbox option includes an external dunking transducer for immediate deployment. This option is designed for ease of use and durability. For more information on connecting and using the Deckbox, refer to Chapter 4.

## 1.3 Required equipment

Along with the hardware and software that comprise Popoto, it is necessary have the following equipment to facilitate the "Getting Started" procedure of this chapter.

- 12-18 Volt 5 Amp DC Power Source
- Ethernet Cable
- PC Running Ubuntu with ethernet capability
- RS-422 to USB Cable
- Configuration Jumpers

Other helpful PC software to have at the ready includes

- MATLAB
- Audacity Audio Software
- Python 3.10 or greater
- Serial Port Terminal software

## 1.4 Bench Testing

Along with the hardware and software that comprise Popoto, it is necessary have the following equipment to facilitate the "Getting Started" procedure of this chapter.

### 1.4.1 What is an Air Test

Although the Popoto modem is designed to operate acoustically in an ocean environment, it can communicate (although somewhat less reliably) in air. The acoustic energy transmitted from Modem 1 can indeed be propagated through the air for short distances and received by Modem 2. Assuming the multipath energy from sound reflection of the walls is not too damaging, this signal can be detected and demodulated. If the multipath of the room prevents detection, some careful placement of sound absorbing materials such as foam or cloth, and repositioning either the transmitter or receiver transducer until reliable communication is usually possible.

Running an air test is a good way to validate operation prior to water operation. Once reliable communication is achieved, various commands such as ranging can be exercised effectively. It should be noted that the range command will not yield accurate range estimates in air because the speed of sound in air is more than 5 times slower than the speed of sound in water. However, ranging in air is still useful for basic system checkout prior to fielding the modem in the water.

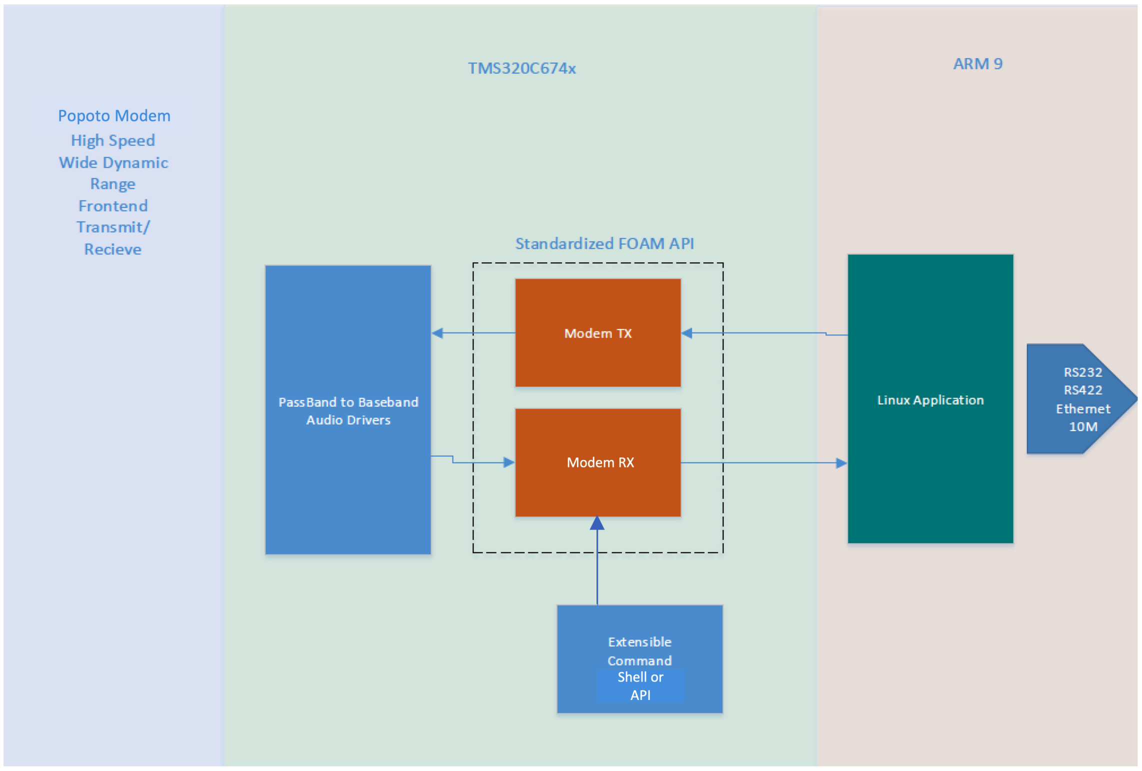

TMS320C674x
ARM 9
Popoto Modem High Speed Wide Dynamic Range Frontend Transmit/ Recieve
Standardized FOAM API
PassBand to Baseband Audio Drivers
Modem TX
Modem RX
Linux Application
RS232 RS422 Ethernet 10M
Extensible Command Shell or API

Figure 1.1: High Level Popoto Block Diagram

### 1.4.2 RS-422 UART connection

For the purpose of “Getting Started”, it is recommended that the RS-422 connection be used. This port can be accessed using the first serial port that enumerates when connected to the Popoto Interface Board’s USB port.

If the Popoto is delivered in a deckbox, this connection will be a standard USB communication port connection.

When the UART USB cable is inserted the OS will discover the new communication device. At that time open any standard serial terminal program configured for communication at 115200 bps, with no parity, 8 data bits, and 1 stop bit. About 20 seconds after power on, the user will be presented with a pshell command prompt.

### 1.4.3 Running the application

For this section it is assumed that we will be running air tests under a serial connected pshell.

Once the modem has been completed the boot process it is possible to connect to the Popoto by way of pshell.

### 1.4.4 Checking the version number

From the pshell type

```
version
```

This is the version command. Popoto will respond with current software version number and serial number of the hardware.

### 1.4.5 Displaying Help

To list the commands supported by the pshell, simply type

```
help
```

Popoto will respond with a list of supported pshell commands. Note that tab completion for these commands is supported.

### 1.4.6 Sending a Test Message

When both modems are online and connected to their pshells, it is possible to send an acoustic ping from one modem to be received by the other.

At the pshell type

```
ping 4
```

This command initiates the transmission of a test packet at about 4 watts of acoustic power. This level of power is appropriate for an air test where the transducers of units are spaced 1-2 meters apart.

While the transmission is executing you will notice a red "transmitting" led illuminate on the transmitters analog board. Once the transmission completes (3-4 seconds) the led will turn off. On the receiver pshell, there should be indication of a packet received and the both the packet and the header data should be displayed.

A message indicating 'CRC error' may occurs at the time of transmission on the receiving Popoto instead of a 'CRC check' message. This occurs if the multipath of the room is adding so much interference that the demodulator cannot successfully demodulate the test packet. In such a case, reposition the transducers or pad any reflective surfaces to minimize acoustic reflection.

### 1.4.7 Sending an Arbitrary Message

To transmit an arbitrary message from the pshell, the transmitJSON API provides the most flexible interface. A JSON message formatted as below is passed as an argument to the transmitJSON command.

```
transmitJSON  { "Payload": {"Data": [ 49,50,51,52,53,54,55,56,57,48,49,50,51,52,53,54]}}
```

sends the bytestream 49,50,51,52,53,54,55,56,57,48,49,50,51,52,53,54. to the remote modem.

### 1.4.8 Addressing a particular modem

Each modem has a LocalID, which is an address between 0 and 254. To address a message to a particular modem, it is necessary to know the remote modem's ID. Then, by setting the variable RemoteID, to the value of the target modem's LocalID, it is possible to address subsequent messages to the desired modem.

### 1.4.9 Setting the data Rate of the Payload

All packets comprised of three parts the acquisition, the header, and an optional payload. The acquisition sequence does not change for different data rates. The header is always sent at 80bps frequency hopping mode. The header contains information such as the transmit ID, intended receiver ID (broadcast ID is 255), transmit power, if there is a payload of information following, what the payload length is, and what the modulation scheme for sending the payload is.

An example of a PSK payload packet is shown.

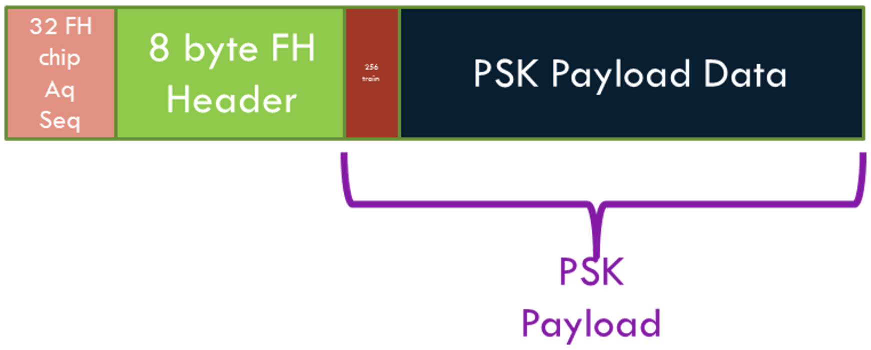


Figure 1.2: PSK Payload Message Structure

The modulation rate of the payload portion of the waveform is configured using the PayloadMode variable. The various modulation schemes are:

- 0 80bps Frequency Hop mode
- 1 5120 bps PSK
- 2 2560 bps PSK
- 3 1280 bps PSK
- 4 640 bps PSK
- 5 10240 bps PSK

The PSK receiver includes user configurable parameters that can be adjusted for optimal reception as a function of the channel. These include the number of taps for the equalizer and the location of the first tap. Under normal operation these parameters are set for typical operation with the number of forward taps (FIR) = 44, the number of backward (IIR) taps=6, and the location of the first tap=16. Note the computational load of the receiver increases with the square of the number of taps and the maximum number of taps (Forward + Backward) should not exceed 70. Also note that additional taps often increase noise and as such more taps does not always mean better performance.

Table 1.1: PSK Parameters

| Parameter | Type | Description |
|---|---|---|
| PayloadMode | int | Sets the modulation scheme of the transmitter payload<br>0. Freqeuncy Hop FSK 80 Bits/sec<br>1. PSK 5120 BPS<br>2. PSK 2560 BPS<br>3. PSK 1280 BPS<br>4. PSK 640 BPS<br>5. PSK 10240 BPS (uncoded) |
| PSK_FnTaps | int | Sets the number of taps for the FIR portion of the filter (default 44) |
| PSK_BnTaps | int | Sets the number of taps for the IIR portion of the filter (default 6) *Note: PSK_FnTaps+PSK_BnTaps must be less than 70* |
| PSK_StartOffset | int | Sets the location of the first tap in the FIR delay line (default 0) ** |

### 1.4.10 Telnet Chat Operation

Lastly, it is possible to open up a chat window between both modems. From a linux prompt on the terminal, type

```
telnet 10.0.0.232 17001
```

this will open a telnet window connected to Modem A (at the 10.0.0.232 address).

Assuming Modem B has been setup with and IP address of 10.0.0.223. Next open another linux prompt on the terminal and type

```
telnet 10.0.0.223 17001
```

This will start another telnet session connected to Modem B (at the 10.0.0.223 address)

Chat operation is a mode of the modem where two modems can communicate keyboard to keyboard in a normal text configuration in a half duplex mode. To enter chat mode the

```
chat
```

command is entered at the pshell prompt. It is necessary to enter chat mode at both the receiver and transmitter for chat mode to work.

While in chat mode characters that are entered in the keyboard are grouped into packets and transmitted through the water, received by the receiver and presented to the user.

The start and stop of a packet is determined by 3 factors. The first method is to enter a carriage return after a string of characters. This return signals the end of a string of characters to be sent out of the modem. The second method to signal the end of a string is to timeout. After period of no typing that exceeds the user configurable timeout parameter, the transmitter console will take the user input gathered up until the timeout interval, group them into a packet and send them. The last way to terminate a sequence of characters for transmission is to exceed the user configured number of bytes per packet. For example if the parameter ConsolePacketBytes is set to 32, then input characters are bundled into groups of 32 and sent out automatically.

Table 1.2: Chat Mode Parameters

| Parameter | Type | Description |
|---|---|---|
| ConsolePacketBytes | int | Sets the number of Sets the number of bytes in the data console after which the console bytes are automatically transmitted |
| ConsoleTimeoutSec | int | Sets the timeout in milliseconds for the data console, afterwhich any typed bytes are transmitted |

To exit chat mode type ctrl-], followed by e for exit. Exit from both the transmitter and receiver to resume normal operation.

### 1.4.11 Sending a Range Command

Once a successful ping has been achieved, it is instructive to try a range command. The syntax of the range command is as follows:

```
range 4
```

This command instructs the initiating modem (Modem A) to send a range request at the power associated with about 4 watts. You will immediately see the transmitter red LED of Modem A illuminate for about a second. This request should be received by the receiving modem Modem B. Upon successful demodulation of the range request by Modem B, it schedules a transmission back to the receiver of Modem A. This new transmission will illuminate the red LED of Modem B. When that transmission is complete, Modem A will measure the time required to receive the response to its request, account for turnaround time, and calculate the round trip time. This is mapped to a distance using the speed of sound in water and range is calculated.

Upon successful completion of the whole ranging cycle, a range report will be displayed on the Modem A pshell.

# 2 OEM Modems

## 2.1 OEM Modem System

A complete Popoto system consists of the following hardware components:

1. Transducer
2. Analog board
3. Digital board
4. SD card

### 2.1.1 Analog Board

The Popoto analog board provides signal conditioning to and from the transducer and provides conversion of the analog signals to the digital domain. The signal conditioning of the receiver includes amplification, high pass filtering of the data, and analog to digital conversion. The signal conditioning for transmitter includes digital to analog conversion, and high power transmit amplification.
The analog board also includes a line level analog path to and from SMA connectors for debug purposes. The analog board directly connects to the digital board by way of a 30 position connector at the bottom of the board. A picture of the analog board is shown in Figure **??**:

### 2.1.2 Digital Board

The Popoto digital board provides for all signal processing, interface to analog board, interface digital communication interfaces including:

- RS-232
- RS-422
- Ethernet
- GPIO

- SPI
- I2C

It also hosts all non-volatile and volatile memory, performs power conditioning, and real-time clock functionality. The heart of this board is and OMAP L138 device made by Texas Instruments. This device includes an ARM 9 host processor which runs Arago Linux, and a TMS320C647x DSP floating point DSP device which performs the computationally intensive signal processing tasks.

### 2.1.3 micro SD Card

The enclosed Popoto micro SD card has been formatted using Ext4 and includes all of the operating system files, the Popoto application, the DSP application. The SD card includes a directory `/captures` and provides room for several GB of diagnostic storage if desired.

### 2.1.4 Heat Sink/Mounting Tray

The Popoto heat sink /mounting tray is used to act as a heat sink for the power amplifier on the underside of the analog board. This heat conductive interface is critical to achieving the full transmit capability of Popoto. The thermal junction between the mounting tray and power amplifier on the analog board requires conductive thermal compound at this interface.

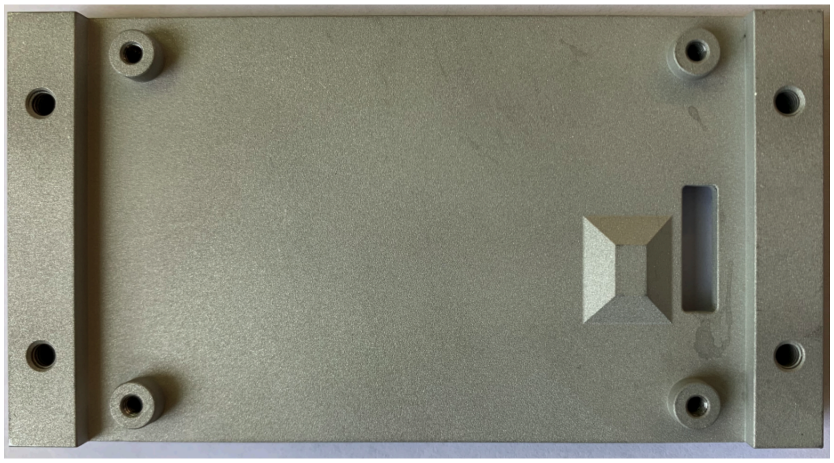


Figure 2.1: The PMM5021 Mounting Tray with M4 mounting screws

# 3 Lab Evaluation Platform

## 3.1 Introduction

The Lab Evaluation Setup for the Popoto Modem offers a comprehensive package for developers and researchers to quickly begin working with the Popoto Modem system. This setup is designed to facilitate easy and efficient evaluation of the modem's capabilities in a laboratory environment or for field tests such as pier-side or pool tests.

## 3.2 What's in the Box

The Lab Evaluation Setup includes the following components:

- An OEM Boardset for the core modem functionality.
- A Modem Interface Board for connections to external devices.
- A Lithium Ion battery to power the setup independently.
- A 3D printed lab evaluation platform that securely holds all components.
- A PMT28 transducer equipped with a cable of sufficient length for versatile testing environments.
- A battery charger for maintaining power supply.
- A USB Cable for connecting the Modem Interface Board to a computer.

## 3.3 Setup Overview

The Lab Evaluation Setup is designed to provide a rapid, yet inexpensive entry point into the world of underwater communication systems. By combining an OEM Boardset, Modem Interface Board, and PMT28 transducer, users can begin testing and development without the need for extensive setup or additional hardware.

This plug-and-play configuration not only reduces initial costs but also accelerates the process from unboxing to operational testing. The included 3D printed mount fixtures all components securely facilitating tests in a lab environment.

# 4 DB100 Deckbox

## 4.1 Description

The DB100 is comprised of a Popoto Modem electronics board set, a Popoto Interface board, and Lithium Ion battery all enclosed in a rugged Pelican 1300 case. All connectors are IP67 splash proof, making for a portable easy to use acoustic communications device. DB100 is designed to be used with an external computation platform such as a laptop or SBC, and can interface to those devices via USB, or via ethernet.

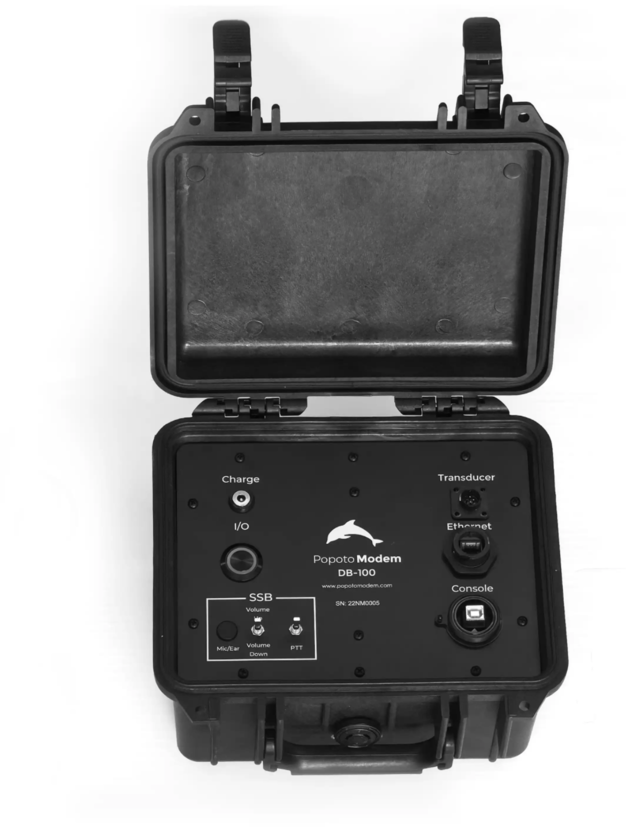


Figure 4.1: The Popoto DB100 Deckbox

## 4.2 Deckbox Models

The DB100 platform supports all Popoto Modem general-purpose modem boardsets. A low cost PMM3511 based DB100-3 is the entry point to the Popoto Deckbox line, and this line is enhanced by the PMM5021 Based DB100-5. This DB100-5 has 2 further variants beyond the base model, DB100-5-2 Provides an extra hydrophone channel for input, and the DB100-5-SSB incorporates Single sideband voice, with connectioins for headphones and microphone, as well as a push to talk switch and volume controls. DB100-6 is built around our multichannel PMM6081 and afford additional processing capability for user scripts and signal processing.

## 4.3 Dunking Transducer

The PMT28-10-DT dunking transducer shipped with the Popoto Modem is cabled with a 10 meter long Polyurethane cable, connected to a 4 Pin JAE connector.

## 4.4 Front Panel connections

### 4.4.1 Transducer

To present the information using tables in the 'longtable' format, you will need to first ensure that the 'longtable' package is included in your document preamble. Then, you can replace the 'itemize' sections with 'longtable' environments for each set of pin assignments. This approach is useful for documents that require detailed tables that may span multiple pages. Here's how you can adjust the LaTeX snippet to include these details in tables:

### 4.4.2 Transducer Connector Specifications on the DB100 Deckbox

The DB100 Deckbox series includes several models, each utilizing different transducer connectors. These connectors are critical for ensuring the correct functionality and compatibility with various transducer and hydrophone systems.

### 4.4.3 Models DB100-3, DB100-5, and DB100-5-2

For the DB100-3, DB100-5, and DB100-5-2 models, the connector type is a 4-pin JAE: JN1AS04MK1. The pin assignments are detailed in the following table:

Table 4.1: Pin Assignments for DB100-3, DB100-5, and DB100-5-2

| Pin Number | Assignment | Notes |
|---|---|---|
| 1 | Transducer Positive | |
| 2 | Alternate Channel | Applicable only for DB100-5-2 |
| 3 | Alternate Channel | Applicable only for DB100-5-2 |
| 4 | Ground | |

### 4.4.4 Model DB100-6

The DB100-6 model utilizes a 10-pin JN1AS10ML1 connector to accommodate additional hydrophones. The pin assignments for this connector are:

Table 4.2: Pin Assignments for DB100-6

| Pin Number | Assignment | Notes |
|---|---|---|
| 1 | Transducer Positive | |
| 2 | Hydrophone 1 Positive | |
| 3 | Hydrophone 2 Positive | |
| 4 | Hydrophone 3 Positive | |
| 5 | Hydrophone 4 Positive | |
| 6 | Hydrophone 5 Positive | |
| 7 | Hydrophone 6 Positive | |
| 8 | Hydrophone 7 Positive | |
| 9 | Hydrophone 8 Positive | |
| 10 | Ground | |

### 4.4.5 USB

The USB port on the front panel of the modem connects to a computer's USB Host port. This connection provides 2 channels of USB-Serial connection. From the factory the first channel is connected to the Pshell, and the second channel is connected to the Popoto Modem's Linux Console. This is generally the fastest way to get started with the Popoto Deckbox.

### 4.4.6 Ethernet

The eThernet port on the front panel is designed to operate with the Stewart XXXXX Ethernet cable. This cable has a locking connector that keeps the connections to the ethernet water tight. Although it is possible to use a standard ethernet cable, it is not recommended, as the IP-rated ethernet connector does not include a provision to latch the ethernet cable in place. Failure to use the proper locking cable will result in unreliable ethernet connetions.

### 4.4.7 Charging

The front panel of the modem features a charging port that utilizes a SwitchCraft 721FMS connector. This connector is designed with a tip-positive pin configuration, ensuring compatibility with specific charging requirements. The Popoto Constant Current Constant Voltage (CCCV) battery charger is designed to connect directly to this port, facilitating efficient charging of the Deckbox battery. This direct connection streamlines the charging process, ensuring that the device is adequately powered for operation.

#### 4.4.8 Headphone and Microphone Jack

For the headphone and microphone interface, the DB100-5-SSB model is equipped with a 3.5mm jack, utilizing a Tensility Intl.: 10-02845 connector. The pinout configuration for this connector is as follows:

Table 4.3: Pinout for Tensility Intl.: 10-02845 Connector

| Pin Number | Function |
|---|---|
| 1 | Left Headphone |
| 1 | Right Headphone |
| 1 | Microphone |
| 4 | Ground |

This connector supports a standard 3.5mm headphone and microphone setup, providing the users with a straightforward means to communicate through the device. The pinout ensures that users can leverage standard audio equipment to interact with the system, enhancing the usability and versatility of the DB100-5-SSB model.

## 4.5 Single Sideband Voice Feature of the DB100-5-SSB

Please refer to 10 for detailed information about the SSB feature of the DB100-5 SSB.

## 4.6 Getting Started with the DB100

The DB-100 Deckbox offers a seamless way to begin working with the Popoto Modem. It is a self-contained unit that integrates a power source (battery) and all necessary interfaces for connecting to a laptop via USB or Ethernet. For newcomers, the most straightforward method to initiate communication with the deckbox is through a USB connection. This connection enumerates as two serial ports on the laptop, providing access to various functionalities of the Popoto Modem.

## 4.7 USB Connection

Upon connecting the DB-100 Deckbox to your laptop via USB, it will enumerate as two serial ports. The appearance of these ports varies depending on the operating system:

- **Windows:** The ports are listed as COM ports in the Device Manager.
- **macOS:** Look for devices named '/dev/tty.*identifier*' in the '/dev' directory.
- **Linux:** Devices appear as '/dev/ttyUSB*X*' in the '/dev' directory.

The first port provides direct access to the Popoto Pshell, a powerful interface for configuring and controlling the modem.

## 4.8 Initial Setup

### 4.8.1 Connecting the Transducer

Begin by connecting the transducer to the transducer connector located on the front panel of the DB-100 Deckbox. Align the arrow on the cable connector with the top mark on the deckbox connector. Gently seat the connector in position before pushing it in until a positive click indicates it is securely connected.

### 4.8.2 Powering On

Next, connect the USB cable from your PC to the Console port on the DB-100 Deckbox. Power on the unit by pressing the I/O button. Note that, depending on the model, it may take up to 3 seconds for the light around the button to illuminate. Once on, you will be greeted with a 'Popoto->' prompt on the first serial port.

### 4.8.3 Connecting to the Modem

To interact with the modem, use a serial utility such as PuTTY. This will allow you to communicate directly with the modem via the connected serial port.

## 4.9 Additional Setup for Multiple Units

If you possess two DB-100 Deckboxes, repeat the setup process for the second unit to enable communication between them. For those with a Deckbox and OEM bundle kit, refer to the "Getting Started" section for the initial setup of the additional unit.

If your setup includes a Deckbox and an enclosed unit, see section **??** for instructions on preparing the second unit. Following these steps will allow you to conduct an airtest as detailed in section 1.4.

## 4.10 Care

To ensure the longevity and optimal performance of the DB100, it is crucial to maintain the cleanliness of its Pelican Case. Given the sensitive electronics housed within, a meticulous approach to cleaning is recommended, focusing on methods that mitigate the risk of water damage. The following guidelines provide a comprehensive approach to safely cleaning the Pelican Case:

1. **Preparation:** Ensure the DB100 is switched off and disconnected from any external power sources.
2. **Dusting:** Utilize a soft, dry cloth or a brush with gentle bristles to dust off the surface of the case. This initial step helps in removing loose dust and debris, reducing the risk of scratches during cleaning.
3. **Spot Cleaning:** For targeted cleaning of spots with stubborn dirt, slightly dampen a soft cloth with water and a mild soap solution, if necessary. It is crucial to ensure the cloth is well-wrung to prevent excess moisture. Gently wipe the affected areas without saturating the case.
4. **Using Spray Cleaners:** If using spray-on cleaners, choose products designed for electronics or those that are mild and non-abrasive. Spray the cleaner onto the cloth rather than directly onto the case to control the amount of moisture applied.
5. **Drying:** After cleaning, thoroughly dry the case with a clean, soft cloth. Confirm the case is completely dry before reconnecting any power sources or using the DB100.
6. **Regular Checks:** Periodically inspect the case for any signs of wear or damage, especially around seals and fasteners. Maintaining the integrity of the case is vital for protecting the DB100 against environmental elements.

Adhering to these cleaning guidelines will help in preserving the condition of your DB100's Pelican Case, ensuring the device remains protected and functional. The emphasis on gentle and dry cleaning methods is paramount to safeguarding the sensitive electronics from moisture-related damages.

# 5 Enclosed Modems M2000/M6000/S1000

## 5.1 Enclosed Modems

### 5.1.1 Popoto M2000

The **Popoto M2000** modem is the flagship product, featuring a robust design with a machined aluminum housing capable of withstanding depths up to 2000 meters. It exemplifies the brand's commitment to durability and reliability in underwater communication.

### 5.1.2 Popoto S1000

The **Popoto S1000** emphasizes compactness and efficiency, housed in a machined aluminum casing that withstands up to 1000 meters. With a 20W transmitter, it serves a wide range of underwater communication needs with versatility.

### 5.1.3 Popoto M6000

Designed for extreme environments, the **Popoto M6000** with its machined titanium shell is capable of withstanding depths of up to 6000 meters. It is the most rugged modem in the lineup, ensuring reliable data transmission in the most challenging conditions.

## 5.2 Connectors

## 5.3 M2000/S1000 Connectors

The M2000 and S1000 series modems use SubConn microcircular connectors to provide an electrical interface between the inside of the bottle and the outside. These connectors are typically either MC8BHF for the S Series Modems or MC16BHF connectors. Legacy M2000 Units may be fitted with an MC10BHM 10 pin connector.

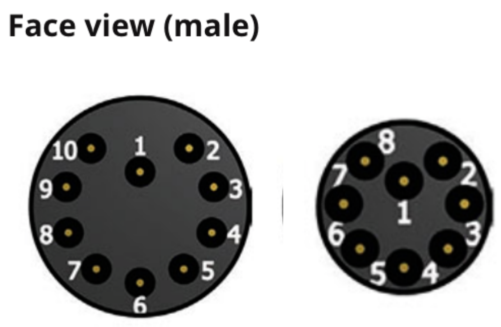


Figure 5.1: Pin Locations: 10 Pin and 8 Pin Connectors as viewed from the face of the male connector.

### 5.3.1 Connector Part Numbers

| Part Number | Description |
|---|---|
| MCBH16F | 16 Pin Bulkhead microcircular female connector |
| MCBH10M | 10 Pin Bulkhead microcircular male connector |
| MCBH8F | 8 Pin Bulkhead microcircular female connector |

### 5.3.2 10 Pin Ethernet Option

| Pin Number | Pin Function | Notes |
|---|---|---|
| 1 | Ethernet Tx+ | T568A Green White<br>T568B Orange White |
| 2 | Ethernet Tx- | T568A Green<br>T568B Orange |
| 3 | Ethernet Rx+ | T568A Orange & White<br>T568B Green & White |
| 4 | Ethernet Rx- | T568A Orange<br>T568B Green |
| 5 | RS232 Rx | |
| 6 | RS232 Tx | |
| 7 | Vin | (+12v to +20v) |
| 8 | LED Power | 5V out when unit is powered up |
| 9 | Gnd | |
| 10 | PowerSwitch | Short to ground to power down unit |

### 5.3.3 10 Pin RS-422 Option

| Pin Number | Pin Function | Notes |
|---|---|---|
| 1 | RS 422 Rx +(FTDI) | J8-1 RS 422 TX+ (Popoto)<br>Yellow |
| 2 | RS 422 Rx -(FTDI) | J8-2 RS433 TX- (Popoto)<br>White |
| 3 | RS 422 Tx+(FTDI) | J8-3 RS422 Rx+ (Popoto)<br>Orange |
| 4 | RS 422 Tx-(FTDI) | J8-4 RS 422 Rx- (Popoto)<br>Red |
| 5 | RS232 Rx | |
| 6 | RS232 Tx | |
| 7 | Vin | (+12v to +40v) |
| 8 | LED Power | 3.3V out when unit is powered up |
| 9 | Gnd | |
| 10 | PowerSwitch | Short to ground to power down unit |

### 5.3.4 16 Pin Universal Option

| Pin Number | Pin Function | Notes |
|---|---|---|
| 1 | LED Power | 3.3V out when unit is powered up |
| 2 | RS 422 Tx+(FTDI) | J8-3 RS422 Rx+ (Popoto) Orange |
| 3 | RS 422 Tx-(FTDI) | J8-4 RS 422 Rx- (Popoto) Red |
| 4 | RS 422 Rx +(FTDI) | J8-1 RS 422 TX+ (Popoto) Yellow |
| 5 | RS 422 Rx -(FTDI) | J8-2 RS433 TX- (Popoto) White |
| 6 | PowerSwitch | Short to ground to power down unit |
| 7 | Gnd | |
| 8 | Ethernet Tx+ | T568A Green White T568B Orange White |
| 9 | Ethernet Tx- | T568A Green T568B Orange |
| 10 | Ethernet Rx+ | T568A Orange & White T568B Green & White |
| 11 | Ethernet Rx- | T568A Orange T568B Green |
| 12 | RS232 Tx | |
| 13 | RS232 Rx | |
| 14 | PPS Interrupt | Used for PPS in or GPIO |
| 15 | Gnd | Ground |
| 16 | Vin | (+12v to +40v) |

### 5.3.5 8 Pin Ethernet Option

| Pin Number | Color | Pin Function | Notes |
|---|---|---|---|
| 1 | Red | Ethernet Tx+ | T568A Green White<br>T568B Orange White |
| 2 | Black | Ethernet Tx- | T568A Green<br>T568B Orange |
| 3 | Yellow | Ethernet Rx+ | T568A Orange & White<br>T568B Green & White |
| 4 | Blue | Ethernet Rx- | T568A Orange<br>T568B Green |
| 5 | Orange | Vin | (+12v to +40v) |
| 6 | Brown | LED Power | 3.3V out when unit is powered up |
| 7 | Purple | Gnd | |
| 8 | Green | PowerSwitch | Short to ground to power down unit |

### 5.3.6 8 Pin RS-422 Option

| Pin Number | Color | Pin Function | Notes |
|---|---|---|---|
| 1 | Red | RS 422 Rx +(Host) | J8-1 RS 422 TX+ (Popoto)<br>Yellow |
| 2 | Black | RS 422 Rx -(Host) | J8-2 RS433 TX- (Popoto)<br>White |
| 3 | Yellow | RS 422 Tx+(Host) | J8-3 RS422 Rx+ (Popoto)<br>Orange |
| 4 | Blue | RS 422 Tx-(Host) | J8-4 RS 422 Rx- (Popoto)<br>Red |
| 5 | Orange | Vin | (+12v to +40v) |
| 6 | Brown | LED Power | 5V out when unit is powered up |
| 7 | Purple | Gnd | |
| 8 | Green | PowerSwitch | Short to ground to power down unit |

### 5.3.7 8 Pin RS-232 Option

| Pin Number | Color | Pin Function | Notes |
|---|---|---|---|
| 1 | Red | RS-232 Rx (Host) | J8-12 RS-232 TX (Popoto) |
| 2 | Black | RS-232 Tx (Host) | J8-13 RS-232 RX (Popoto) |
| 3 | Yellow | GPIO/PPS | J8-14 PPS |
| 4 | Blue | No Connect | No Connect |
| 5 | Orange | Vin | (+12v to +40v) |
| 6 | Brown | LED Power | J8-1 3.3V out when unit is powered up |
| 7 | Purple | Gnd | |
| 8 | Green | PowerSwitch | J8-6 Short to ground to power down unit |

## 5.4 Lab Cable

Lab cables are a means of connecting Popoto modems to evaluation interfaces, facilitating a straightforward method for testing and exploring modem functionalities in lab settings. These cables are specifically designed to match the connectivity options of different modem models.

## 5.5 Types of Lab Cables

Depending on the Popoto modem model, there are various lab cables available, each designed to support the interface options of the specific modem.

### 5.5.1 16-Pin Lab Cable

The 16-pin lab cable is compatible with the **M2000** and **M6000** models, providing RS232, RS422, Ethernet, and control connections for these devices.

### 5.5.2 8-Pin Lab Cables for S1000

The **S1000** modem, given its compact design, uses a Subconn 8 pin connector. This connector offers tailored connectivity options requiring specific 8-pin lab cables. Users can choose from:

- 8-Pin Ethernet
- 8-Pin RS232
- 8-Pin RS422

It is important to note that the S1000's 8-pin connector does not support all interfaces simultaneously. Thus, the desired interface must be specified at the time of order, and it is important to match the selected configuration with the proper Lab cable.

### 5.5.3 Extension Cables

For broader deployment applications, the lab cable's reach can be significantly extended using a standard Subconn compatible Male to Female extension cable. This accessory is designed to facilitate flexible deployment configurations, accommodating varying depths and distances as required by the operational environment.

**5.5.3.0.1 Availability:** The compatible extension cable can be acquired directly from www.popotomodem.com, ensuring that you have access to products designed to work seamlessly with your Popoto modem, providing the following benefits.

- **Operational Flexibility:** By extending the lab cable, modems can be deployed in a wider variety of environments, ensuring optimal placement for data transmission and reception.
- **Customized Deployment:** The availability of extension cables allows for tailored setup configurations, meeting specific depth and distance requirements without compromising the integrity of the connection.
- **Seamless Integration:** Designed specifically for compatibility with Popoto modems, these extension cables provide a reliable and straightforward solution for enhancing your modem's deployment capabilities.

## 5.6 Power Down and Dummy Plugs

### 5.6.1 Understanding Power Down Plugs

For ensuring the safety and longevity of Popoto modems during storage or shipment, a special component called the ”Power Down Plug” is utilized. This section describes its functionality, usage, and precautions. For uncabled deployment, a dummy plug is included that provides for a water-tight termination of the electrical connections on the bottle.

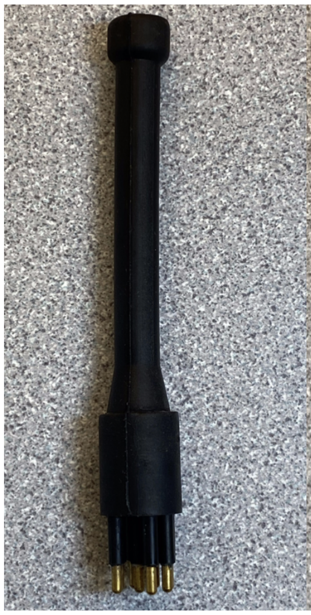
### 5.6.2 Design and Functionality

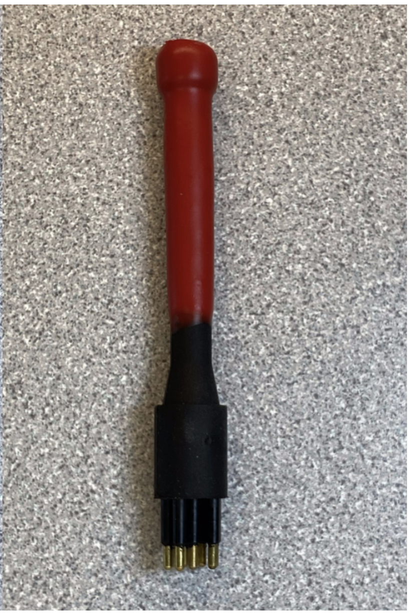
Each Popoto modem is equipped with a Subconn Microcircular connector that includes a designated power down pin. This configuration is designed to ensure that the modem can be securely powered down when necessary. The power down process is initiated by connecting the power down pin to the ground pin within the same connector, effectively powering off the unit.

When the power down pin is disconnected, the modem is in the ON state. This method ensures that the modem is maintained in an ”on” state, ready for operation when deployed with a dummy plug.

### 5.6.3 The Power Down Plug

For shipping and storage purposes, a "Power Down Plug" is provided with each modem. This plug is designed to short the appropriate pins, guaranteeing that the unit remains powered off during these periods. It's a critical component for maintaining the modem's safety and ensuring it does not inadvertently power on.


(a) 8 Pin Dummy plug. Note the BLACK rubber whip indicating that this is a dummy plug


(b) 8 Pin Powerdown plug. Note the RED rubber whip indicating that this is NOT a dummy plug

NOTE

DO NOT DEPLOY a modem with a RED whip plug. This plug turns off the modem, and you will not be able to contact it acoustically. All deployments should be with cables, or with BLACK whip dummy plugs.

## 5.7 Charging

Ensuring your Popoto modem is properly charged is crucial for optimal performance and longevity. This section outlines the correct charging procedure using the designated Popoto Lithium Ion (Li-ion) battery charger, which adheres to the Constant Current Constant Voltage (CCCV) charging protocol.

Each lab cable provided with your enclosed modem features designated battery and ground pins. These are specifically configured for direct connection to the Popoto Li-ion battery charger, ensuring a secure and efficient charging process.

### 5.7.1 Using the Popoto Li-ion Battery Charger

The Popoto Li-ion battery charger is designed to deliver a CCCV charging cycle, optimal for the specific battery chemistry of the Popoto modem's battery. This charging method is essential for maintaining battery health, preventing overcharging, and ensuring longevity.

#### 5.7.1.1 Indicator LED

The charger is equipped with an indicator LED that communicates the charging status:

- **Red LED:** Indicates that the charger is actively charging the battery.
- **Green LED:** Signals that the charging cycle is complete, and the battery is fully charged.

This visual feedback allows users to easily monitor the charging process and ensures the modem is ready for use when needed.

## 5.8 Disassembly

While disassembly of the M2000 enclosure may be necessary for maintenance or upgrades, it is important to proceed with caution. The units are vacuum tested before shipping to ensure a tight seal, and disassembly will break this seal, potentially leading to leaks.

### 5.8.1 Recommendation

It is generally recommended to keep the units sealed whenever possible. If disassembly is performed, it is recommended to conduct a re-vacuum test after reassembly to ensure the integrity of the seal and prevent any possible leaks. Contact Popoto Modem for information on conducting a vacuum test.

### 5.8.2 M2000/M6000

For a visual guide on the assembly and disassembly process, refer to the official video tutorial available at M2000 Enclosure Assembly and Disassembly on YouTube.

### 5.8.3 S1000

For detailed information about disassembling and reassembling the S1000, please contact Popoto Modem.

# 6 Popoto Transducer (PMT-28)

## 6.1 Transducer

The transducer for the Popoto Modem is available in three distinct delivery options, each designed to meet specific operational and environmental requirements. This section outlines the configurations and their respective applications.

## 6.2 Transducer Configurations

### 6.2.1 Internal Wiring Configuration

The internal wiring option utilizes a shielded, non-waterproof cable. This configuration is ideal for applications where the transducer is housed within a protective enclosure, ensuring the system's integrity against environmental factors.

### 6.2.2 External Wiring Configuration

For applications requiring direct exposure to the environment, the external wiring configuration employs a durable Polyurethane jacketed cable. This design enhances the transducer's resilience in outdoor or marine settings, offering reliable performance under varying conditions.

### 6.2.3 Dunking Transducer

The dunking transducer is equipped with a long cable that features a Polyurethane jacket and a strength member. This configuration is suited for applications that involve deploying the transducer into the water from a stationary platform, vessel, or buoy. The inclusion of a strength member ensures the cable's durability and integrity, even under the stress of deployment and retrieval.

All Popoto transducer options consist of a potted piezo ceramic. It is designed to efficiently convert mechanic signal energy to and from electrical analog signals in the 28 KHz region. A picture of the transducer is shown in Figure **??**

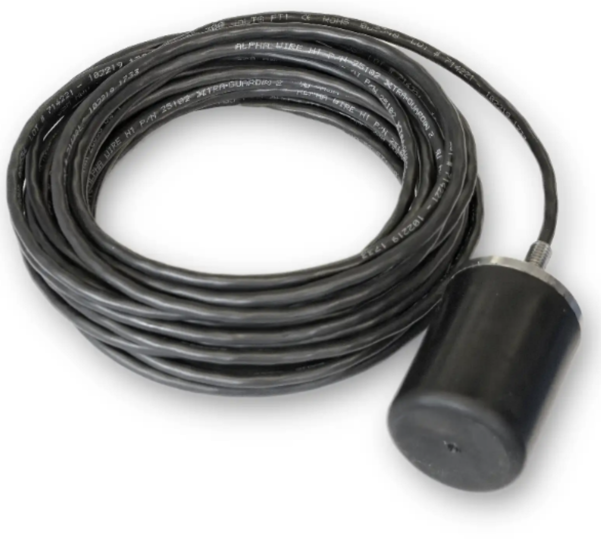


Figure 6.1: The Popoto 28 Khz Transducer

### 6.2.4 Transducer Performance

This section provides an overview of the transducer performance for the Popoto modem PMT28, based on comprehensive testing conducted by an independent laboratory. The results offer insights into the transducer's capabilities and efficiency in operational scenarios.

## 6.3 Performance Curves

The performance of the PMT28 transducer is detailed through a series of curves that illustrate its free field voltage sensitivity, transmit voltage response, and transmit beam pattern. Each of these metrics provides valuable information for assessing the transducer's effectiveness in acoustic communication.

### 6.3.1 Free Field Voltage Sensitivity

The free field voltage sensitivity curve indicates how effectively the transducer converts acoustic power into electrical signals across a range of frequencies. This metric is crucial for understanding the transducer's ability to detect and process incoming signals.

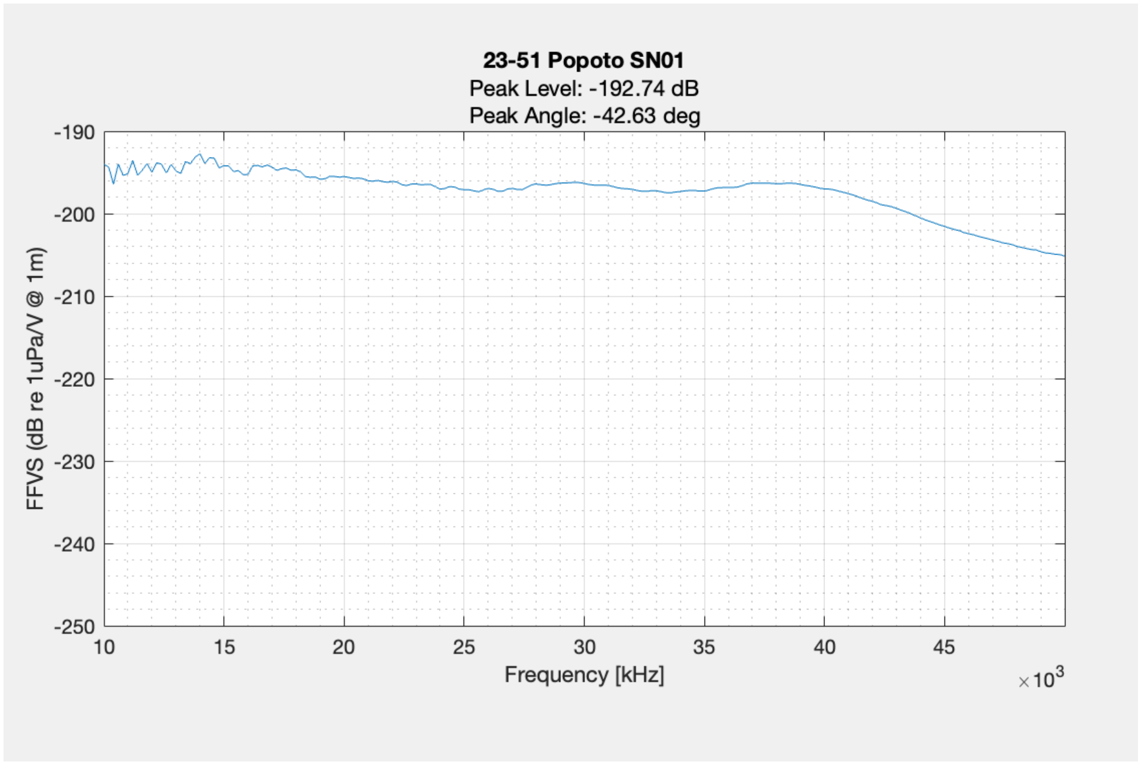


Figure 6.2: The Popoto 28 Khz Transducer Free Field Voltage Sensitivity

### 6.3.2 Transmit Voltage Response

The transmit voltage response curve demonstrates the transducer's efficiency in converting electrical signals into acoustic energy. This is essential for evaluating the power output and overall performance of the transducer during transmission.

### 6.3.3 Transmit Beam Pattern

The transmit beam pattern illustrates the directional characteristics of the transducer's emitted signal. Understanding the beam pattern is vital for optimizing system setup and ensuring effective communication over the intended area of coverage.

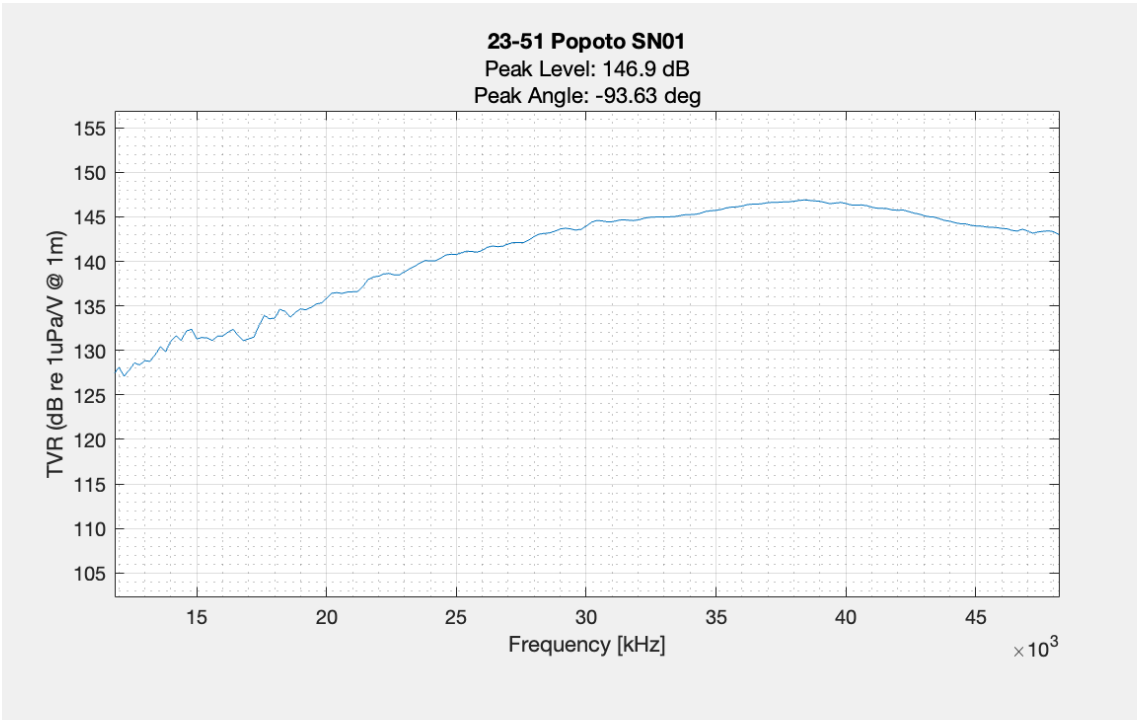


Figure 6.3: The Popoto 28 Khz Transducer Transmit Voltage Response

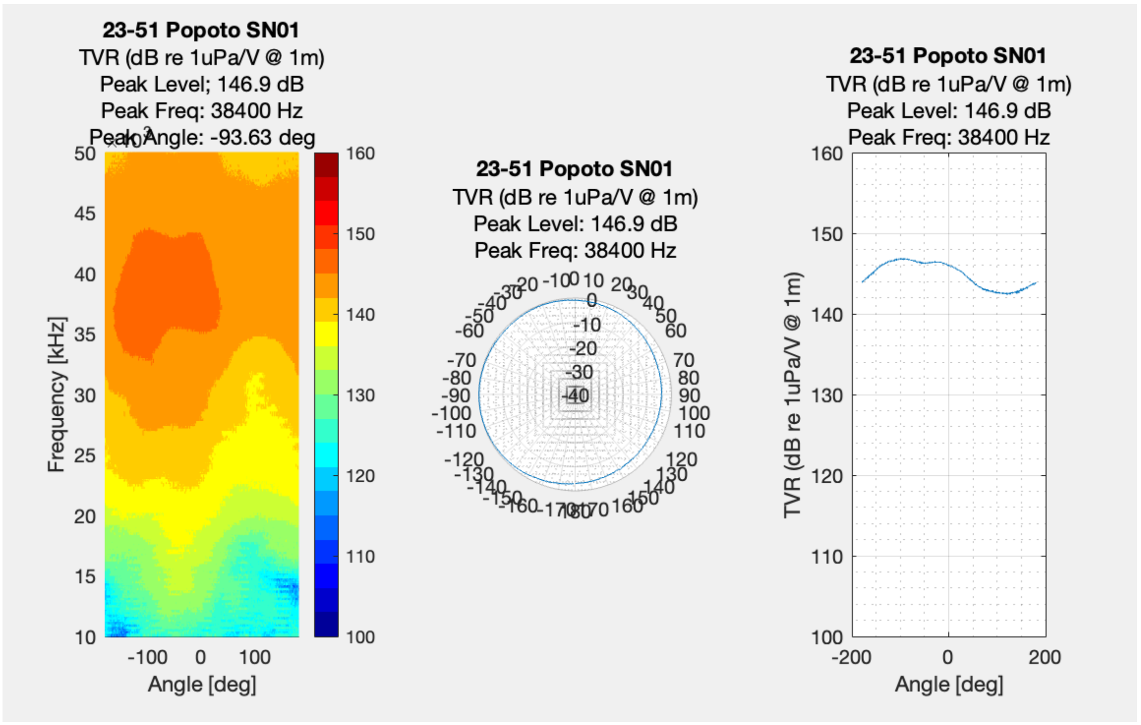


Figure 6.4: The Popoto 28 Khz Transducer Transmit Voltage Response

# 7 Communicating with Popoto

## 7.1 Introduction

The Popoto system consists of several components working together to create an acoustic digital communication system. Refer to Figure 7.1. At the lowest level, a Transducer provides the physical interface between the Modem and the water. This transducer is connected to the Analog board which can both drive the transducer as an output, and receive from the transducer as an input. The analog board digitizes input and converts the analog signal in the water to digital data which is sent to the Digital board. The digital board demodulates the data on the DSP, and sends the bitstream to the ARM9 which determines what to do with the data based on the current processing state.

## 7.2 Socket based JSON

The lingua franca of Popoto is JSON messages over sockets. Although there are many ways and APIs to communicate with Popoto, all of these methods and APIs funnel down to creating or displaying a JSON message to/from a socket.

### 7.2.1 Highlevel Description of Popoto API Sockets

The IO to all of the embedded Popoto software is accomplished using IP Sockets. Even the analog signal data supports the socket IO. This provides great flexibility for interface, test, software portability, and software test. These sockets also can interface through a thin layer of code to give us the familiar standard interfaces that are used in the field such as RS-422. Sockets are

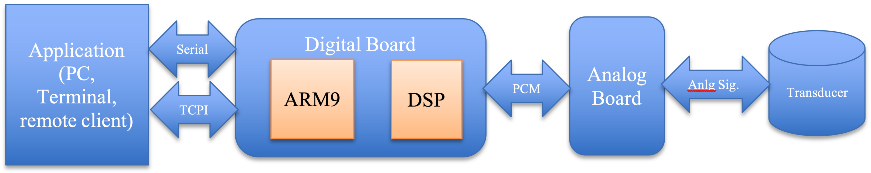


Figure 7.1: Popoto System Overview.

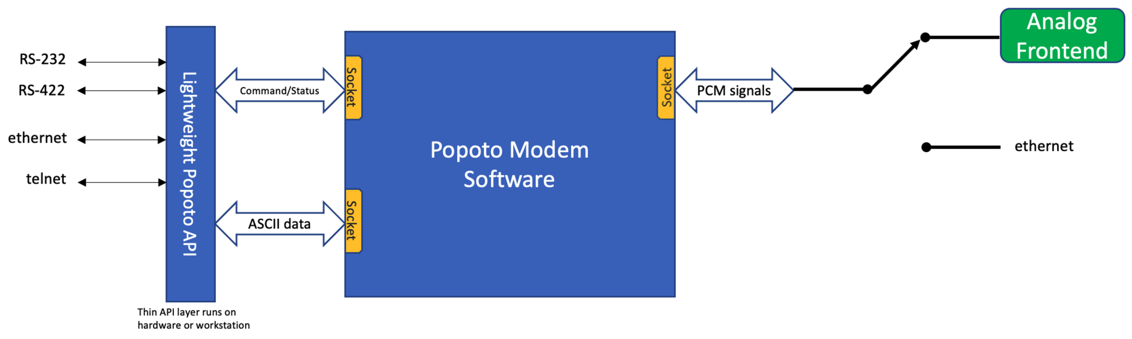


Figure 7.2: Popoto Modem Socket interfaces.

specified by the IP address of the Popoto modem as set by the user In addition to the IP address the following ports are used.

1. 17000 Command Port
2. 17001 Data Port (Telnet)
3. 17002 PCM Logging Port (Not for typical use)
4. 17003 PCM Output Port (Not for typical use)
5. 17004 PCM Input Port (Not for typical use)

### 7.2.2 Introduction JSON Messages

JSON stands for JavaScript Object Notation. JSON is a lightweight format for storing and transporting data. JSON is often used when data is sent from a server to a web page. JSON is "self-describing" and easy to understand.
JSON is built on two structures:

- A collection of name/value pairs. In various languages, this is realized as an object, record or struct.
- An ordered list of values. In most languages, this is realized as an array, vector, list, or sequence.

High level languages such as Python typically have JSON parsers available to easily parse JSON messages into variables of that language.

### 7.2.3 Commands

The basic structure for commanding Popoto happens using a JSON command message. This message consists of two parts, the Command keyword, followed by the Argument keyword. The basic structure of the command is as follows:

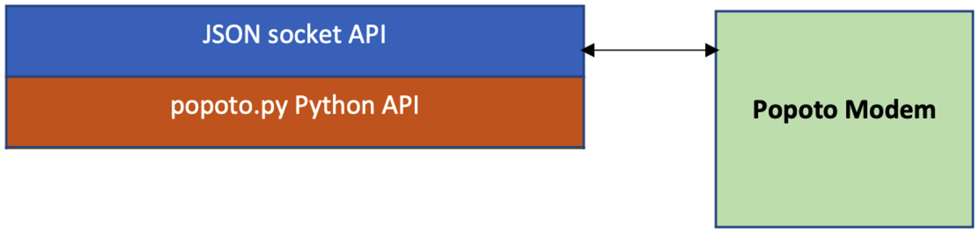


Figure 7.3: JSON API Interfacing to Python.

```
{"Command": "", "Arguments": ""}
```

Example: Get the software version
An example of a simple JSON command is the command to check the software version. This command would be issued as follows:

```
{"Command": "GetVersion", "Arguments": "Unused Arguments"}
```

And would result in the modem responding as follows:

```
{"Info": "Popoto Modem Version 2.7.0"}
```

### 7.2.4 The Keyword Return Values

Popoto modem returns information to the user using various keyword identifiers. These return keywords are designed to be self-identifying, and can be used for user application parsing.

### 7.2.5 System Level Variables

Popoto modem contains various internal variables. These variables are mode variables, configuration variables, or contain parameters extracted from the signal.

## 7.3 Facilitating JSON messages

As mentioned previously, the primary interface to the embedded Popoto algorithm is done over sockets using JSON messages. To make interaction and automated development easiest for a Popoto user, Popoto provides several API and a user shell Pshell. These APIs and shell, constitute a very thin layer that creates and interprets the socket based JSON messages.

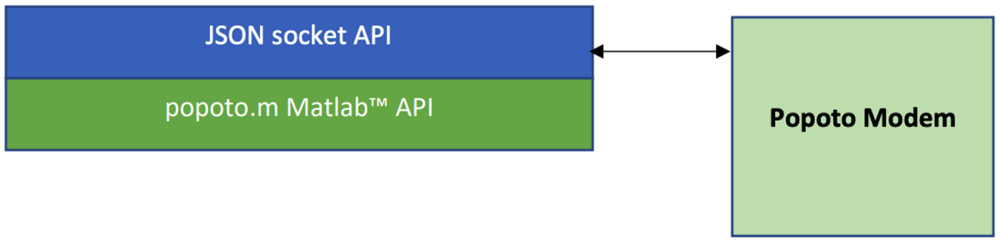


Figure 7.4: Popoto Modem Matlab and JSON API.

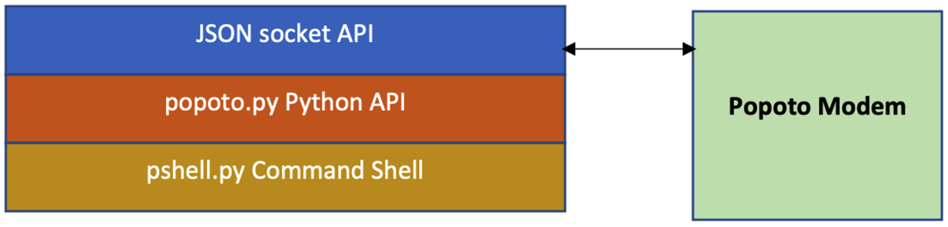


Figure 7.5: Popoto pshell to Popoto.py to JSON.

For example, the popoto.py layer provides python access and methods to create the JSON messages using python. Importing this library gives a user full control over the Popoto modem in the python language.

Much in the same way, a Matlab™ based API has been generated. The structure of how it interacts with Popoto is the same. Finally, a command shell called Pshell has been written in python, using the popoto.py API and the cmd command interpreter. This shell allows users to interact with the modem at a user level, typically through a serial connection. The pshell is default way for a user to interact with Popoto modems. The structure of this connection is a follows:

# 8 System Connections

The Popoto modem has 4 primary interfaces for an external CPU or computer to connect to:

1. RS422 4 Wire serial
2. RS-232 Uart
3. 10/100 BaseT networking
4. TTL (3.3V) UART

Each of these connections has properties that make it attractive in different situations.

## 8.1 RS-422 4 wire serial

### 8.1.1 Reasons to use it

Good for long distance connections, up to 1200 meters. Simple serial interface. Robust to noise and interference.

### 8.1.2 Reasons to avoid it

Remote unit needs drivers. Only good for up to 115200 bits per second which is not adequate for PCM Streaming.

## 8.2 RS-232 Uart

### 8.2.1 Reasons to use it

The RS-232 uart is a 3 wire serial interface. It consists of 3 signals, Transmit data, Receive Data, and ground. The signal lines run at +/-15 Volts This interface is particularly attractive if the user is interfacing the modem to a local device, such as a micro controller on a UAV. All that is required is a tx, rx and gnd signal. For PC or laptop lab use, the pinout for this connector is a 5 pin 10mil header configured exactly as the standard FTDI USB cables, which makes for a simple USB to serial interface available off the shelf.

### 8.2.2 Reasons to avoid it

This interface is only good for very short distances, such as within the same enclosure. The bandwidth for this interface is limited to 115200 Bits per second which is not adequate for PCM streaming.

## 8.3 10/100BaseT

### 8.3.1 Reasons to Use it

The 10-100BaseT Ethernet networking provides the highest speed and most flexible connection to the Popoto system. Using TCP sockets over the ethernet provides upto 100MBits/S of full- duplex throughput to the Popoto from a remote computer located up to 100 meters away. This bandwidth can be used for real-time PCM capture, or rapidly updating software. Additionally, the flexibility of the TCP sockets allows for 3

### 8.3.2 Reasons to avoid it

The additional speed and flexibility of the ethernet comes at a cost of 250 milliwatts. In addition, the range of the ethernet is limited to 100 meters.

## 8.4 TTL (3.3V) UART

### 8.4.1 Reasons to use it

The TTL (3.3V) uart is a 3 wire serial interface. It consists of 3 signals, Transmit data, Receive Data, and ground. The signal lines run at 3.3Volts This interface is particularly attractive if the user is interfacing the modem to a local device, such as a micro controller on a UAV. All that is required is a tx, rx and gnd signal. For PC or laptop lab use, the pinout for this connector is a 5 pin 10mil header configured exactly as the standard FTDI USB cables, which makes for a simple USB to serial interface available off the shelf.

### 8.4.2 Reasons to avoid it

This interface is only good for very short distances, such as within the same enclosure. The bandwidth for this interface is limited to 115200 Bits per second which is not adequate for PCM streaming.

## 8.5 Modes of operations

The flexibility of the Popoto system provides for several use-cases. Each of these use-cases applies to a different product scenario, so it is important when deciding which to employ, that the requirements of the end product are carefully considered.

### 8.5.1 Local pshell

The pshell is a python program that connects with the Popoto application and provides a shell interface to the modem and its command, status and data interfaces. This shell provides simple commands such as send ranging, or setTxPower level so that either under human or computer control the modem can be utilized. In this use-case, the interface to the modem can be any one of:

- Serial RS-232
- 4 Wire RS-422
- Ethernet over SSH
- Ethernet over Telnet

The pshell program runs co-resident with the popoto_app on the OMAP's ARM core processor. Figure 8.1 shows local pshell processing.

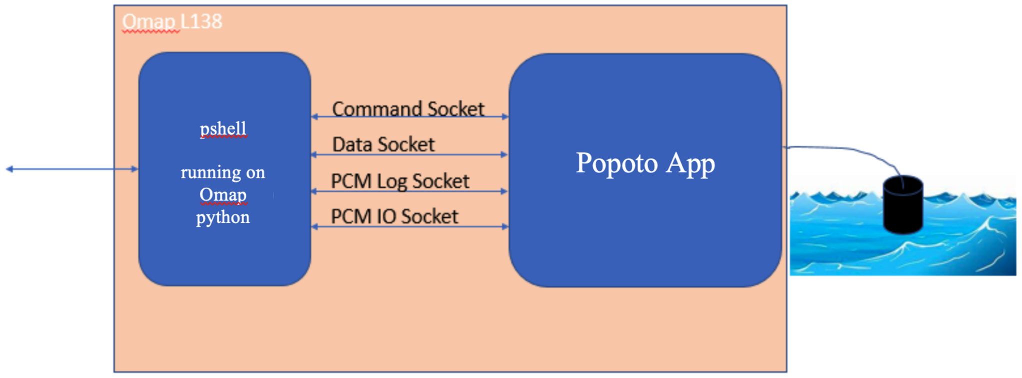


Figure 8.1: Local Pshell operation.

### 8.5.2 Remote pshell

The remote pshell operates in the same way as local pshell, however the pshell python program runs on a remote processor, and the connection to the popoto_app is over TCP Sockets and networks as shown in figure 8.2. Using a remote pshell is advantageous for streaming PCM directly to the PC's harddrive. Additionally the remote pshell is a good choice for running regression tests, as the regression suites can live on the remote pc, which can also log results.

### 8.5.3 Matlab™

Matlab™ mode is very similar to remote-pshell mode, except that the connection to the popoto_app does not use a Python program, rather it connects

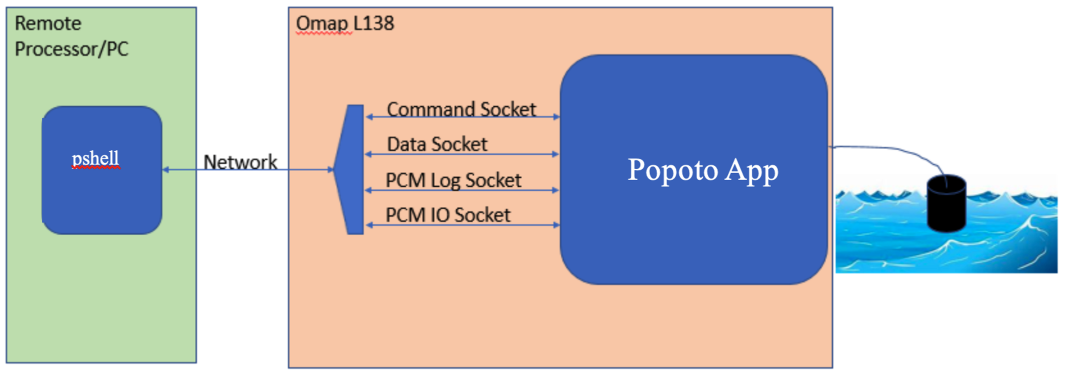


Figure 8.2: Connecting to Popoto using a remote pshell

using Matlab™. Matlab™is an excellent choice for running lab tests as it is a powerful language that is easy to use. Given Matlab™'s expense, and need for a full PC to run, it is not likely to be deployed in a customer's end product.

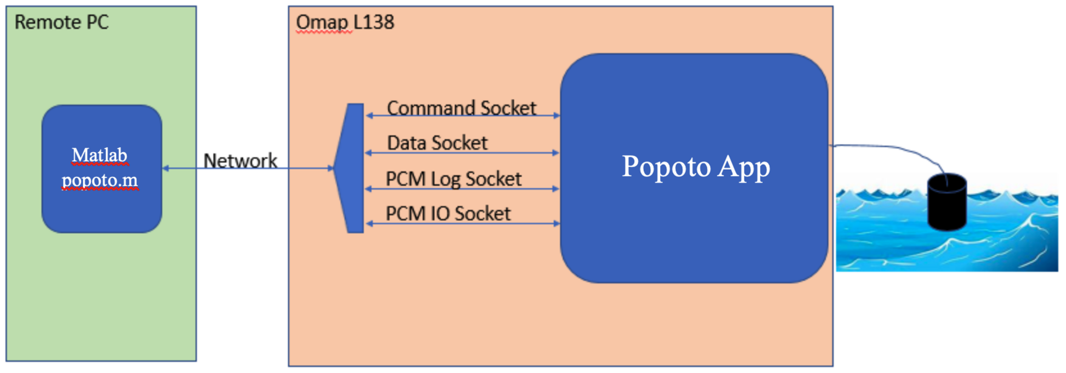


Figure 8.3: Connecting to Popoto Over Matlab™.

### 8.5.4 Custom interfaces

The Popoto system uses standard sockets for communications, so it is entirely possible for a customer to generate a custom interface written in the language of his choice. Figure 8.4 shows an example of a custom Popoto application. Please see the Popoto.py and Popoto.m files for ideas on how to implement such an interface.

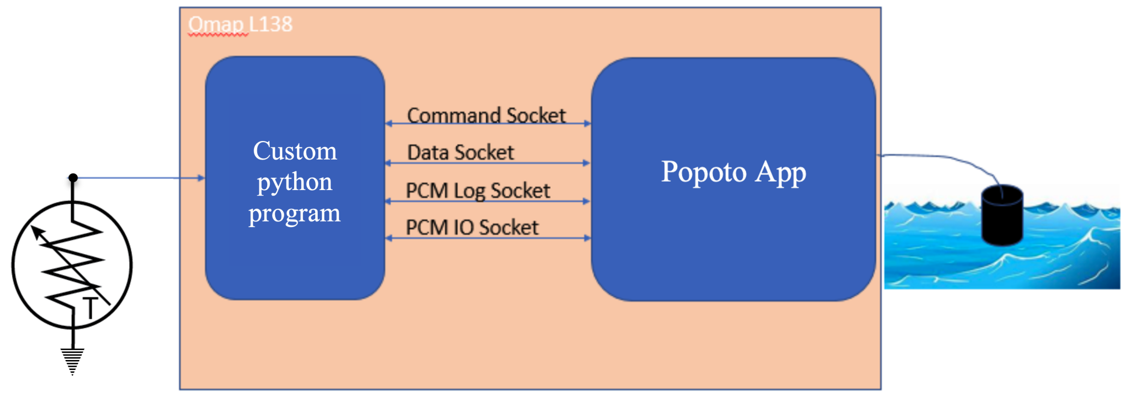


Figure 8.4: Popoto Modem implementing a custom application. In this picture, a Popoto modem is configured to measure a temperature sensor, and report its measurements via the acoustic channel.

## 8.6 Sleep and Power Down

Popoto has 2 different sleep modes for low-power operation, POWERDOWN and DEEPSLEEP. In Powerdown mode, nearly all of the voltage supplies on the board are shut down, resulting in a very low-power sleep. It takes about 20 seconds to power up and out of POWERDOWN mode. In DEEPSLEEP mode, the processor is put into hibernation, and all RAM is kept powered and refreshed. This mode consumes more power, but wakes up quite quickly (<1Sec). Each mode can be entered via an API or pshell command. The pshell exposes 2 commands powerdown, and deepsleep. Refer to the Popoto API reference for information about API access to the powerdown states. In either powerdown mode, a dedicated wake-up processor monitors the acoustic signals in the water looking for a wakeup signal. The wakeup signal is based on the standard modem message header acquisition pattern. To wake a modem, simply send any message into the water, and the acquisition signal will wake the modem. This transmitted message will be lost, but it serves simply to wake the unit.

# 9 Pshell

The pshell is a python command line shell utilizes commands defined in Popoto.py to provide a python scriptable command shell containing all of the most useful commands from Popoto.py. In addition the command shell provides for help and tab completion for ease of use. Responses from commands are echoed to the command shell along with asynchronous alerts from Popoto.

## 9.1 Modes of operation

There are two fundamental modes of operation of the pshell, it can be run on the user PC under the PC's local python or it can be run on the python that exists on Popoto OMAP platform. Because communication from pshell to the Popoto is done through IP sockets, this gives the flexibility of running pshell locally on the target or remotely on any PC on the network.

## 9.2 Requirements for running

python 2.7 (it is already installed on the Popoto hardware) CMD command shell installed (it is already installed on the Popoto hardware) CMD2 command shell installed (this gives some added features)

## 9.3 Invoking pshell

As delivered, the Popoto will invoke the pshell automatically and present a command prompt to the user on the RS-422 port.

### 9.3.1 The pshell.init file

The pshell.init file is located in the root directory /. This file is a collection of pshell commands that get executed on power up of Popoto. This file is intended for the user to customize this file and set bootable parameters such as localID, carrier frequency etc. The syntax is normal pshell syntax where line comment character # (first position) and whitespace are ignored.

### 9.3.2 Invoking pshell from a linux prompt

Although pshell runs automatically at boot. It is possible to terminate the local running pshell process and run the pshell from any python with an IP connection to Popoto. From the linux command prompt

```
python pshell
```

This will start the up the pshell and you are ready to being typing commands.

## 9.4 Invoking commands

### 9.4.1 Help

To gain a complete list of commands at any time simply type the command help. A full list of commands will be displayed. To get help on any of those commands, enter help <command> at the Popoto prompt.

### 9.4.2 Tab Completion

The pshell supports tab completion. Tab completion will also show a list of various options for a particular command.

### 9.4.3 Commands

This section presents a list of the currently implemented commands. A brief description is presented along with typical invocations.

## 9.5 Extending the pshell

One of the best parts of pshell is that it is easy to extend with simple python. For example if you want to make a command that does five ranges spaced by 30 seconds, it is as simple as adding these lines:

```
def do_nranges(self,line):
 for x in range(1,5):
  self.dol.range(.1)
  time.sleep(30.)
```

Note the command name in the pshell would be nranges. With the pshell, you have the power of the python language to create complex commands or specific syntaxes, mappings, command checking etc very quickly and efficiently.

## 9.6 Scheduling Transmissions

The Popoto Modem API offers a feature allowing users to schedule the transmission of a data packet at a specific time, utilizing the PCM sample count for precision. This document guides you through using this feature.

### Understanding PCM Sample Time

Time within the Popoto Modem is measured in PCM samples, with a frequency of 102,400 samples per second. The `PCMSampleCounter` variable holds a 32-bit count of these samples, offering a high-resolution time base for scheduling transmissions.

### Querying the PCMSampleCounter

To retrieve the current PCM sample count, use one of the following methods:

- Send the command `get PCMSampleCounter` to the modem.
- From the pshell, type `PCMSampleCounter` and press Enter.

In versions 3.2.6.3, 3.2.8, or later, the `PCMSampleCounter` at the start of each received packet is reported in a JSON message, e.g., `{"PCMSampleCount":4446530}`.

### Scheduling a Transmission

To schedule the transmission of a packet, use the `transmitJSON` command with a specified departure time in PCM sample count. Here is the syntax for scheduling a transmission:

```
pshell> transmitJSON {"Payload":{"Data":"Hello"}, "DepartureTime":30000000}
```

This command schedules the packet containing the message "Hello" to be transmitted at the PCM sample count of 30,000,000.

### Transmission Status

After scheduling a transmission, the modem reports the status through a series of JSON messages, indicating the scheduled departure time, the actual PCM sample count at transmission, and various modem settings adjustments. For example:

```
{"DepartureTime":150000000}
{"PCMSampleCount":138576000}
{"Info":"Value Set MODEM_Enable=1"}
{"Info":"Value Set MODEM_Enable=1"}
{"Alert":"TxComplete"}
{"Info":"Value Set MODEM_Enable=1"}
{"Info":"Value Set RxEnable=1"}
```

### Handling Early or Past Scheduled Transmissions

It is important to note that scheduling a transmission to occur too soon (considering it takes approximately 300ms to power on the transmit Power Amplifier) or in the past will result in the transmission happening as soon as the hardware is ready. If a requested departure time is too early or has already passed, you will receive status messages indicating this, alongside the actual transmission details:

```
{"Info":"Requested Departure Time Too Early or in the Past. "}
{"DepartureTime":130555520}
{"PCMSampleCount":130483840}
{"Info":"Value Set MODEM_Enable=1"}
{"Info":"Value Set MODEM_Enable=1"}
{"Alert":"TxComplete"}
{"Info":"Value Set MODEM_Enable=1"}
{"Info":"Value Set RxEnable=1"}
```

## 9.6.1 Streaming Mode Operation for Popoto Modem

### 9.6.1.1 Introduction

**9.6.1.1.1 Purpose** This document explains the configuration and operational benefits of Streaming mode on the Popoto modem. This mode is designed to handle larger data packets efficiently, which is critical for applications requiring robust and continuous data transmission.

**9.6.1.1.2 Scope** The guide outlines the necessary settings for Streaming mode and quantifies the benefits in terms of transmission time savings.

### 9.6.1.2 Configuration

**9.6.1.2.1 Enabling Streaming Mode** To activate Streaming mode, set the following variables:

- **ConsolePacketBytes**: Set to 256. This configuration specifies the packet size that the modem processes.
- **StreamingTxLen**: Set to 2048. This setting allows the modem to consolidate transmitted data into super packets or frames, reducing the frequency of required headers.

### 9.6.1.3 Operation

**9.6.1.3.1 Sending Data** In Streaming mode, transmitJSON messages of 256 bytes are sent continuously without the need for waiting for transmit complete messages. This setup significantly streamlines the data flow to the modem.

**9.6.1.3.2 Data Handling by the Modem** The modem software queues the incoming 256-byte messages and automatically combines them into super frames of 2048 bytes. This process minimizes communication overhead and increases data throughput.

#### 9.6.1.4 Efficiency Gains

**9.6.1.4.1 Header Duration and Transmission Savings** Each header in Streaming mode consists of 176 chips (32 + 128 + 16 chips), with each chip lasting 6.25 milliseconds. The duration of one header is therefore 1100 milliseconds. Unlike the standard mode, where each packet would require a new header, Streaming mode only necessitates a header for each super packet (2048 bytes).

- **Header Duration**: 1100 ms per super packet.
- **Savings**: By transmitting seven fewer headers for each super packet, Streaming mode saves 7700 milliseconds per super packet compared to non-streaming mode.

**9.6.1.4.2 Mathematical Expression of Savings** The time saved per super packet in Streaming mode is calculated as:

$$Savings = HeaderDuration \times 7 = 7700ms$$

# 10 Single Side Band Voice Operation

# 11 Single Side Band Voice Operation

## 11.1 Overview

Utilizing Popoto's single sideband transmitter (SSB) and receiver allow for half duplex voice communication through the water. The SSB signal is inherently and analog signal being through the ocean at a carrier frequency. As an analog signal, this means that the reception of the analog waveform includes the analog impairments of the channel. So if the channel is noisy, the receiver will hear the noise. If the channel has echo, the resulting speech will include echo. If there is no noise and no echo, and analog levels are set properly, there will be no distortion of speech aside of the normal band limiting associated with telecom speech. To utilize the SSB functionality of Popoto, it is necessary to ensure that the voice path electronics are powered up. This is done by ensuring jumpers J1 and J5 are populated.

## 11.2 SSB Transmitter

The transmitter consists of a single sideband modulator which receives speech from the microphone input J3 and modulates it up to carrier for transmission out of the tranducer and through the water. There are 3 ways to place the SSB transmitter in transmit mode.

1. A Popoto ssbtx command
2. A hardware PTT signal
3. Using the properly adjusted VOX

### 11.2.1 The ssbtx command

Issuing the ssbtx command places Popoto in transmit mode. This can be clearly seen by the transmit LED glowing red on the analog board. Once in transmit mode, audio that is input on SMA J3 will be modulated, shifted up to carrier,power amplified, and delivered to the transducer.

### 11.2.2 Adjustment of transmit power

Proper adjustment of the transmit power is critical for good operation of the SSB transmitter. Setting this power properly is a function of 2 variables

1. Microphone sensitivity
2. Desired transmit power

Both of these variables is are controlled by the SSB_Txpower variable. This variable should be set such that the desired PEP power is achieved while speaking at a normal level in the microphone.

### 11.2.3 Peak Envelope Power

The proper adjustment of power for voice operation revolves around properly setting the Peak Envelope Power. PEP is the value of power that is output by the transmitter when the speech is at peaks in its overall envelope. Typically average power of speech is between 10%-20% of the peak envelope power. These adjustments should be made while the transducer is in water. Also these setting can be approximated by careful monitoring of the input power in these peak regions and setting the SSB_Txpower constant appropriately. Choosing an appropriate PEP level is a function of the distance that one wishes to transmit, the SNR of the channel, along with the reflectivity of the channel. These settings can be experimentally derived in the water and presets can be made in the pshell for optimum speech quality.

### 11.2.4 PTT keying of the transmitter

The Popoto hardware presently includes two GPIOs that are used for PTT and also headset volume control. The truth table shown below illustrates the various modes associated with the GPIOS. When the two GPIOs are zero, the transmitter is keyed, when they are 1,1 the receiver operates, and the other two states will raise or lower the headset volume by 1 dB per click.

Table 11.1: SSB Control Bits

| Gpio8[6] | Gpio7[14] | State |
|---|---|---|
| 0 | 0 | PTT Depressed (Transmit Mode) |
| 0 | 1 | Headphone Volume UP |
| 1 | 0 | Headphone Volume DOWN |
| 1 | 1 | Receive Mode ** |

In order to work with the PTT and VOL UP VOL DN the J7 Pin 3 and J7 Pin 9 Must be pulled up to 5V through their own individual 4.7K Resistors.

Table 11.2: SSB Pinout

| Function | GPIO Number | Processor Signal | J7 Pin |
|---|---|---|---|
| VOL UP/PTT | GPIO8[6] | SPI_SOMI | J7_3 |
| VOL DN/PTT | GPIO7[14] | EXP1 | J7_9 |

### 11.2.5 Transmitter Vox

The SSB transmitter can be switched on using the speech signal itself. To utilize this feature, the SSB_Vxmode should be set to 1. Next the SSB_Vxlevel should be increase from zero slowly while speaking to arrive at the trigger point for the VOX. Proper setting of this level will ensure that constant level audio background will not trigger the transmitter, but onsets of speech will trigger the transmitter. Note that once the transmitter is keyed, the transmitter remains on for a period of 2 seconds.

## 11.3 SSB Receiver

Voice mode reception is enabled by issuing the ssb command from the pshell. At this command the modem will transition from data modem mode to single side band receiver. Demodulated audio will be present on the SMA connector J4. The audio level present on J4 is controllable by setting the SSB_Volume parameter to the user desired level.

### 11.3.1 Squelch

Additionally, the receiver incorporates a squelch for eliminating background noise between segments of received speech. To utilize the squelch it is important to set the SSB_SqLevel parameter in the pshell. An SSB_SqLevel of zero reflects no squelch and the receiver will be continuously in the receive state with demodulated audio being presented to the headphones. The user can gradually increase the squelch level until the interspeech segments are muted.

### 11.3.2 Noise Reduction and AGC

The SSB Receiver incorporates an advanced Noise reduction and AGC which are enabled using the SSB_NREnable flag as detailed in Table 11.3. This module monitors the background noise using spectral analysis to provide an adaptive noise reduction and speech quality improvement. Enabling this mode also enables the receiver automatic gain control. Using the noise reduction algorithm's internal metrics, the automatic gain control is able to determine when speech signals are present in the received signal. During these times, the receiver gain is adjusted to provide speech at an audible signal level.

## 11.4 Return to data mode

To return to data mode simply enter `datamode` at the pshell prompt.

## 11.5 SSB Controllable parameters

The table below show all of the settable/gettable parameters available through the pshell for the purpose of controlling SSB operation.

Table 11.3: SSB Control Bits

| Parameter | Type | Description |
|---|---|---|
| SSB_Volume | float | Sets volume level of headset |
| SSB_Txpower | float | Sets microphone gain; for SSB, this controls the Tx power |
| SSB_VxMode | int | Normal PTT set to 0; VOX mode PTT set to 1 |
| SSB_VxLevel | float | Sets the trigger level for PTT VOX |
| SSB_SqLevel | float | Sets the background noise level for squelch trigger (0.-always on) |
| SSB_NREnable | int | Enable or disable the Noise reduction/AGC algorithm 1=On 0=Off |

# 12 Janus Operation

## 12.1 Janus Overview

Janus is a standardized physical and data link layer for acoustic underwater commmunications designed and implemented by NATO's Centre for Maritime Research and Experimentation (CMRE). The standard is described in the NATO ANEP-87 specification. Further details about Janus are available at the wiki page maintained by CMRE.

## 12.2 Janus Bitstream

One of the defining features of Janus is its configurable payload scheme. Each message begins with an acquisition pattern, followed by modulated bits. These definition of these bitfields is variable based on the message content. The baseline bit allocation table for the Janus message is shown in Figure 12.1. In this figure, you will notice that bits 31-56 are referred to as the application data block. The definition of this block of bits is dependent on the Class UserID and Application Type bitfields found earlier in the message.

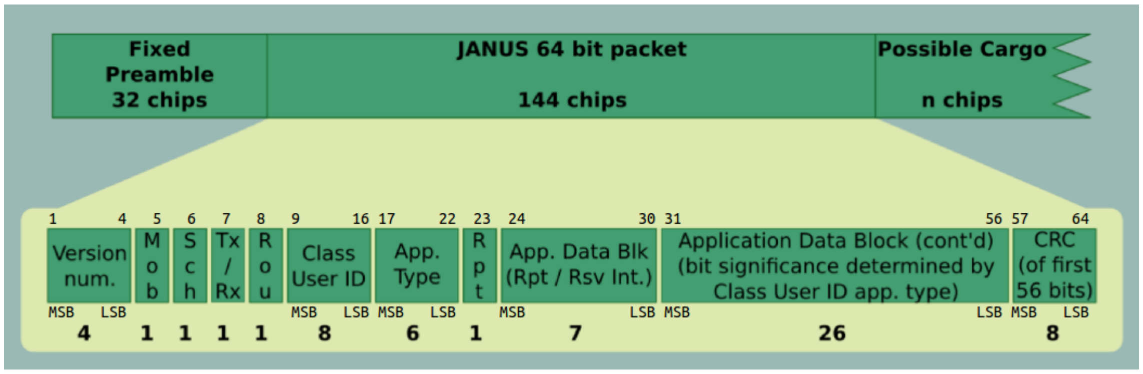


Figure 12.1: Janus Baseline Bit Aloocation. (from the Januswiki.com webiste)

## 12.3 Popoto Modem Implementation of Janus

The Popoto Janus modem fully implements all of the ratified Janus Class ID's, which currently include Class ID's 0, 2, and 16. Within the Popoto modem, each of the fields exported in the Class definition are represented by a field in a JSON encoded message. In this way, a JSON encoded message can be translated directly into a Janus message class. What follows are examples of each of the supported message types along with a link to the Class description on the JanusWiki.com website.

### 12.3.1 Class User Id: 000 Emergency

#### 12.3.1.1 ApplicationType 1: Position Message

Refer to the wiki page Emergency Position Message Format for details about the fields associated with the Emergency position message. The example below shows how to construct a representative ClassID 000 ApplicationType 1 Emergency Position message for transmission by the Popoto Modem. This JSON structure would be encoded on a single line, and passed to the transmitJSON api of the pshell, or other Popoto API (C++, Python, Matlab).

```
{
  "ClassUserID": 0,
  "ApplicationType": 1,
  "Nationality": "AB",
  "Latitude": "90.000000",
  "Longitude": "0.000000",
  "Depth": "8190",
  "Speed": "0.000000",
  "Heading": "180",
  "MobilityFlag": "1",
  "ForwardingCapability": "1",
  "TxRxFlag": "0",
  "ScheduleFlag": "1",
  "Schedule": "10"
}
```

#### 12.3.1.2 ApplicationType 2: Status Message

Refer to the wiki page Emergency Status Message Format for details about the fields associated with the Status message. The example below shows how to construct a representative ClassID 000 ApplicationType 2 Status message for transmission by the Popoto Modem. This JSON structure would be encoded on a single line, and passed to the transmitJSON api of the pshell, or other Popoto API (C++, Python, Matlab).

```
{
  "ClassUserID": 0,
  "ApplicationType": 2,
  "Nationality": "ZX",
  "O2": "17.000000",
  "CO2": "5.000000",
  "CO": "0.000000",
  "H2": "5.000000",
  "Pressure": "103.199997",
  "Temperature": "50.000000",
  "Survivors": "1",
  "MobilityFlag": "1",
  "ForwardingCapability": "1",
  "TxRxFlag": "0",
  "ScheduleFlag": "1",
  "Schedule": "10",
  "RepeatFlag": "1"
}
```

#### 12.3.1.3 ApplicationType 3: Position + Status Message

Refer to the wiki page Emergency Position and Status Message Format. The example below shows how to construct a representative ClassID 000 ApplicationType 3 Position and Status Message for transmission by the Popoto Modem. This JSON structure would be encoded on a single line, and passed to the transmitJSON api of the pshell, or other Popoto API (C++, Python, Matlab).

```

{
  "ClassUserID": 0,
  "ApplicationType": 3,
  "Nationality": "PT",
  "Latitude": "38.386547",
  "Longitude": "-9.055858",
  "Depth": "16",
  "Speed": "1.400000",
  "Heading": "0.000000",
  "O2": "17.799999",
  "CO2": "5.000000",
  "CO": "76.000000",
  "H2": "3.500000",
  "Pressure": "45.000000",
  "Temperature": "21.000000",
  "Survivors": "43",
  "MobilityFlag": "1",
  "ForwardingCapability": "1",
  "TxRxFlag": "0",
  "ScheduleFlag": "0"
}
```

### 12.3.2 Class User Id: 002 Underwater AIS

Refer to the wiki page Underwater AIS Message Format for details about the fields associated with the Underwater AIS message. The example below shows how to construct a representative ClassID 002 ApplicationType 8 underwater AIS message for transmission by the Popoto Modem. Note this AIS message has 2 contacts. This JSON structure would be encoded on a single line, and passed to the transmitJSON api of the pshell, or other Popoto API (C++, Python, Matlab).

```
{
  "ClassUserID": 2,
  "ApplicationType": 8,
  "MobilityFlag": 1,
  "Schedule": 0,
  "TxRxFlag": 1,
  "ForwardingCapability": 0,
  "Contacts": [
    {
      "UserID": "0",
      "Type": "15 =n.a.",
      "Latitude": "-89.999001",
      "Longitude": "0",
      "Depth": "0.000000",
      "Speed": "0.000000",
      "Heading": "180",
      "NavigationalStatus": "15 = Undefined/default"
    },
    {
      "UserID": "1073741823",
      "Type": "9 = Bottom node",
      "Latitude": "-89.6485",
      "Longitude": "-0.351552",
      "Depth": "0.000000",
      "Speed": "0.000000",
      "Heading": "180",
      "NavigationalStatus": "0 = Under way, using engine"
    }
  ]
}
```

### 12.3.3 Class User Id: 016 NATO JANUS reference

Refer to NATO Janus Reference implementation for description of the application types and the fields in the NATO Janus Reference Class ID. This Class is used for underwater chat applications, or for transmission of other short messages. Application Type 0 does not have a CRC to ensure delivery, while ApplicationType 001 validates the message with a CRC16.
Application Type 0

```
{
  "ClassUserID":16,
  "ApplicationType":0,
  "StationID":"4",
  "MobilityFlag":"1",
  "ForwardingCapability":"1",
  "DestinationID":"0",
  "ParameterSetID":"0",
  "Payload_Size":"16",
  "Payload":{"Data":[49,50,51,52,53,54,55,56,57,48,49,50,51,52,
     53,54]}
}
```

Application Type 1

```
{
  "ClassUserID": 16,
  "ApplicationType": 1,
  "StationID": "4",
  "MobilityFlag": "1",
  "ForwardingCapability": "1",
  "TxRxFlag": "1",
  "AckRequest": "1",
  "DestinationID": "0",
  "ParameterSetID": "0",
  "Payload_Size": "16",
  "Payload": {"Data": [ 49,50,51,52,53,54,55,56,57,48,49,50,51,
     52,53,54]}
}
```

# 13 OEM Interface Description

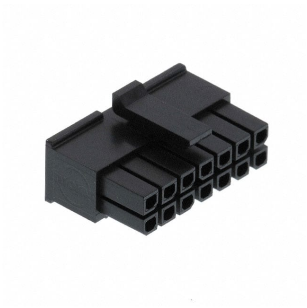
## 13.1 Popoto Digital Interface

### 13.1.1 Overview

The Popoto Digital Interface (PDI) is a single connector which provides access to the most commonly used interfaces in the Popoto Modem system. These include RS-232, RS-422, 10/100 Ethernet, board On/Off control, and Pulse Per Second (PPS) clock input signal.

### 13.1.2 PDI Hardware Components

The PDI is connected to using a Molex Micro-Fit connector (P/N 0430251400 or equivalent), which is sold as a shell plus discrete pins. While Molex produces many different pins for use with such connectors, the best pins for use with a Popoto Modem are Molex part number 0462355001. These pins are gold plated, rated for 250 mating cycles, and have a low insertion force. They are suitable for use with 20-24Ga wire. These pins can be crimped using a Molex hand crimp tool such as the 0638190000. Alternately, if the expense of the crimp tool is cost-prohibitive for small prototype or limited production runs, pre-crimped wires are available from suppliers such as Digikey.



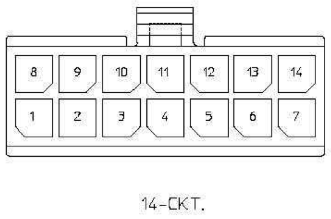


Figure 13.1: PDI User-Side Molex Connector. Interfacing to the PDI is accomplished with a Molex Microfit shell (P/N 0430251400) and either pre-pinned jumper wires, or Molex socket crimps.

### 13.1.3 Electrical Connections

Figure 13.2 shows the electrical connections for the the PDI.

- Pins labeled RS-422 are UART signals that comply with EIA-RS-422 interface standards. Default UART signaling parameters are 115200N81.
- Pins labeled with RS-232 are UART signals that comply with EIA-RS-232 electrical interface standards. UART signaling parameters for the RS-232 port default to 115200N81.
- Power_OFF_N allows the unit to be powered off by connecting this signal to ground.
- ENET Signals are 10 100 Ethernet signals. As the Popoto board has on-board magnetics, these signals are standard 10 100 BaseT Ethernet signals.
- PpsInput is a 3.3V logic level input signal that is used for PPS input for clock discipline.

Table 13.1: PDI Components and Part Numbers

| Part Number | Manufacturer | Description |
|---|---|---|
| 0430251400 | Molex | Microfit 14 position connector Receptacle 3.0MM |
| 0462355001 | Molex | Microfit 20-24Ga gold plated, lubricated sockets |
| 0638190000 | Molex | Microfit Hand Crimp tool |
| 0797580010 | Molex/Digikey | Precrimped Microfit leads |

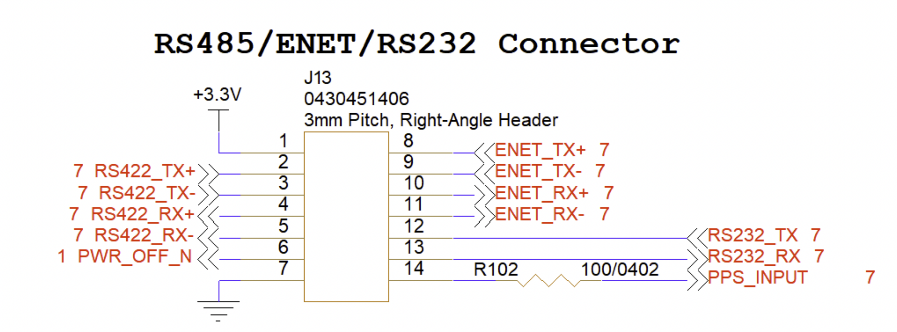


Figure 13.2: PDI Schematic connections.

Table 13.2: PDI Electrical Pinout

| Pin Number | I/O | Pin Name | Notes |
|---|---|---|---|
| 1 | O | 3.3V | 3.3V out when unit is powered up |
| 2 | O | RS 422 Tx + | Connect to Rx+ on Host |
| 3 | O | RS 422 Tx - | Connect to Rx- On Host |
| 4 | I | RS 422 Rx+ | Connect Tx+ on Host |
| 5 | I | RS 422 Rx- | Connect to Tx- on Host |
| 6 | I | PowerSwitch | Short to ground to power down unit |
| 7 | - | Gnd | Digital Ground |
| 8 | O | Ethernet Tx+ | T568A Green White<br>T568B Orange White |
| 9 | O | Ethernet Tx- | T568A Green<br>T568B Orange |
| 10 | I | Ethernet Rx+ | T568A Orange & White<br>T568B Green & White |
| 11 | I | Ethernet Rx- | T568A Orange<br>T568B Green |
| 12 | O | RS-232 TX | Connect RX on Host |
| 13 | I | RS-232 RX | Connect to Tx On Host |
| 14 | I | PPS Interrupt | PPS interrupt for optional time Sync<br>Max Voltage 5V |

### 13.1.4 Digital Interfaces

Popoto Modems have 3 additional digital interfaces beyond the PDI port. These interfaces are used to connect to external devices, or to provide alternate digital connection schemes for a host controller.

#### 13.1.4.1 TTL Uart

The TTL UART port is used for connecting Popoto to a local controller over a short distance. The TTL UART port is a 5 pin Molex picoblade connector. Figure 13.3 shows the schematic connections on the TTL-UART port. In order to enable the 3.3V uart port, pins one and 2 of J6 must be shorted together. Doing this disables the RS-232 level translator, and thereby disables the RS232 port on the PDI connector.

Table 13.3: Popoto TTL UART Parts

| Part Number | Manufacturer | Description |
|---|---|---|
| 0510210500 | Molex | Picoblade 5 position connector Receptacle |
| 0500798000 | Molex | Picoblade 26-28Ga sockets |
| 2002181900 | Molex | HAND TOOL FOR PICO-BLADE 26-32AW |
| 2149202214 | Molex | Precrimped Picoblade 150mm 26Ga |

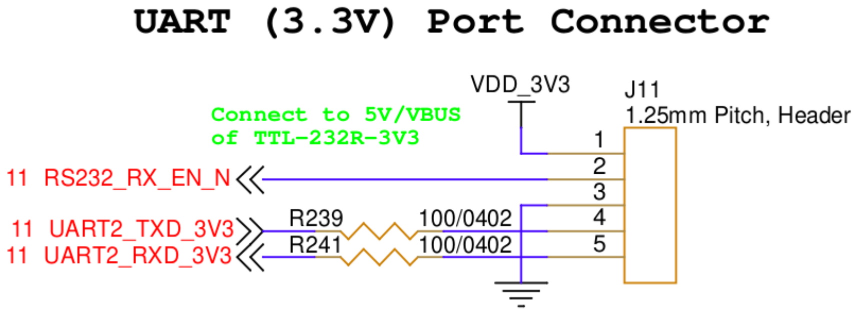


Figure 13.3: Popoto TTL UART Plug. This port allows 3.3V logic-level UART connections

Table 13.4: Popoto 3.3V Uart Port

| Pin Number | I/O | Pin Name | Notes |
|---|---|---|---|
| 1 | P | V+ | +3.3V |
| 2 | I | V+ | RS232_EN_N Tie this pin high (short to pin 1) to enable the 3.3V UART port |
| 3 | G | GND | Ground |
| 4 | O | UART0_TXD | Popoto UART Output |
| 5 | I | UART0_RXD | Popoto UART Input |

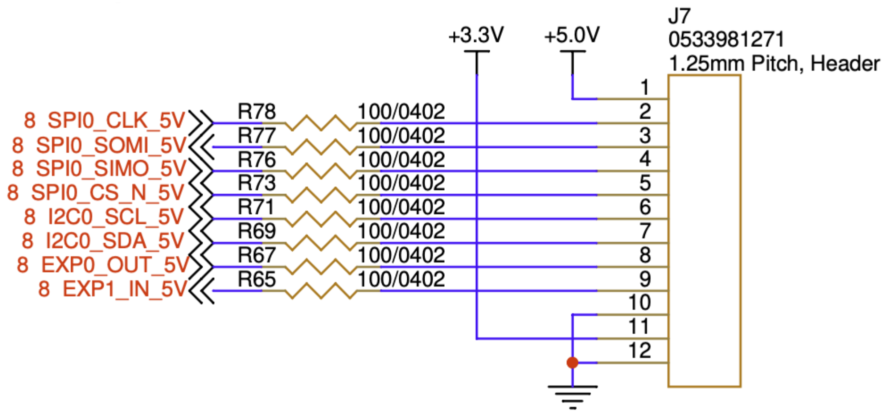


Figure 13.4: Popoto Expansion Header. This connector allows access to I2C, SPI and General purpose I/O from the Popoto Modem.

#### 13.1.4.2 Digital Expansion Header

Figure 13.4 shows the schematic for the Digital Expansion Header. This header enables peripheral access when applications execute directly on the Popoto Modem's System on a Chip (SOC). It features general-purpose input/output (GPIO) pins, along with SPI and I2C interfaces. Furthermore, signals from this connector are utilized for Push-to-Talk (PTT) and volume control within SSB mode. The connector is a 12-pin Picoblade type, and the necessary components are listed in Table 13.5

Table 13.5: Popoto Expansion Header Parts

| Part Number | Manufacturer | Description |
|---|---|---|
| 0510211200 | Molex | Picoblade 12 position connector Receptacle |
| 0500798000 | Molex | Picoblade 26-28Ga sockets |
| 2002181900 | Molex | HAND TOOL FOR PICO-BLADE 26-32AW |
| 2149202214 | Molex | Precrimped Picoblade 150mm 26Ga |

#### 13.1.4.3 0056 Analog Board GPIO Expansion Header

On the PMM6081 and PMM5544 boards shipped with the 068-0056-xx version analog boards, a GPIO header is provided for additional interface possibilities. The connector is found at J5 along the edge of the board and is a Molex 12 pin Picoblade connector. Refer to 13.6 for part numbers for this part, and refer to 13.5 for the schematic diagram. This pins are accessible from the Linux GPIO subsystem.

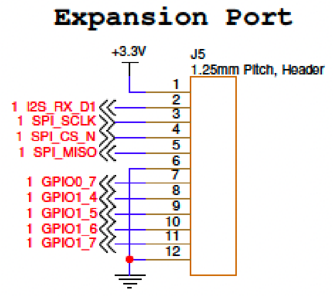


Figure 13.5: Popoto 0056 Board Expansion Header. This connector allows access to I2C, and General Purpose I/O (GPIO) from the Popoto Modem.

Table 13.6: 0056 Analog Board GPIO Expansion Header

| Part Number | Manufacturer | Description |
|---|---|---|
| 0510211200 | Molex | Picoblade 12 position connector Receptacle |
| 0500798000 | Molex | Picoblade 26-28Ga sockets |
| 2002181900 | Molex | HAND TOOL FOR PICO-BLADE 26-32AW |
| 2149202214 | Molex | Precrimped Picoblade 150mm 26Ga |

#### 13.1.4.4 MCU Expansion Header

The MCU Expansion header allows interface to the Popoto wake up processor. The Popoto wakeup processor is a mixed signal device. This device has Analog inputs, as well as digital I/O at 1.8V. This port is expecially useful for monitoring signals while the main processor is in Deep sleep mode. Use of this port requires special firmware support from Popoto Modem. If you require access to these signals for your application, please reach out to info@popotomodem.com.

#### 13.1.4.5 PDI Expanded Gigabit Ethernet

In addition to the standard Ethernet capabilities, the PMM5544 includes an extra connection for enhanced network performance. A separate 4-pin port (see Figure 13.6 and Figure 13.7 below) is located near the PDI connector on the device. This port, when used in conjunction with the 14-pin connector's four Ethernet pins, unlocks the full potential of Gigabit Ethernet speeds. This feature is particularly beneficial for applications that require high-speed data transfer, such as large file transfers, multichannel audio streaming, or rapid upgrades.

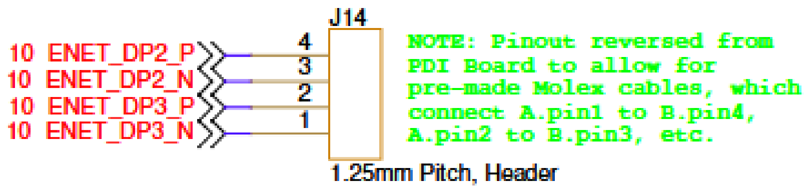

J14
10 ENET_DP2_P
10 ENET_DP2_N
10 ENET_DP3_P
10 ENET_DP3_N
4
3
2
1
NOTE: Pinout reversed from PDI Board to allow for pre-made Molex cables, which connect A.pin1 to B.pin4, A.pin2 to B.pin3, etc.
1.25mm Pitch, Header

Figure 13.6: Additional PDI Connection to enable Gigabit Ethernet.

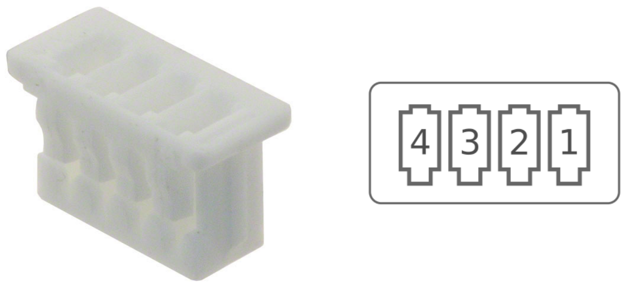


Figure 13.7: PDI Extended Gigabit User-Side Molex Connector. By Adding the 2 additional differential pairs, the Extended Gigabit connector enables gigabit ethernet to the PMM5544. The connector pictured here is P/N 0510210400 from Digikey

#### 13.1.4.6 Micro USB Port

The Micro USB port is a standard USB OTG port as configured by the Popoto Modem Linux Operating system. This port is extremely flexible, allowing both host and peripheral connections. If you have need for the Micro USB port, please contact Popoto Modem at info@popotomodem.com.

## 13.2 PMM5544 Specific Interfaces

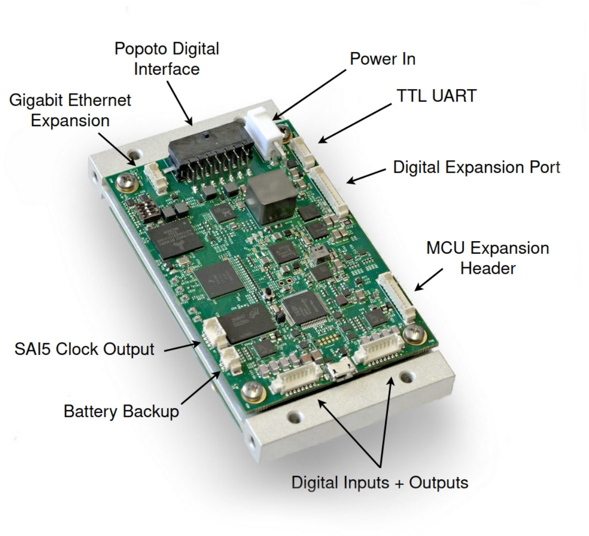


Figure 13.8: PMM5544 Digital Board Connector Locations

### 13.2.1 Power

Power is provided to the PMM5544 OEM Boardset via connector J12 on the Digital Board. This connector is a 2 pin Molex MiniFit Jr connector, and has provisions for V+ pin and Ground pin. Acceptable input voltages are between 8.5 and 36 Volts. Table 13.8 and Figure 13.9 show the connections required for powering the PMM5544. Table 13.7 shows the parts required for attaching to the power connector on the PMM5544. Two option are given: Using sockets and a crimp tool for larger production runs, or ordering precrimped wires from Digikey for smaller prototype/production runs.

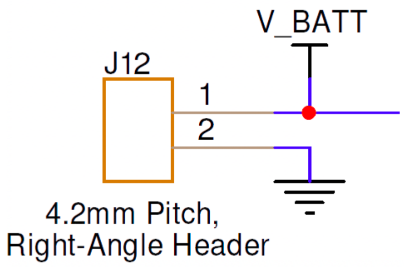


Figure 13.9: PMM5544 Power Schematic.

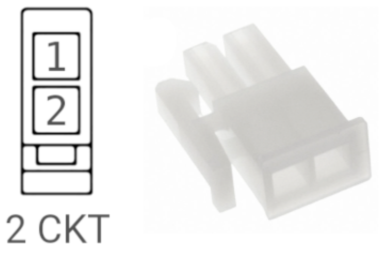


Figure 13.10: PMM5544 Power Connectors and pinout.

Table 13.7: PMM5544 Power Plug Components

| Part Number | Manufacturer | Description |
|---|---|---|
| 0039013022 | Molex | MiniFit Jr 2 position connector Receptacle |
| 0039000182 | Molex | MiniFit Jr 18-24Ga gold plated, sockets |
| 0638190901 | Molex | Minifit Hand Crimp tool |
| 0039000038-12-R9 | Molex/Digikey | Precrimped MiniFit 12in 18Ga Red |
| 0039000038-12-K9 | Molex/Digikey | Precrimped MiniFit 12in 18Ga Black |

Table 13.8: PMM5544 Power Connector Pinout

| Pin Number | I/O | Pin Name | Notes |
|---|---|---|---|
| 1 | P | V+ | 8.5-36 Volts 150 Watts |
| 2 | G | GND | Ground |

## 13.2.2 Analog Interfaces

### 13.2.2.1 Hydrophone Interfaces for PMM5544 Digital Board

The PMM5544 Digital Board features two 8-pin Picoblade connectors for four extra channels of analog signal input and four of analog signal output. These connectors are designated as J2 and J3, each providing two inputs and two outputs. The pinout of these connectors is shown on the schematic below:

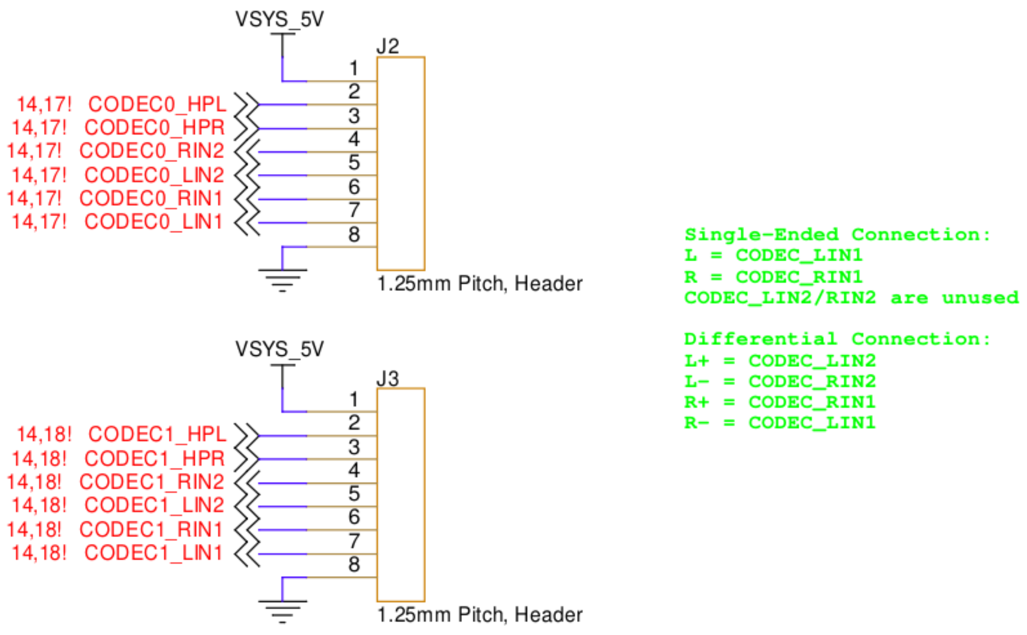


Figure 13.11: The additional inputs and outputs on the PMM5544

### 13.2.2.2 Extra Input/Output Connectors Part Number Table

| Component | Manufacturer Part Number |
|---|---|
| Crimps | Molex 0500588020 |
| Housing | Molex 0510210800 |

Table 13.9: Manufacturer Part Number for Picoblade Pins and Shells

## 13.2.3 Analog Board

The remaining analog interfaces to the PMM5544 can be found on the analog board. This board has the large round pot-core inductor, and can be seen in Figure 13.12

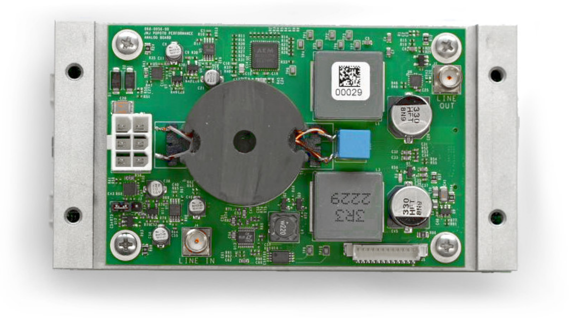


Figure 13.12: The PMM5544 Analog board

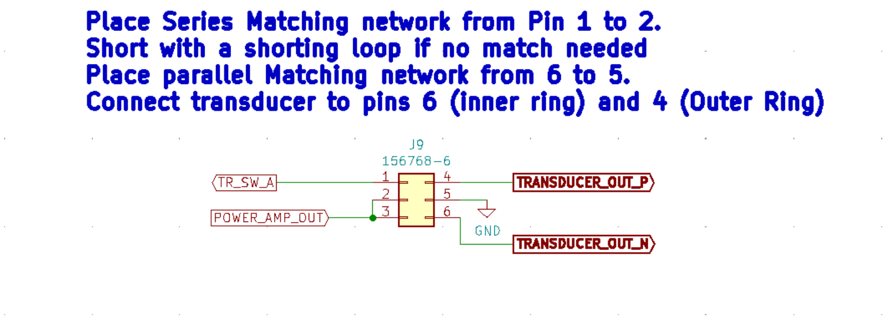

Place Series Matching network from Pin 1 to 2.
Short with a shorting loop if no match needed
Place parallel Matching network from 6 to 5.
Connect transducer to pins 6 (inner ring) and 4 (Outer Ring)
J9
156768-6
TR_SW_A
POWER_AMP_OUT
TRANSDUCER_OUT_P
TRANSDUCER_OUT_N
GND
1
2
3
4
5
6

Figure 13.13: The PMM5544 Transducer connector schematic.

### 13.2.3.1 Transducer

The Transducer is connected to the Popoto Modem by a 6 pin Molex MiniFit Jr connection, labelled J9. This connector provides access to the TPA output and provides positions for series and parallel matching networks. In its default configuration with the Popoto 25-30Khz transducer, no additional matching networks are required. See Figures 13.13 and 13.14 for the pinout for this connector.

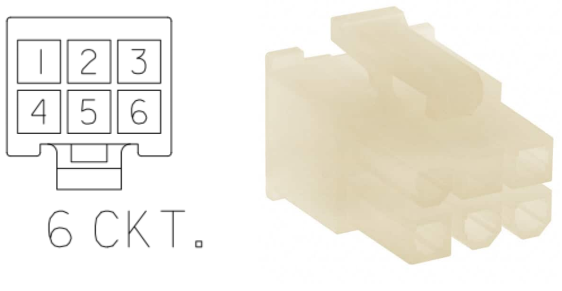


Figure 13.14: PMM5544 Transducer connector and pinout.

Table 13.10: PMM5544 Transducer Connector Pinout

| Pin Number | I/O | Pin Name | Notes |
|---|---|---|---|
| 1 | I | TR_SW_A | Input to the TR Switch. Connect to Pin 2 with series matching network |
| 2 | O | POWER_AMP_OUT | Connect to Pin 1 with series Matching network |
| 3 | O | POWER_AMP_OUT | Same signal as Pin 2 |
| 4 | O | TRANSDUCER_OUT_P | Positive transducer connection. Connect to Pin 5 with parallel matching network if needed |
| 5 | G | GND | Ground |
| 6 | O | TRANSDUCER_OUT_N | Negative transducer connection. |

Table 13.11: PMM5544 Transducer Plug Parts

| Part Number | Manufacturer | Description |
|---|---|---|
| 0039012060 | Molex | MiniFit Jr 6 position connector Receptacle |
| 0039000182 | Molex | MiniFit Jr 18-24Ga gold plated, sockets |
| 0638190901 | Molex | Minifit Hand Crimp tool |
| 0039000038-12-R9 | Molex/Digikey | Precrimped MiniFit 12in 18Ga Red |
| 0039000038-12-K9 | Molex/Digikey | Precrimped MiniFit 12in 18Ga Black |

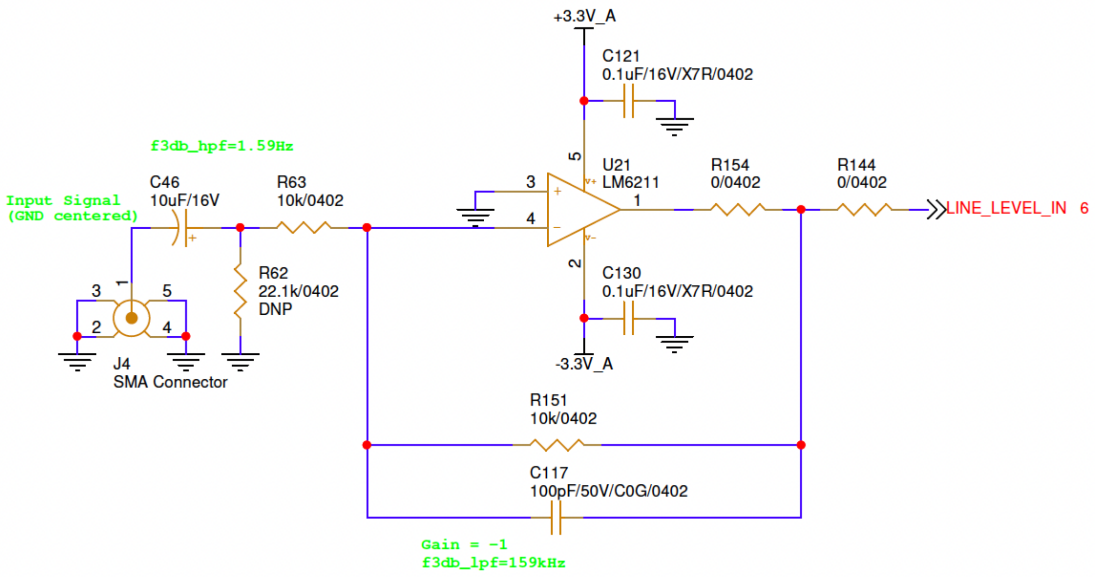


Figure 13.15: PMM5544 Analog input schematic excerpt. This circuit conditions the input signal and is used for SSB voice input or for applications providing line level analog input.

### 13.2.3.2 Analog In

The PMM5544 Analog board has provisions for analog input via an SMA connector mounted on the analog board. This connector is used for SSB voice input, as well as for applications that have line level outputs of transducer signals. The Analog input port drives an adjustable gain amplifier to allow for level matching between different equipment. An excerpt of the schematic, showing the input amplifier topology is shown in Figure 13.15. Note that for the analog input to operate, the J5 and J1 jumpers must be installed and J2 should be installed in the 2-3 position to connect the input to SMA. The input impedance of the SMA connection is 22.1 K. The input gain is adjustable by R13 yield a gain spanning from 1/2 to 25. The A/D input spans +/- 2.5 volts.

### 13.2.3.3 Analog Out

The PMM5544 Analog board has provisions for analog output via an SMA connector mounted on the analog board. This connector is used for SSB voice output, as well as for applications that utilize offboard power amplifiers. The Analog output port drives a fixed gain amplifier to provide buffering and level setting of the output. An excerpt of the schematic, showing the input amplifier topology is shown in Figure 13.16. The full scale output voltage on the SMA

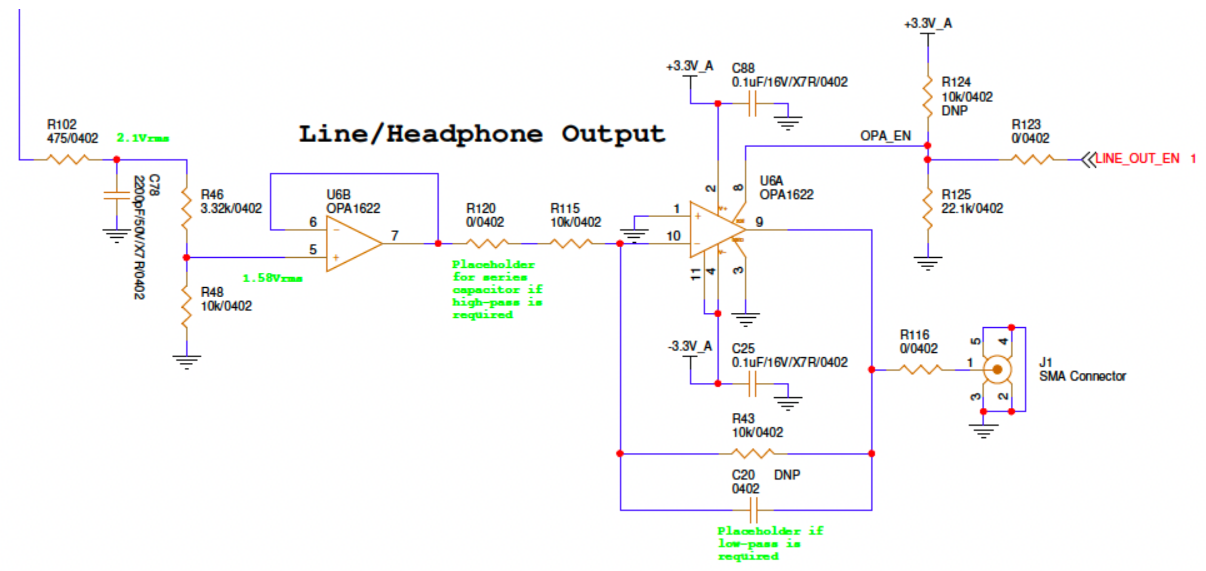


Figure 13.16: PMM5544 Analog output schematic excerpt. This circuit provides a +/- 3.3V signal to the SMA output port. This signal is used for the headphones output during SMA voice mode, or for a diagnostic port or to drive an external power amplifier if needed.

is +/- 3.3 Vpp. The maximum output current is 145mA and is ground centered. The 3dB cut off point of the output low-pass filter is 152KHz.

# 14 Battery Multiplexer

## 14.1 Battery Multiplexer

### 14.1.1 Overview

The Popoto Battery Multiplexer is a hardware component that allows use of multiple Lithium Ion battery packs in parallel. The Battery Multiplexer draws power from the most fully charged battery, and will draw that battery down until it is below the charge level of another battery, at which point it will seamlessly switch over to that one. Similarly, it allows bank charging of the batteries, charging the most drained battery first, and then switching to the others as they charge. Charging is accomplished with the standard Popoto Lithium Ion Charger. For wired installations, this will require an adapter cable from

### 14.1.2 Power Connectors

Table 14.1: Battery Multiplexer Power In and Out Plug Components

| Part Number | Manufacturer | Description |
|---|---|---|
| 0039013042 | Molex | MiniFit Jr 4 position connector Receptacle |
| 0039000182 | Molex | MiniFit Jr 18-24Ga gold plated, sockets |
| 0638190901 | Molex | Minifit Hand Crimp tool |
| 0039000038-12-R9 | Molex/Digikey | Precrimped MiniFit 12in 18Ga Red |
| 0039000038-12-K9 | Molex/Digikey | Precrimped MiniFit 12in 18Ga Black |

Table 14.2: Battery Mux Power Connector Pinout

| Pin Number | I/O | Pin Name | Notes |
|---|---|---|---|
| 1 | P | V+ | 12-29 Volts 150 Watts |
| 2 | P | V+ | 12-29 Volts 150 Watts |
| 3 | G | GND | Ground |
| 4 | G | GND | Ground |

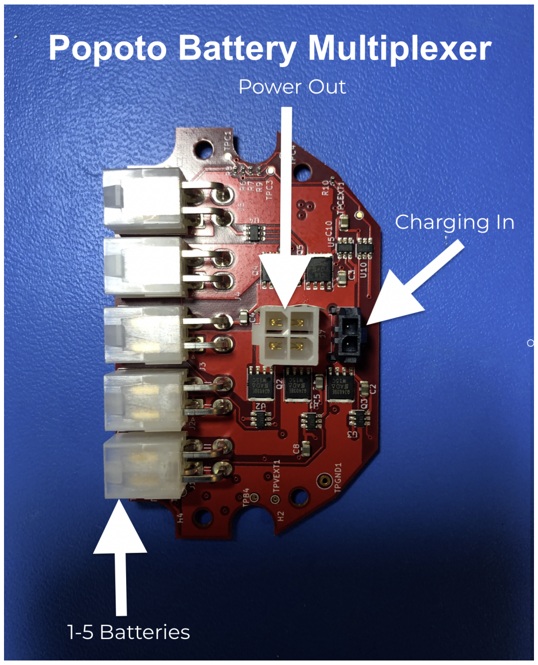


Figure 14.1: Popoto Battery Mux Board. Power is provided by 1-5 6S Lithium Ion Batteries provided on the Molex MiniFit Jr 4 pin connectors on the left. Power is drawn from the Minifit Jr 4 port connector on the top, and charging is accomplished by connecting the charger to the 2 port microfit connector on the right side of the diagram.

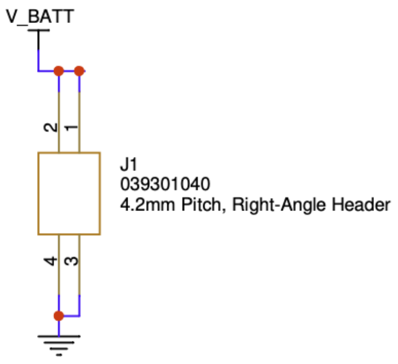


Figure 14.2: Battery Mux: Battery in Power out Schematic.

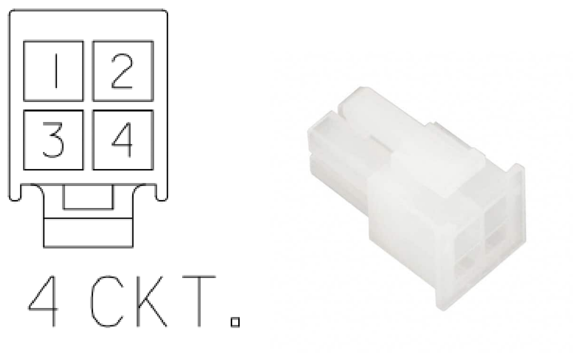


Figure 14.3: PMM5021 Power Connectors and pinout.

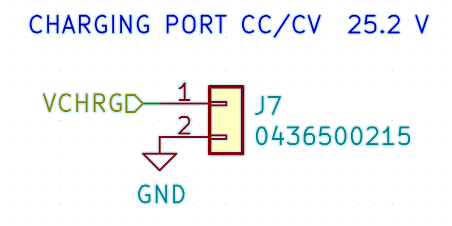


Figure 14.4: Battery Mux: Charging Port Schematic. Use a constant current/-constant voltage lithium ion charger for 6S Battery Packs. (1.875A)

### 14.1.3 Charging Connectors

The charging connector, J7, on the Battery Multiplexer (see Figure 14.4) will charge all battery packs in parallel using the standard Popoto CC/CV charger.

Table 14.3: Battery Mux Charging Port Part Numbers

| Part Number | Manufacturer | Description |
|---|---|---|
| 0436500214 | Molex | Microfit 2 position connector Receptacle 3.0MM |
| 0462355001 | Molex | Microfit 20-24Ga gold plated, lubricated sockets |
| 0638190000 | Molex | Microfit Hand Crimp tool |
| 0797580010 | Molex/Digikey | Precrimped Microfit leads |

# 15 Popoto Interface Board

## 15.1 Popoto Interface Board

### 15.1.1 Overview

The Popoto interface board provides a simple way to connect a host computer to the Popoto Modems. The Popoto Interface board connects to the modem via the PDI, and the PC connects to the Popoto Interface Board via USB and ethernet.

### 15.1.2 PDI Connector J10

The PDI connector connects pin for pin to the PDI connector on the Popoto Modem. Pin 1 of J10 connects to pin 1 of the PDI, pin (J10) 2 to PDI pin 2, ...

### 15.1.3 USB Port (J2)

The Popoto Interface board connects via USB to the host computer. The USB Port enumerates as 2 serial ports. These ports will typically show up in Windows as COMn and COMn+1, and in Linux as TTYUSBn and TTYUSBn+1. Both serial ports are enabled on all M2000/M6000 devices. S1000 devices are ordered with either ethernet, RS-232 or RS-422. On these devices, only the enabled interface will be available.

Table 15.1: USB Ports

| Port Number | Serial Protocol | Default terminal |
|---|---|---|
| PORT n+0 | RS-422 | Pshell |
| PORT n+1 | RS-232 | Linux Terminal |

### 15.1.4 Ethernet Port (J1)

The Ethernet port (J1) provides a standard RJ-45 ethernet connection to the Popoto Modem. This port is active on all M2000 devices, and on S1000 devices that are configured for ethernet.

### 15.1.5 Switch SW1 and Jumper J9

SW1 provides an illuminated power on/off switch. To enable this switch jumper J9 must be installed. Note that the illumination of the switch will be delayed by 3-5 seconds after turn-on of the Popoto board.

### 15.1.6 PWRDN LED (J8)

The PWRDN LED connector is a 4 pin Molex microfit connector that allows the user to supply a remote illuminated switch. In order to use the remote switch, Jumper J9 must be removed.

Table 15.2: PWRDN LED Connector Pinout

| Pin | I/O | Signal |
|---|---|---|
| 1 | P | MODEM 3.3V output voltage |
| 2 | I | PWDN N Signal: Connect to GND to power down |
| 3 | O | LED voltage. |
| 4 | P | GND |

### 15.1.7 SSB Connections

The following connectors are used for Single Side Band Voice with the Popoto PMM5021 based devices. In order to use SSB voice, Connections J3, J4, J5, J6, and J7 are needed for SSB voice input and control.

Table 15.3: SMA Ports J6 and J7

| Port Number | I/O | Signal | PMM5021 connection |
|---|---|---|---|
| J6 | I | SSB Headphone | PMM5021 Analog Port J4 |
| J7 | O | SSB Microphone | PMM5021 Analog Port J3 |

Table 15.4: SSB Control Port J3

| Pin | I/O | Signal | Operation |
|---|---|---|---|
| 1 | I | VOL+ | Momentarily Ground to increment Volume |
| 2 | - | GND | |
| 3 | I | VOL- | Momentarily Ground to decrement Volume |
| 4 | I | PTT0 | Momentarily Ground at the same time as PTT1 for Push to talk |
| 5 | - | GND | |
| 6 | I | PTT1 | Momentarily Ground at the same time as PTT0 for Push to talk |

Table 15.5: Headphone/Microphone Connector J5

| Pin | I/O | Signal |
|---|---|---|
| 1 | O | Left Headphones |
| 2 | O | Right Headphone |
| 3 | I | Microphone |
| 4 | P | GND |

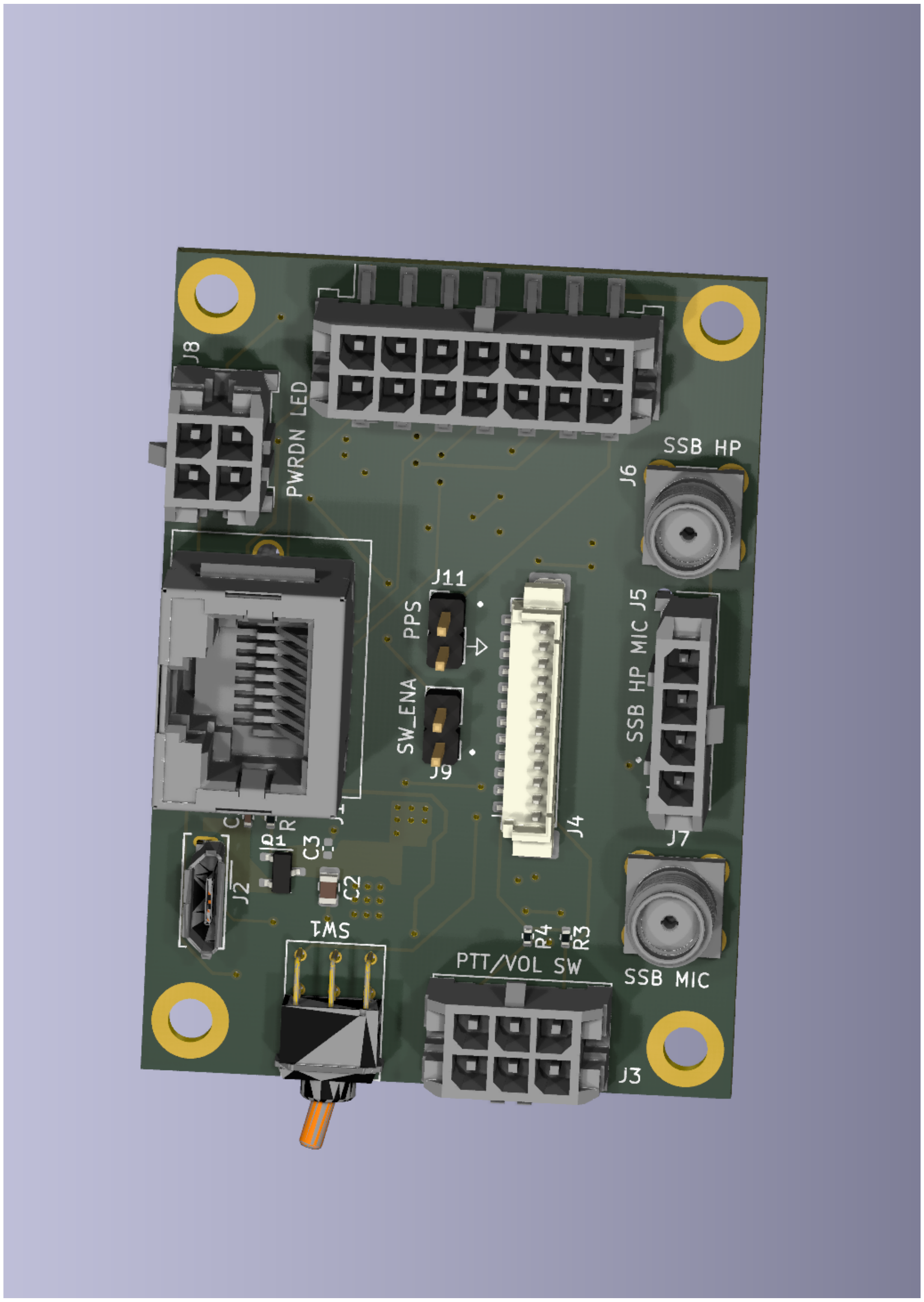


Figure 15.1: Popoto Interface Board

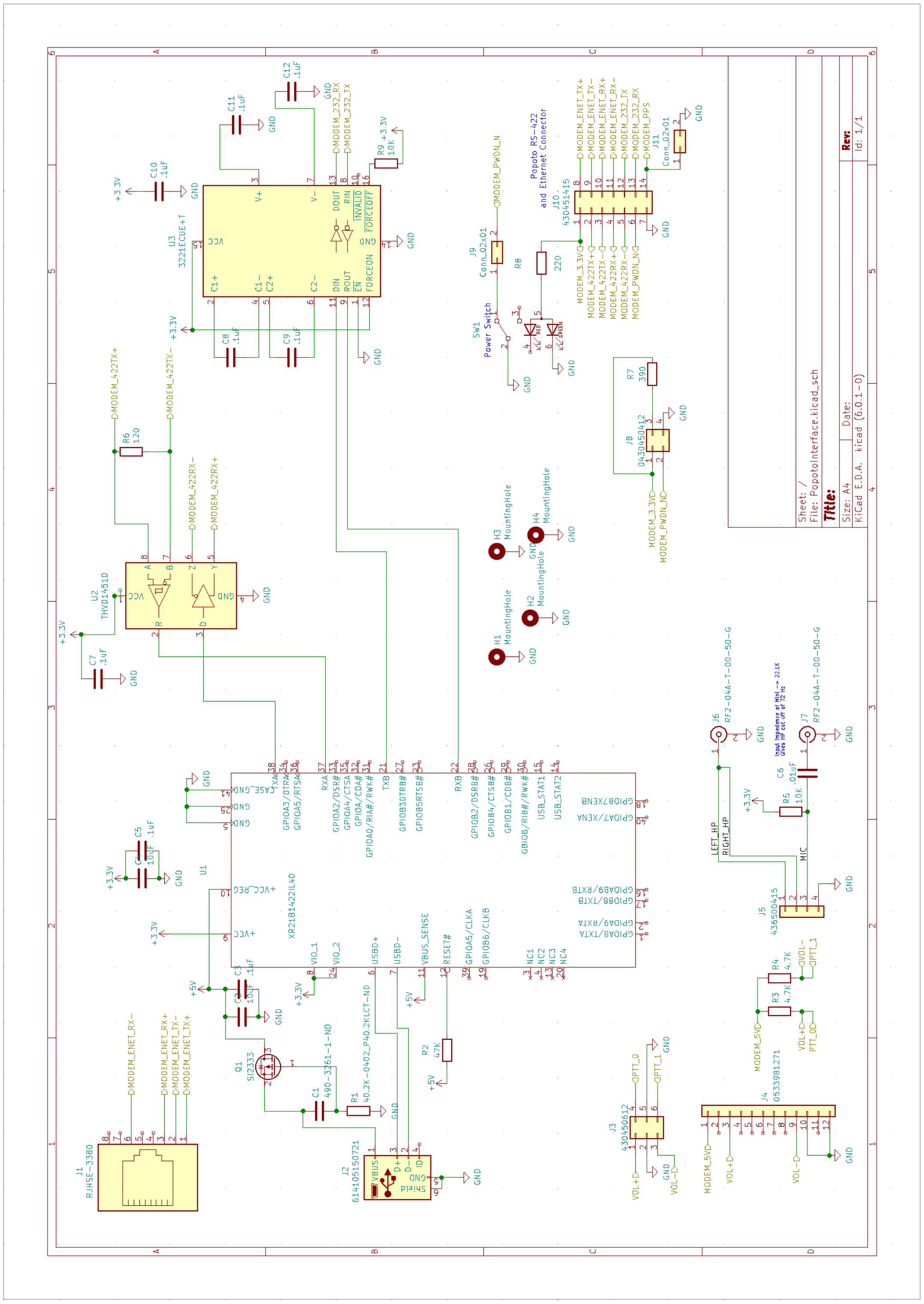


Figure 15.2: Popoto Interface Board Schematic

# 16 Upgrading the Firmware

## 16.1 Introduction

Firmware updates are accomplished through the ethernet port. As an overview the process involves three steps:

1. SCP an update tar file
2. Extract the tar file
3. Run the update shell script

### 16.1.1 Details on how to update the firmware

Requirements:

- Laptop or Desktop Computer
- Network Connection
- Pshell connection (Rs 422)
- Secure Shell/Copy utility
- Update_<version_num>.tar

## 16.2 Upload Procedure

**Note:** By default the Popoto boardset is shipped without a root password. the examples below all remote operations happen without password entry. If you have added a root password to your system, please enter the password when prompted by the SSH and SCP utilities in the steps below.

### Step 1

Connect Popoto to ethernet connection.

## Step 2

Determine or Set the Popoto IP Address From the pshell issue getIP

```
Popoto-> getIP
IPv4 Address: eth0 Link encap:Ethernet HWaddr 2E:A4:4D:D2:40:82
inet addr:10.0.0.232 Bcast:10.255.255.255 Mask:255.0.0.0
inet6 addr: 2603:3005:82a:8000:2ca4:4dff:fed2:4082\%71/64 Scope:Global
inet6 addr: fe80::2ca4:4dff:fed2:4082\%71/64 Scope:Link UP ...
RX packets:639 errors:0 dropped:0 overruns:0 frame:0 TX packets:15...
RX bytes:57888 (56.5 KiB) TX bytes:26702 (26.0 KiB) Interrupt:33
```

In this example the IP address is 10.0.0.232.
To change the IP address of the Popoto, issue the `setIP` command from pshell.

## Step 3

Confirm connection to the Popoto's network connection using the ping command from your local computer's command window.

```
ping 10.0.0.232
PING 10.0.0.232 (10.0.0.232): 56 data bytes
64 bytes from 10.0.0.232: icmp\_seq=0 ttl=64 time=0.853 ms 64 bytes from...
```

## Step 4

Using a secure copy utility, such as OpenSSH's scp, located on your local computer, copy the update file to the Popoto's root directory

```
scp Update_2.7.0.tar root@10.0.0.232:/
```

## Step 5

Shell into the Popoto, using an ssh utility

```
ssh root@10.0.0.232
```

You should receive a prompt like:

```
root@popoto:~#
```

## Step 6

From the `root@popoto:` prompt, change directories to the root directory, and untar the update file previously uploaded.

```
root@popoto:~# cd /
root@popoto:/# tar xvf Update\_2.6.0.tar
```

This will create (or overwrite) the following 2 files

- Update.sh
- Update.tgz

### Step 7

Execute the Update shell command to install the newest version.

```
root@popoto:/# ./Update.sh
```

This will generate the output similar to.

```
Update.sh
Version.txt
boot/
boot/dolphin.dtb
home/
home/root/
home/root/popoto.py
home/root/pshell
home/root/popoto\_app
lib/
lib/firmware/
lib/firmware/platform.out
pshell.init
version.txt
Connection to 10.0.0.232 closed by remote host. Connection to 10.0.0.232 closed.
```

At this point the Popoto unit will reboot, and come up with the new firmware version installed.

In the pshell window (RS-422) you should end up at a prompt that says

```
             Welcome to the Popoto modem Shell! Communicating Naturally
Popoto-> {"Info ":"Popoto Modem Version <New Version Number and informational tag> "}
```

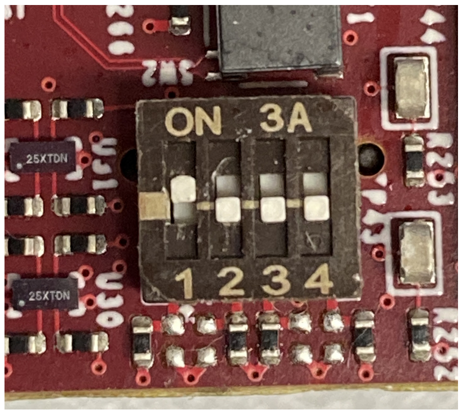


Figure 16.1: PMM6081 Switch Position used for running program command

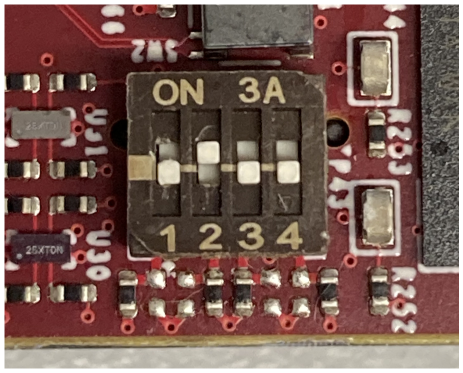


Figure 16.2: PMM6081 Switch Position used for running program command

## 16.3 Updating Image using UUU

#### 16.3.0.1 Instructions for for Ubuntu 22.04

To reprogram the EMMC flash on a PMM6081 board follow the procedure below:

First set the dip switches as shown in 16.2 and run the following command:

```
sudo uuu -v -b emmc_all ./imx-boot ./pmm6081-image-pmm6081.wic
```

To program a board on a specific USB port, use the -m argument, followed by the USB port:

```
sudo uuu -m 1:1 -v -b emmc_all ./imx-boot ./pmm6081-image-pmm6081.wic
```

When done, reset the dip switches to the :

NOTE: This will be slow!  30 min, follow instructions below to get a faster update utility

#### 16.3.0.2 Fast UUU Upload

This section covers the procedure and tools required to program a compressed archive. These archives are distributed as a wic.bz2 file along with.a bmap. Many distributions do not include a pre-built uuu, part of the mfgtools package, capable of flashing a bz2 file. So we will need to build one from source.

#### 16.3.0.3 Setup

We will obtain the proper version mfgtools source from the following website and commit hash

```
https://github.com/nxp-imx/mfgtools commit hash: `dc3ca54`
```

Using the following procedure obtain the source code from the repository.

```
 mkdir ~/fast_uuu
 cd ~/fast_uuu
 git clone https://github.com/nxp-imx/mfgtools.git
 cd mfgtools
```

Install all required dependencies for the mfgtools build.

```
 sudo apt-get install libusb-1.0-0-dev libbz2-dev libzstd-dev pkg-config cmake libssl-
dev g++ zlib1g-dev libtinyxml2-dev
```

Once this completes, we will execute the build commands

```
 cmake . && make
```

After the build is complete, copy the executable from the uuu subdirectory to your user software folders:

```
 cd ~/fast_uuu/mfgtools/uuu/
 sudo cp uuu /usr/bin/uuu
 sudo cp uuu /usr/local/bin/uuu
```

This enables using the uuu command from any directory.

### 16.3.1 Updating with fast uuu

To update using the new fast uuu, use the following command:

```
sudo uuu -bmap -v -b emmc_all /path/to/imx-boot path/to/pmm6081-image-pmm6081.wic.bz2
```

NOTE: In order for fast flashing to work, you must use the .wic.bz2 file.

# 17 Network Settings

## 17.1 Adjusting Network Settings on Popoto Debian

The network on the Popoto Modem operating system is configured to use a static IP address and a MAC address that is randomly generated when the system boots. To change the IP address, you can use the pshell's setIP command (see in Pshell Command Reference below).

In the Debian OS, the file /etc/init.d/staticip is used to set the static IP address of the modem. The file should look like this on the inside:

```
#!/bin/sh
NAME=staticip
DESC="Configure Eth0 Static"

case "$1" in
  start)
        echo -n "$DESC: "
        /sbin/sysctl -w net.ipv4.igmp_max_memberships=10
        /sbin/ifconfig eth0 10.0.0.237
        /sbin/ifconfig eth0 up &
        /bin/mount -a
        ;;
  stop)
        echo -n "Stopping $DESC: "
        /sbin/ifdown eth0
        ;;
  restart|force-reload)
        ;;
esac

exit 0
```

To set a static MAC address, you should modify this file such that the MAC address is specified immediately after the IP address:

```
#!/bin/sh
NAME=staticip
```

```
DESC="Configure Eth0 Static"

case "$1" in
  start)
        echo -n "$DESC: "
        /sbin/sysctl -w net.ipv4.igmp_max_memberships=10
        /sbin/ifconfig eth0 10.0.0.237
        /sbin/ifconfig eth0 hw ether 02:XX:XX:XX:XX:XX
        /sbin/ifconfig eth0 up &
        /bin/mount -a
        ;;
  stop)
        echo -n "Stopping $DESC: "
        /sbin/ifdown eth0
        ;;
  restart|force-reload)
        ;;
esac

exit 0
```

The MAC address should begin with 02: or 06: and contain randomly-generated bytes (in hexadecimal format, from 00 to FF) in place of the XX's above.

# 18 Diagnostics

The FOAM architecture has built in logging support to enable diagnostics and debug of any in field problems. The logging consists of a rolling file based log file, along with options for saving the passband PCM data. The log file is useful for determining message flow and state transitions, and the PCM passband logging is useful for diagnosing signal processing and signal quality issues.

## 18.1 Popoto log

### 18.1.1 Introduction

The Popoto.log is a diagnostic logfile which is updated as the Popoto_app runs, keeping track of message and logic flows within the system. This logfile has the following properties.

- The Log file is Leveled: All logs are assigned a severity level in the code, and by changing the output filter, only logs greater than a set severity level are displayed.
- The log file is Timestamped: Each log message is tagged with a millisecond accurate realtime clock stamp, as well as a PCM Count timestamp. The Realtime clock is useful for comparing transmit to receive times between units, and the PCM clock gives an indication of when a message is displayed with respect to reception or transmission of acoustic messages.
- The Logfile is Rolling: Each time the Popoto app is started, the previous log file is added to a list of 10 preceeding log files. So that in the Popoto_app directory we have Popoto.log, Popoto.log.1, Popoto.log.2 through Popoto.log.10 where Popoto.log is the current logfile, and Popoto.log.1 is the most recent log file preceding this logfile.

### 18.1.2 Location

On the target hardware the Popoto.log file is found in the /home/root directory. On the PC-Based Linux simulation, the Popoto.log is found in the /tmp directory. In order to allow more than one Popoto image to run on . a pc, the base-port number is appended to the Popoto.log filename. /tmp/Popoto.log.17000 Corresponds to a Popoto image run at a base port of 17000

Or /tmp/Popoto.log.18000 Corresponds to a Popoto image run at a base port of 18000. For example:

### 18.1.3 Logging Levels

Each log message is assigned a logging level from 0 to 7. Lower log levels are more severe, and higher log levels are increasing details. follows:

0. logERROR
1. logWARNING
2. logINFO
3. logDEBUG
4. logDEBUG1
5. logDEBUG2
6. logDEBUG3
7. logDEBUG4

The log levels are defined as By default all log messages with a logging level of logINFO or lower are written to the log. To increase or decrease the log level issue the `SetValue LoggingLevel int <Level> 0` command Or from the pshell:
`setvaluei LoggingLevel <level>`
To get the current logging level, issue the GetValue LoggingLevel int 0 command, Or from the pshell:
`getvaluei LoggingLevel`

### 18.1.4 MSM Logs

The Modem State Machine has a built in logging mechanism that can be connected to the Popoto.log file. This allows the user to see events, and state transitions as the modem state machine operates. To enable the MSM logs, send the command EnableMSMLogs. Or, from the pshell: `enablemsmlogs`
To disable logs, send the DisableMSMLogs command. Or from the pshell:
`disablemsmlogs`

## 18.2 PCM Logging

### 18.2.1 Introduction

The Popoto system incorporates a means for logging the inbound PCM signals as seen on the A/D. This logging mechanism is useful for diagnosing system problems. Since the

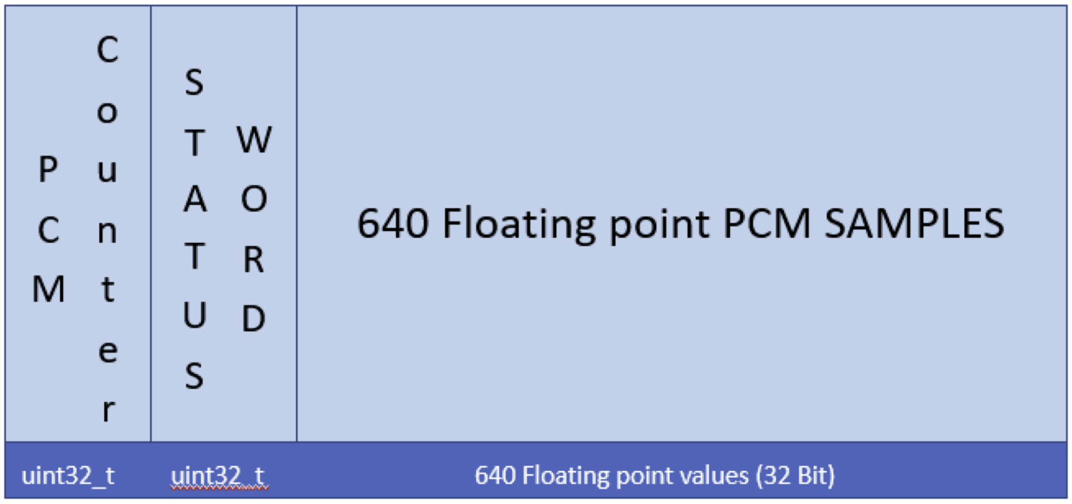

PCM Counter
STATUS WORD
640 Floating point PCM SAMPLES
uint32_t
uint32_t
640 Floating point values (32 Bit)

Figure 18.1: Format of a single PCM Log Packet. These packets are transmitted on the TCP PCM Recording socket.

PCM signals that are logged are exactly what is presented to the Demodulator, it possible to "re-run" a test condition, to determine the signal parameters or noise environment. Two methods of logging are provided to the user:

1. TCP Socket Based Logging
2. Target File Logging

Each of these methods produces a data stream of packets that are formatted as follows:

Table 18.1: PCM Packet Format

| Count | Data type | Description |
|---|---|---|
| 1 | 32 Bit unsigned int | PCM Counter. Gives the current PCM counter. Should increase by 640 each frame. A skip in this count indicates lost data |
| 1 | 32 Bit unsigned int | Status Word. Currently 0 indicates High Gain Channel, and 1 indicates low gain channel |
| 640 | 32 Bit Floating point | PCM Samples. All normalized to High Gain Receive Level. |

### 18.2.2 Socket based PCMLogs

The Popoto system opens a TCP Server at baseport+2 (17002 default) which continually streams PCM Packets as described above. Both the Popoto.py

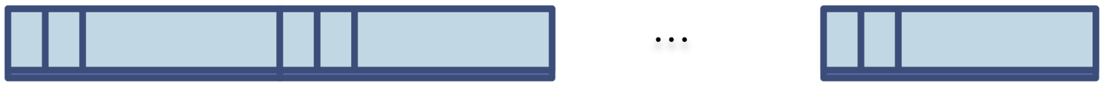


Figure 18.2: The PCM Packets are sent one after the other to the TCP Socket or to the Target log file

and Popoto.m interface classes have functions to read that socket and log the data to the local pc.
From the pshell

```
recordstart <Filename> local
```

will start the recording in the current working directory. To stop the recording: From the pshell:

```
recordstop
```

### 18.2.3 Target File based PCM Logs

The Popoto system provides a command to store the received pcm locally. Using the

```
RecordFileStart <FileName>
```

command, the user can start logging data to the local SD card.
If the filename is specified without a path, it will be recorded in `/home/root`. paths should be complete paths. Wild cards are not parsed.
From the pshell:

```
recordstart WaterTestCapeCodCanal2_20.pcm
```

will begin a recording on the Popoto unit in the `/home/root` directory
To stop the recording, a RecordFileStop command can be sent on the command socket. Or, from the pshell:

```
 recordstop
```

A Matlab utility: `rPCMData()` is provided in the `test/MATLAB GUI` directory. This utility can read a file logged by the pshell or by the Target recording, and returns 3 arrays, the PCM data, the PCM Counter(sequence number) and the status word.

### 18.2.4 Notes

It is important to realize that PCM recording generates data very quickly. Each packet is

$$642 \times 4$$

Bytes long, and 160 packets are generated per second. This results in a file that grows at 410,810 bytes per second, or roughly 1.5 G Bytes per hour.

## 18.3 pshell Logging

The pshell provides a log of all commands and status responses for a pshell session. This is useful for capturing the results of tests, or to evaluate the responses and commands that were run. pshell logs are size-limited, and rotate. These logs can be found in the directory that the pshell was run in.

# 19 Pshell Command Reference

## pshell Command: Rx

Description:

Rx Receive packets and format the output for test purposes. Continues to run until a key is hit.

Invocation

```
Rx [Verbose Flag]
Verbose Flag = 1 Output SNR and Doppler info
```

Examples

```
Rx
Enter test receive in quiet mode
Rx 1
Enter test receive in verbose mode.
```

## pshell Command: chat

Description:

This command puts Popoto into a character chat mode, In chat mode, the user can type characters, and they will be transmitted when one of 2 conditions occur. 1) the user stops typing for a period of time greater than ConsoleTimeoutMS, or 2) a string of characters greater in length than ConsolePacketBytes is typed. ConsoleTimeoutMS and ConsolePacketBytes are Settable Variable parameters.

Invocation

```
chat
```

Examples

```
chat
ctrl-] to exit
```

## pshell Command: configure

Description:

This api configures the modem for different modulation schemes. It is used to allow switching between major operating modes such as Janus and default Popoto modes. Invocation of this command issues a reboot, after which the modem is in the new mode of operation.

Invocation

```
configure <MODE>
```

Examples

```
configure Janus
to setup Janus mode
configure Popoto
to setup Popoto Mode
```

## pshell Command: connect

Description:

The connect command is used to connect the pshell with the command socket. This is typically the first command executed in the session of a pshell. A successful connection responds with the list of available parameters.

Invocation

```
connect <ipaddress> <port>
```

Examples

```
connect localhost 17000
connect 10.0.0.232 17000
```

## pshell Command: datamode

Description:

This command ends voice mode, and returns the device to data mode,

Invocation

```
datamode
```

Examples

```
datamode
```

## pshell Command: deepsleep

Description:

Place Popoto into Deep Sleep mode to be awakened by a wake up tone on the acoustic interface. Once in deep sleep, any 25Khz acquisiton pattern will wake the popoto modem. This can most easily be generated by sending a ping command from the remote modem. Deepsleep is a low power mode that consumes  150mW. Awakening from Deepsleep takes approximately 1 second after the acquisition.

Invocation

```
deepsleep
```

Examples

```
deepsleep
```

## pshell Command: disablemsmlog

Description:

This api disables logging of modem statemachine transitions.

Invocation

```
disablemsmlog
```

Examples

```
disablemsmlog
```

## pshell Command: disconnect

Description:

Disconnect the pshell from the popoto modem application. This command is sent if the user wishes to connect an application via ethernet.

Invocation

```
disconnect
```

Examples

```
disconnect
```

## pshell Command: download

Description:

downloads a file in streaming mode. The remote unit must issue an upload. if the start remote start power level is set to other than 0, the local modem will send an upload command to the remote modem using the specified power level., and then begin the download process. Otherwise it will sit and wait for the remote modem to start on its own.

Invocation

```
download <filename> [Remote Start Power Level]
```

Examples

```
download MyDownload.txt
download MyDownload.txt 10
```

## pshell Command: enablemsmlog

Description:

This api enable logging of modem statemachine transitions. These transition sare logged in the popoto.log file on the modem, and are noted with the ENTER STATE text

Invocation

```
enablemsmlog
```

Examples

```
enablemsmlog
```

## pshell Command: exit

Description:

Exits Popoto Modem pshell. Note: On hardware pshell, quit and exit are disabled

Invocation

```
exit
```

Examples

```
exit
```

## pshell Command: getEXP1

Description:

The EXP1 Pin is a GPIO Input pin available on the Popoto expansion header. This API allows the user to get the value of that pin.

Invocation

```
getEXP1
```

Examples

```
getEXP0
```

## pshell Command: getIP

Description:

Display the currently configured IP address and status of the Popoto modem

Invocation

```
getIP
```

Examples

```
getIP

IPv4 Address: eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 10.0.0.65 netmask 255.255.255.0 broadcast 10.0.0.255
ether 00:0c:29:36:4f:2f txqueuelen 1000 (Ethernet)
RX packets 3178079 bytes 843820500 (843.8 MB)
RX errors 0 dropped 508 overruns 0 frame 0
TX packets 2392420 bytes 2432926671 (2.4 GB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

## pshell Command: getPEP

Description:

Returns the peak envelope power of the transmitted waveform. PEP is a metric used to quantify the voice transmit power.

Invocation

```
getPEP
```

Examples

```
getPEP
```

## pshell Command: getclock

Description:

Get the Realtime clock in the format YYYY.MM.DD-HH:MM;SS

Invocation

```
getclock
```

Examples

```
getclock
2021.04.02-10:22:30
get the Realtime clock in the format YYYY.MM.DD-HH:MM;SS
```

## pshell Command: getvaluef

Description:

(DEPRECATED) Returns the value of an floating point variable within the Popoto modem. This API is deprecated in favor of the simpler pshell api which allows getting variables without a command. See examples below.

Invocation

```
getvaluef <Element>
```

Examples

```
getvaluef TxPowerWatts
This expression can be replaced with the simpler
TxPowerWatts
Both will return a JSON message like:

{"TxPowerWatts":1.000000}
```

## pshell Command: getvaluei

Description:

(DEPRECATED) Returns the value of an integer variable within the Popoto modem. This API is deprecated in favor of the simpler pshell api which allows getting variables without a command. See examples below.

Invocation

```
getvaluei <Element>
```

Examples

```
getvaluei UPCONVERT_Carrier
This expression can be replaced with the simpler
UPCONVERT_Carrier
Both will return a JSON message like:

{"UPCONVERT_Carrier":25000}
```

## pshell Command: getverbosity

Description:

The getverbosity command is used to read the current verbosity of the popoto api This command returns an integer from 0 to 5. 0 = silent 5 = most verbose

Invocation

```
getverbosity
```

Examples

```
getverbosity
```

## pshell Command: ls

Description:

ls generates a directory listing of the local Popoto storage. it takes 2 arguments. 1) a directory name 2) a regular expression to match for the files to list.

Invocation

```
connect <ipaddress> <port>
```

Examples

```
connect localhost 17000
connect 10.0.0.232 17000
print a directory listing
ls <directory name> <regex>
ls /captures
ls . *.rec
```

## pshell Command: mips

Description:

Query the popoto modem to determine internal cycle counts for algorithms. Cycle counts are returned in a JSON dictionary for parsing by Popoto development tools. This is a typically a command used by the developers.

Invocation

```
mips
```

Examples

```
mips
```

## pshell Command: multiping

Description:

Send an series of acoustic test messages. This api sends the text ”Popoto Test Message” repeatedly using the configured data rate, and the approximate specified power level. This api is used to run packet level reliability checks. The power is specified, along with a count, and an interpacket delay.

Invocation

```
multiping <power Watts> <number of pings> <delay in seconds>
```

Examples

```
multiping 10 20 5
Will send 20 ping messages at 10 watts with 5 seconds of delay between
messages
```

## pshell Command: netplay

Description:

Plays a file file using the network sockets

Invocation

```
netplay <delresearchfile> <scale> <BB/PB>
where
delresearchfile: is a valid filename
scale: is a floating point gain to be applied to the signal p
prior to transmission
BB/PB: Baseband or passband 1 -> Baseband Recording 0->Passband Recording
Base band carrier is selected by setting the BBAND_PBAND_UpCarrier
variable.
```

Examples

```
netplay TestPBRecording 1.0 0
plays the file TestPBRecording for at a gain of 1.0 in Passband
netrec TestBBRecording 20 1
records the file TestBBRecording at a gain of 1.0 in Baseband
```

## pshell Command: netrec

Description:

Records a file file using the network sockets

Invocation

```
netrec <delresearch File> <time in seconds> <BB/PB>
where
delresearch file is a valid filename
time in seconds is the desired length of the recording
BB/PB=1 -> Baseband Recording 0->Passband Recording
Base band carrier is selected by setting the BBAND_PBAND_DownCarrier
variable.
```

Examples

```
netrec TestRecording 20 0
records the file TestRecording for 20 seconds in Passband
netrec TestRecording 20 1
records the file TestRecording for 20 seconds in Baseband
```

## pshell Command: ping

Description:

Send an acoustic test message. This api sends the text ”Popoto Test Message” using the configured data rate, and the approximate specified power level. It is important to note that calling ping with a power level latches that power level in the transmitter, to be used for subsequent transmissions.

Invocation

```
ping <Power level>
```

Examples

```
ping 10
Sends a test message (Popoto Test Message) using approximately 10 watts
of power
```

## pshell Command: playstart

Description:

Starts a playback from the local modem’s filesystem. where filename is the name of the file to play where scale factor is a floating point gain to apply to the file

Invocation

```
playstart <filename> <scale factor>
```

Examples

```
playstart /captures/Tone.pcm 1.0
```

## pshell Command: playstop

Description:

Stop and close an in-process playback

Invocation

```
playstop
```

Examples

```
playstop
```

## pshell Command: powerdown

Description:

Place Popoto into POWERDOWN mode to be awakened by a wake up tone on the acoustic interface. Once in powerdown mode, any 25Khz acquisiton pattern will wake the popoto modem. This can most easily be generated by sending a ping command from the remote modem. Things to note: Powerdown mode is the lowest power state of the Popoto Modem, typically 13mW. To awaken from Powerdown mode requires 20 seconds after the acquistion.

Invocation

```
deepsleep
```

Examples

```
deepsleep
```

## pshell Command: q

Description:

Minimize (quiet) the output to the console during normal operation.

Invocation

```
q
```

Examples

```
q
```

## pshell Command: quit

Description:

An alias for exit. Exits Popoto Modem pshell. Note: On hardware pshell, quit and exit are disabled

Invocation

```
quit
```

Examples

```
quit
```

## pshell Command: range

Description:

Sends a two way range request using approximately <Power> watts. This command issues a range request and sends it to the modem at the configured remoteID. The remote modem holds the request for a predetermined amount of time, and then replys with a range response. Popoto will then send back a range report consisting of the distance between the modems, and the configured speed of sound and the computed round trip time. Note that the Speed of sound, and the ranging hold time are configurable parameters, if you do change the ranging hold time, it is imperative that you configure both the local and remote modems to have the same hold time. Otherwise, Popoto will give erroneous range reports.

Invocation

```
range <power>
```

Examples

```
range 20
{"Range":500.002441,"Roundtrip Delay":666.669922,"SpeedOfSound":1500.000000,"Units":"m,
ms, meters per second"}
```

## pshell Command: recordstart

Description:

starts a recording to the local storage device.. Filenames are extended with a timestamp. The file(s) will continue to record until the record-stop command is issued

Invocation

```
recordstart <filename> [duration]
where
filename: is the name of the file to record on the target processor
duration: Optional parameter that tells how long each individual record
file length
is in seconds.
```

Examples

```
recordstart /captures/TestCapeCodBay 60
records a file called TestCapeCodBay<Timestamp>.rec, and rolls the file
every 60 seconds, starting
a new file with the same base filename with a new appended timestamp
```

## pshell Command: recordstop

Description:

Stop and close an in-process recording

Invocation

```
recordstop
```

Examples

```
recordstop
```

## pshell Command: remote

Description:

Toggles remote mode. In remote mode, any command issued at the pshell is wrapped into an acoustic message and transmitted to the remote modem, where the command is executed, and the status is returned in an acoustic message from the remote modem. Note: It is not permissable to issue a remote transmission using remote mode.

Invocation

```
remote <on/off>
```

Examples

```
remote on
Enables remote mode
remote off
Disables remote mode
NOTE: You cannot issue a transmit command remotely
```

## pshell Command: setEXP0

Description:

The EXP0 Pin is a GPIO Output pin available on the Popoto expansion header. This API allows the user to set the value of that pin. Note that the GPIO pin has limited current drive, and if a high current device is to be controlled, it is necessary to use an external FET or relay. Please see Popoto.com for application notes concerning controlling high current devices.

Invocation

```
setEXP0 <1,0>
```

Examples

```
setEXP0 0
Turn off the EXP0 pin
setEXP0 1
Turn on the EXP0 pin
```

## pshell Command: setRate10240

Description:

Set the modem payload transmission rate to 10240 bits per second

Invocation

```
do_setRate10240
```

Examples

```
do_setRate10240
NOTE: This modulation rate is UNCODED, and will only work on very clean
channels
Use with caution.
```

## pshell Command: setRate1280

Description:

Set the modem payload transmission rate to 1280 bits per second

Invocation

```
setRate1280
```

Examples

```
setRate1280
Set the local modem to use the 1280 bit per second modulation scheme
```

## pshell Command: setRate2560

Description:

Set the modem payload transmission rate to 2560 bits per second

Invocation

```
setRate2560
```

Examples

```
setRate2560
```

## pshell Command: setRate5120

Description:

Set the modem payload transmission rate to 5120 bits per second

Invocation

```
setRate5120
```

Examples

```
setRate5120
```

## pshell Command: setRate640

Description:

Set the modem payload transmission rate to 640 bits per second

Invocation

```
setRate640
```

Examples

```
setRate640
Set the local modem to use the 640 bit per second modulation scheme
```

## pshell Command: setRate80

Description:

Set the modem payload transmission rate to 80 bits per second

Invocation

```
setRate80
```

Examples

```
setRate80
```

## pshell Command: setTerminalMode

Description:

Set the pshell terminal to raw mode or ANSI mode. ANSI Mode allows for highlighting of responses, Raw mode is easier to use if controlling the device programatically

Invocation

```
setTerminalMode <raw/ansi>
```

Examples

```
setTerminalMode raw
setTerminalMode ansi
```

## pshell Command: setcarrier

Description:

A helper function to set the transmit and receive carriers to a value. Note that given the version of the modem, there will be different bounds for carrier frequencies. Check documentation UPCONVERT_Carrier and DOWNCONVERT_Carrier for details on acceptable ranges.

Invocation

```
setcarrier <Carrier Frequency>
```

Examples

```
setcarrier 25000
```

## pshell Command: setcarrier25

Description:

A helper function to set the transmit and receive carriers to 25Khz

Invocation

```
setcarrier25
```

Examples

```
setcarrier25
```

## pshell Command: setcarrier30

Description:

A helper function to set the transmit and receive carriers to 30Khz

Invocation

```
setcarrier30
```

Examples

```
setcarrier30
```

## pshell Command: setclock

Description:

Set the Realtime clock in the format YYYY.MM.DD-HH:MM;SS

Invocation

```
setclock <Date Time>
```

Examples

```
setclock 2021.04.02-10:22:30
```

## pshell Command: setgainmode

Description:

Sets the way the modem manages the high and low gain channels

Invocation

```
setGainMode <0,1,2>
GainMode 0 = High Gain Only
GainMode 1 = Low Gain Only
GainMode 2 = Automatic Gain Selection
```

Examples

```
setGainMode 2
```

## pshell Command: setvaluef

Description:

(DEPRECATED) Sets an floating point value on the popoto modem This API is deprecated in favor of the simpler pshell api which allows setting variables without a command. See examples below.

Invocation

```
setvaluef <Element>
```

Examples

```
setvaluef TxPowerWatts 10.0
This expression can be replaced with the simpler
TxPowerWatts 10.0
```

## pshell Command: setvaluei

Description:

(DEPRECATED) Sets an integer value on the popoto modem This API is deprecated in favor of the simpler pshell api which allows setting variables without a command. See examples below.

Invocation

```
setvaluei <Element>
```

Examples

```
setvaluei UPCONVERT_Carrier 30000
This expression can be replaced with the simpler
UPCONVERT_Carrier 30000
```

## pshell Command: setverbosity

Description:

The setverbosity command is used to control the verbosity of the popoto api This command takes an integer from 0 to 5. 0 = silent 5 = most verbose

Invocation

```
setverbosity <value>
```

Examples

```
setverbosity 0
setverbosity 2
```

## pshell Command: sleep

Description:

This command pauses the pshell for N Seconds. It is useful when writing scripts or commands that need to perform tasks at a prescribed interfveal

Invocation

```
sleep <N>
Sleep for N seconds, where N is an integer.
```

Examples

```
sleep 5
```

## pshell Command: ssb

Description:

Place the ssb Voice into Receive mode

Invocation

```
ssb
```

Examples

```
ssb
```

## pshell Command: ssbtx

Description:

Force the SSB Voice mode into Transmit mode

Invocation

```
ssbtx
```

Examples

```
ssbtx
```

## pshell Command: startrx

Description:

This command enables the modem receiver, and returns the modem statemachine to the listening state pshell invokes this command automatically at boot up.

Invocation

```
startrx
```

Examples

```
startrx
```

## pshell Command: transmit

Description:

Transmit a string to the remote modem.  Strings do not need to be delimited, and can have spaces in them. This is used for sending data to the remote modem

Invocation

```
transmit <message>

Where message is a text string
```

Examples

```
transmit Hello
transmit Hello World it's me, Popoto
```

## pshell Command: transmitJSON

Description:

Transmit a JSON encoded message to the remote modem. This is used for sending data to the remote modem

Invocation

```
transmitJSON <message>

The structure of the message is
{"Payload":{"Data":[<COMMA SEPARATED 8 BIT VALUES>]}}
```

Examples

```
transmitJSON {"Payload":{"Data":[1,2,3,4,5]}}
sends the binary sequence 0x01 0x02 0x03 0x04 0x05

transmitJSON {"Payload":{"Data": "Hello World"}}

sends the text sequence Hello World
```

## pshell Command: transmitJSONFiles

Description:

Transmit a file of JSON encoded messages to the remote modem.

Invocation

```
transmitJSONFiles <filename> <power> <delay between transmissions> <num
transmissions per packet>
```

Examples

```
transmitJSONFiles JanusTestCase1.txt 10 30 10
```

## pshell Command: unq

Description:

Unquiet the output to the console during normal operation.

Invocation

```
unq
```

Examples

```
unq
```

## pshell Command: upload

Description:

Uploads a file in streaming mode.

Invocation

```
upload [filename] [power level]
```

Examples

```
upload myfile 10
```

## pshell Command: version

Description:

Return the serial number and software version of the Popoto modem. Each item is returned in an informational JSON message as shown below

Invocation

```
version
```

Examples

```
version

{"Info ":"Popoto Modem Version 2.7.0 847"}
{"Info ":"SerialNumber FFFFFFFFFFFFFFFFFFFF"}
```

# 20 Popoto Variables

The Popoto modem system has a database of configurable parameters which allow customization of the operation of the Popoto modem. These parameters, referred to as Settable/Gettable Variables provide system information such as battery voltage, control modulation parameters such as transmission power and carrier frequency, and provide runtime status such as constellation points, and PLL errors. Settable/Gettable Variables have permissions and bounds checking associated with them. It is important to note that some variables, such as BatteryVoltage, are read-only, and some variables such as UPCONVERT_Carrier, are read and writeable.

Setting variables is accomplished within the JSON API using the Set command. In the example below, we set the Baseband Recording downconvert carrier to 45Khz. The format of the message is:

```
{"Command":"Set", "Arguments": "SPACE DELIMITED ARGUMENT LIST"}
```

Table 20.1: Argument List format

| Variable | Data Type | Value | Channel |
|---|---|---|---|
| BBAND_DownCarrier | int | Value | 0 |

```
{"Command":"Set","Arguments":"BBAND_DownCarrier int 45000.0 0 }
```

Table 20.2: Variable Set Return Conditions

| API | Condition | Example Return |
|---|---|---|
| { ”Command”: ”SetValue”, ”Arguments”: ”BBAND_DownCarrier 25000 0”} | Success | {”Info”:”Value Set BBAND_DownCarrier=25000”} |
| { ”Command”: ”SetValue”, ”Arguments”: ”BBAND_DownCarrier 5000 0”} | Below Min | {”Info”:”Value Out of Range: BBAND_DownCarrier=5000 Below Minimum”} |
| { ”Command”: ”SetValue”, ”Arguments”: ”BBAND_DownCarrier 500000 0”} | Above Max | {”Info”:”Value Out of Range: BBAND_DownCarrier=500000 Above Maximum”} |
| { ”Command”: ”SetValue”, ”Arguments”: ”bband_downcarrier 25000 0”} | Misspelled | {”Error”:”Unknown Element bband_downcarrier”} |

What follows is a reference for all of the controllable varables within the Popoto Modem system

## APP_CycleCount

Description:
    Display Cycle Counter
Data Type
    int

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"APP_CycleCount int 0 }
{"Command":"SetValue","Arguments":"APP_CycleCount int 0.0 0 }
```

Return:
```
{"APP_CycleCount": value}
```

## APP_CycleCountReset

Description:
    Display Cycle Counter and Reset
Data Type
    int

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"APP_CycleCountReset int 0 }
{"Command":"SetValue","Arguments":"APP_CycleCountReset int 0.0 0 }
```

Return:
```
{"APP_CycleCountReset": value}
```

## APP_ModemSMAOut

Description:
Flag to Send Modem Data to the SMA Port out
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"APP_ModemSMAOut int 0 }
{"Command":"SetValue","Arguments":"APP_ModemSMAOut int 1.0 0 }
```

Return:
```
{"APP_ModemSMAOut": value}
```

## APP_SocketBasedPCM

Description:
  Flag to enable Socket based PCM
Data Type
  int

Minimum Value
  0.0
Maximum Value
  1.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"APP_SocketBasedPCM int 0 }
{"Command":"SetValue","Arguments":"APP_SocketBasedPCM int 1.0 0 }
```

Return:
```
{"APP_SocketBasedPCM": value}
```

## BBAND_DownCarrier

Description:
    Downconvert Baseband Streaming carrier 5120 to 45000
Data Type
    int

Minimum Value
    5120.0
Maximum Value
    45000.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"BBAND_DownCarrier int 0 }
{"Command":"SetValue","Arguments":"BBAND_DownCarrier int 45000.0 0 }
```

Return:
```
{"BBAND_DownCarrier": value}
```

## BBAND_OutputScale

Description:
    Upconvert Output scaling for Baseband Passband module
Data Type
    float

Minimum Value
    0.0
Maximum Value
    10.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"BBAND_OutputScale float 0 }
{"Command":"SetValue","Arguments":"BBAND_OutputScale float 10.0 0 }
```

Return:
```
{"BBAND_OutputScale": value}
```

## BBAND_UpCarrier

Description:
Upconvert Baseband Streaming carrier 5120 to 45000

Data Type
int

Minimum Value
5120.0

Maximum Value
45000.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"BBAND_UpCarrier int 0 }
{"Command":"SetValue","Arguments":"BBAND_UpCarrier int 45000.0 0 }
```

Return:

```
{"BBAND_UpCarrier": value}
```

## BatteryCharge

Description:
Battery Charge in mAh
Data Type
float

Minimum Value
0.0
Maximum Value
271.98999

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"BatteryCharge float 0 }
{"Command":"SetValue","Arguments":"BatteryCharge float 271.98999 0 }
```

Return:
```
{"BatteryCharge": value}
```

## BatteryCurrent

Description:
Battery Current in positive (to battery; unused) / negative (from battery) in mA

Data Type
float

Minimum Value
0.0

Maximum Value
200.0

Permissions
Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"BatteryCurrent float 0 }
{"Command":"SetValue","Arguments":"BatteryCurrent float 200.0 0 }
```

Return:
```
{"BatteryCurrent": value}
```

## BatteryVoltage

Description:
System Battery Voltage in volts

Data Type
float

Minimum Value
0.0

Maximum Value
40.0

Permissions
Read Only

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"BatteryVoltage float 0 }
{"Command":"SetValue","Arguments":"BatteryVoltage float 40.0 0 }
```

Return:

```
{"BatteryVoltage": value}
```

## Carrier

Description:
Sets both the Transmit and Receiver Carriers. Reading this variable returns the Transmitter Carrier.
Data Type
int

Minimum Value
20000.0
Maximum Value
59750.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"Carrier int 0 }
{"Command":"SetValue","Arguments":"Carrier int 59750.0 0 }
```

Return:
```
{"Carrier": value}
```

## CarrierTxMode

Description:
set the transmitter to send FH waveform (0-default) or 1-simply a carrier note
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"CarrierTxMode int 0 }
{"Command":"SetValue","Arguments":"CarrierTxMode int 1.0 0 }
```

Return:
```
{"CarrierTxMode": value}
```

## ChannelIR

Description:
Measured channel impulse response: Getter returns number of expected values
Data Type
int

Minimum Value
0.0
Maximum Value
0.0

Permissions
Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"ChannelIR int 0 }
{"Command":"SetValue","Arguments":"ChannelIR int 0.0 0 }
```

Return:
```
{"ChannelIR": value}
```

## ConsolePacketBytes

Description:
Number of console characters input to trigger an autosend

Data Type
int

Minimum Value
0.0

Maximum Value
8192.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"ConsolePacketBytes int 0 }
{"Command":"SetValue","Arguments":"ConsolePacketBytes int 8192.0 0 }
```

Return:

```
{"ConsolePacketBytes": value}
```

## ConsoleTimeoutMS

Description:
    Number of console milliseconds expired to trigger an autosend
Data Type
    int

Minimum Value
    0.0
Maximum Value
    60000.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"ConsoleTimeoutMS int 0 }
{"Command":"SetValue","Arguments":"ConsoleTimeoutMS int 60000.0 0 }
```

Return:
```
{"ConsoleTimeoutMS": value}
```

## DOWNCONVERT_Carrier

Description:
  Downconverter Carrier Frequency in Hz
Data Type
  int

Minimum Value
  20000.0
Maximum Value
  59750.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"DOWNCONVERT_Carrier int 0 }
{"Command":"SetValue","Arguments":"DOWNCONVERT_Carrier int 59750.0 0
}
```

Return:
```
{"DOWNCONVERT_Carrier": value}
```

## DataPortMode

Description:
0-Data Port acts as Telnet; 1 Data Port is raw TCP data

Data Type
int

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"DataPortMode int 0 }
{"Command":"SetValue","Arguments":"DataPortMode int 1.0 0 }
```

Return:
```
{"DataPortMode": value}
```

## DepartureDelay_samples

Description:
    Tx departure delay
Data Type
    int

Minimum Value
    0.0
Maximum Value
    3072000.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"DepartureDelay_samples int 0 }
{"Command":"SetValue","Arguments":"DepartureDelay_samples int 3072000.0
0 }
```

Return:
```
{"DepartureDelay_samples": value}
```

## DopplerDisable

Description:
Switch to control the doppler compensation 1= Doppler Compensation on 0 = Doppler Compensation off

Data Type
int

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"DopplerDisable int 0 }
{"Command":"SetValue","Arguments":"DopplerDisable int 1.0 0 }
```

Return:

```
{"DopplerDisable": value}
```

## DopplerEnable

Description:
enable (1) or disable(0) doppler estimation
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"DopplerEnable int 0 }
{"Command":"SetValue","Arguments":"DopplerEnable int 1.0 0 }
```

Return:
```
{"DopplerEnable": value}
```

## FHDEMOD_DetectThresholdDB

Description:
    Detection threshold for signal aquire default  160 for -5db AWGN detect
Data Type
    float

Minimum Value
    0.0
Maximum Value
    300.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"FHDEMOD_DetectThresholdDB float 0
}
{"Command":"SetValue","Arguments":"FHDEMOD_DetectThresholdDB float 300.0
0 }
```

Return:
```
{"FHDEMOD_DetectThresholdDB": value}
```

## FHDEMOD_HopSeqLen

Description:
  Set the hop sequence length demodulator
Data Type
  int

Minimum Value
  1.0
Maximum Value
  8192.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"FHDEMOD_HopSeqLen int 0 }
{"Command":"SetValue","Arguments":"FHDEMOD_HopSeqLen int 8192.0 0 }
```

Return:
```
{"FHDEMOD_HopSeqLen": value}
```

## FHMOD_HopSeqLen

Description:
Set the hop sequence length demodulator

Data Type
int

Minimum Value
1.0

Maximum Value
8192.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"FHMOD_HopSeqLen int 0 }
{"Command":"SetValue","Arguments":"FHMOD_HopSeqLen int 8192.0 0 }
```

Return:

```
{"FHMOD_HopSeqLen": value}
```

## FHMOD_NumChipReps

Description:
  Set the hop frequency redundancy for payloads
Data Type
  int

Minimum Value
  1.0
Maximum Value
  4.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"FHMOD_NumChipReps int 0 }
{"Command":"SetValue","Arguments":"FHMOD_NumChipReps int 4.0 0 }
```

Return:
```
{"FHMOD_NumChipReps": value}
```

## GainAdjustMode

Description:
Set the gain mode 0-lowgain, 1-highgain, 2-automatic
Data Type
int

Minimum Value
0.0
Maximum Value
2.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"GainAdjustMode int 0 }
{"Command":"SetValue","Arguments":"GainAdjustMode int 2.0 0 }
```

Return:
```
{"GainAdjustMode": value}
```

## HP_FilterEnable

Description:
HP Filter enable / disable flag 0=disable 1 = enable

Data Type
int

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"HP_FilterEnable int 0 }
{"Command":"SetValue","Arguments":"HP_FilterEnable int 1.0 0 }
```

Return:
```
{"HP_FilterEnable": value}
```

## Headerless

Description:
    Enable headerless streaming mode (0-default)
Data Type
    int

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"Headerless int 0 }
{"Command":"SetValue","Arguments":"Headerless int 1.0 0 }
```

Return:
```
{"Headerless": value}
```

## InBandNoiseEnergy

Description:
  Noise Energy Measured after downsampling filter
Data Type
  float

Minimum Value
  0.0
Maximum Value
  1.0

Permissions
  Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"InBandNoiseEnergy float 0 }
{"Command":"SetValue","Arguments":"InBandNoiseEnergy float 1.0 0 }
```

Return:
```
{"InBandNoiseEnergy": value}
```

## InbandEnergy

Description:
Inband energy parameter
Data Type
float

Minimum Value
0.0
Maximum Value
0.0

Permissions
Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"InbandEnergy float 0 }
{"Command":"SetValue","Arguments":"InbandEnergy float 0.0 0 }
```

Return:
```
{"InbandEnergy": value}
```

## LedEnable

Description:
0-disable all board LEDS; 1 enable board LEDS

Data Type
int

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"LedEnable int 0 }
{"Command":"SetValue","Arguments":"LedEnable int 1.0 0 }
```

Return:
```
{"LedEnable": value}
```

## LocalID

Description:
    Local Modem ID 0-254;255 broadcast
Data Type
    int

Minimum Value
    0.0
Maximum Value
    255.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"LocalID int 0 }
{"Command":"SetValue","Arguments":"LocalID int 255.0 0 }
```

Return:
```
{"LocalID": value}
```

## LoggingLevel

Description:
    Logging verbosity level
Data Type
    int

Minimum Value
    0.0
Maximum Value
    5.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"LoggingLevel int 0 }
{"Command":"SetValue","Arguments":"LoggingLevel int 5.0 0 }
```

Return:
```
{"LoggingLevel": value}
```

## MODEM_Enable

Description:
enable (1) or disable (0) modem processing
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"MODEM_Enable int 0 }
{"Command":"SetValue","Arguments":"MODEM_Enable int 1.0 0 }
```

Return:
```
{"MODEM_Enable": value}
```

## PSK_BnTaps

Description:
The number of Backward taps for the PSK Equalizer. The number of forward taps + the number of backwards taps must be less than MAX value

Data Type
int

Minimum Value
0.0

Maximum Value
100.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"PSK_BnTaps int 0 }
{"Command":"SetValue","Arguments":"PSK_BnTaps int 100.0 0 }
```

Return:

```
{"PSK_BnTaps": value}
```

## PSK_Constellation

Description:
Returns the last 64 Constellation points from the PSK Modem
Data Type
float

Minimum Value
0.0
Maximum Value
0.0

Permissions
Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PSK_Constellation float 0 }
{"Command":"SetValue","Arguments":"PSK_Constellation float 0.0 0 }
```

Return:
```
{"PSK_Constellation": value}
```

## PSK_FnTaps

Description:
The number of Forward taps for the PSK Fractional (N/2) Equalizer. The number of forward taps + the number of backwards taps must be less than MAX value.

Data Type
int

Minimum Value
0.0

Maximum Value
100.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PSK_FnTaps int 0 }
{"Command":"SetValue","Arguments":"PSK_FnTaps int 100.0 0 }
```

Return:
```
{"PSK_FnTaps": value}
```

## PSK_PDSNR

Description:
    Post detection SNR for the PSK
Data Type
    int

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PSK_PDSNR int 0 }
{"Command":"SetValue","Arguments":"PSK_PDSNR int 1.0 0 }
```

Return:
```
{"PSK_PDSNR": value}
```

## PSK_PLL

Description:
    Returns the PLL Error
Data Type
    float

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PSK_PLL float 0 }
{"Command":"SetValue","Arguments":"PSK_PLL float 0.0 0 }
```

Return:
```
{"PSK_PLL": value}
```

## PSK_Taps

Description:
Returns the Current Equalizer taps as an array with forward taps concatenated with backwards taps

Data Type
float

Minimum Value
0.0

Maximum Value
0.0

Permissions
Read Only

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"PSK_Taps float 0 }
{"Command":"SetValue","Arguments":"PSK_Taps float 0.0 0 }
```

Return:

```
{"PSK_Taps": value}
```

## PayloadMode

Description:
BitRate of Payload transmission 0-FH, 1-QPSK5120bps, 2-QPSK2560bps, 3-QPSK1920bps,4-QPSK1280bps, 5-BPSK2560bps, 6-BPSK1280bps, 7-BPSK960bps, 8-BPSK640bps

Data Type
int

Minimum Value
0.0

Maximum Value
8.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PayloadMode int 0 }
{"Command":"SetValue","Arguments":"PayloadMode int 8.0 0 }
```

Return:
```
{"PayloadMode": value}
```

## PeakEnvelopePower

Description:
    Peak envelope power of previous transmission
Data Type
    float

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PeakEnvelopePower float 0 }
{"Command":"SetValue","Arguments":"PeakEnvelopePower float 0.0 0 }
```

Return:
```
{"PeakEnvelopePower": value}
```

## PlayMode

Description:
  0-Play in Passband; 1 Play in baseband

Data Type
  int

Minimum Value
  0.0

Maximum Value
  1.0

Permissions
  Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"PlayMode int 0 }
{"Command":"SetValue","Arguments":"PlayMode int 1.0 0 }
```

Return:

```
{"PlayMode": value}
```

## RNG_SpeedOfSound

Description:
Speed of sound in meters per second. Adjust this value for different water salinity etc.

Data Type
float

Minimum Value
340.0

Maximum Value
1600.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"RNG_SpeedOfSound float 0 }
{"Command":"SetValue","Arguments":"RNG_SpeedOfSound float 1600.0 0 }
```

Return:
```
{"RNG_SpeedOfSound": value}
```

## RNG_TA_DelayMs

Description:

Sets the hold time for ranging in milliseconds. This is the amount of time a modem waits before responding to a range request.

Data Type

int

Minimum Value

2500.0

Maximum Value

8000.0

Permissions

Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"RNG_TA_DelayMs int 0 }
{"Command":"SetValue","Arguments":"RNG_TA_DelayMs int 8000.0 0 }
```

Return:

```
{"RNG_TA_DelayMs": value}
```

## RangeTimeout_mS

Description:
    Range reply timeout in ms
Data Type
    int

Minimum Value
    0.0
Maximum Value
    60000.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"RangeTimeout_mS int 0 }
{"Command":"SetValue","Arguments":"RangeTimeout_mS int 60000.0 0 }
```

Return:
```
{"RangeTimeout_mS": value}
```

### RecordMode

Description:
  0-Record in Passband; 1 Record in baseband 2 Record Dual Channel

Data Type
  int

Minimum Value
  0.0

Maximum Value
  2.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"RecordMode int 0 }
{"Command":"SetValue","Arguments":"RecordMode int 2.0 0 }
```

Return:
```
{"RecordMode": value}
```

## RemoteID

Description:
    Local Modem ID 0-254;255 broadcast
Data Type
    int

Minimum Value
    0.0
Maximum Value
    255.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"RemoteID int 0 }
{"Command":"SetValue","Arguments":"RemoteID int 255.0 0 }
```

Return:
```
{"RemoteID": value}
```

## ReportErroredBytes

Description:
    Switch to control whether to report the bytes in a bad CRC packet
Data Type
    int

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"ReportErroredBytes int 0 }
{"Command":"SetValue","Arguments":"ReportErroredBytes int 1.0 0 }
```

Return:
```
{"ReportErroredBytes": value}
```

## RxEnable

Description:
enable (1) or disable (0) receiver processing
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"RxEnable int 0 }
{"Command":"SetValue","Arguments":"RxEnable int 1.0 0 }
```

Return:
```
{"RxEnable": value}
```

## RxScramblerMode

Description:
 Scrambler Enable on Rx 0-disable 1-enable
Data Type
 int

Minimum Value
 0.0
Maximum Value
 1.0

Permissions
 Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"RxScramblerMode int 0 }
{"Command":"SetValue","Arguments":"RxScramblerMode int 1.0 0 }
```

Return:
```
{"RxScramblerMode": value}
```

## SNR

Description:
    SNR Estimate
Data Type
    float

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SNR float 0 }
{"Command":"SetValue","Arguments":"SNR float 0.0 0 }
```

Return:
```
{"SNR": value}
```

## SSB_Enable

Description:
SSB Enable, default 0
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_Enable int 0 }
{"Command":"SetValue","Arguments":"SSB_Enable int 1.0 0 }
```

Return:
```
{"SSB_Enable": value}
```

## SSB_NREnable

Description:
SSB Enable advanced squelch, AGC and Noise Reduction
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_NREnable int 0 }
{"Command":"SetValue","Arguments":"SSB_NREnable int 1.0 0 }
```

Return:
```
{"SSB_NREnable": value}
```

## SSB_SetPTT

Description:
SSB set state of ptt from console
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_SetPTT int 0 }
{"Command":"SetValue","Arguments":"SSB_SetPTT int 1.0 0 }
```

Return:
```
{"SSB_SetPTT": value}
```

## SSB_SqLevel

Description:
SSB Sqelching threshold 0-always on, default=.005

Data Type
float

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"SSB_SqLevel float 0 }
{"Command":"SetValue","Arguments":"SSB_SqLevel float 1.0 0 }
```

Return:

```
{"SSB_SqLevel": value}
```

## SSB_Txpower

Description:
    SSB Output power scale, default=1
Data Type
    float

Minimum Value
    0.0
Maximum Value
    100.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_Txpower float 0 }
{"Command":"SetValue","Arguments":"SSB_Txpower float 100.0 0 }
```

Return:
```
{"SSB_Txpower": value}
```

## SSB_UseGPIO

Description:
    Process J7 P3 GPIO 8/6 and P9 GPIO 7/14 Switches, default=0
Data Type
    int

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_UseGPIO int 0 }
{"Command":"SetValue","Arguments":"SSB_UseGPIO int 1.0 0 }
```

Return:
```
{"SSB_UseGPIO": value}
```

## SSB_Volume

Description:
 SSB Speaker Volume, default=1
Data Type
 float

Minimum Value
 0.0
Maximum Value
 100.0

Permissions
 Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_Volume float 0 }
{"Command":"SetValue","Arguments":"SSB_Volume float 100.0 0 }
```

Return:
```
{"SSB_Volume": value}
```

## SSB_VxHang

Description:
SSB Vox hangover switch time seconds, default=2.0
Data Type
float

Minimum Value
0.0
Maximum Value
10.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_VxHang float 0 }
{"Command":"SetValue","Arguments":"SSB_VxHang float 10.0 0 }
```

Return:
```
{"SSB_VxHang": value}
```

## SSB_VxLevel

Description:
    SSB Vox switching threshold 0-always on, default=.005
Data Type
    float

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_VxLevel float 0 }
{"Command":"SetValue","Arguments":"SSB_VxLevel float 1.0 0 }
```

Return:
```
{"SSB_VxLevel": value}
```

## SSB_VxMode

Description:
SSB 1-Enable voice activated PTT (vox), 0-disable
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_VxMode int 0 }
{"Command":"SetValue","Arguments":"SSB_VxMode int 1.0 0 }
```

Return:
```
{"SSB_VxMode": value}
```

## SSB_carrier

Description:
    SSB set Tx Rx carrier
Data Type
    int

Minimum Value
    22000.0
Maximum Value
    35000.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SSB_carrier int 0 }
{"Command":"SetValue","Arguments":"SSB_carrier int 35000.0 0 }
```

Return:
```
{"SSB_carrier": value}
```

## SSB_sideband

Description:
SSB sidband 0-L 1-U

Data Type
int

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"SSB_sideband int 0 }
{"Command":"SetValue","Arguments":"SSB_sideband int 1.0 0 }
```

Return:

```
{"SSB_sideband": value}
```

## SignalEnergy

Description:
    Signal Energy Measured during last FH acquisition
Data Type
    float

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SignalEnergy float 0 }
{"Command":"SetValue","Arguments":"SignalEnergy float 1.0 0 }
```

Return:
```
{"SignalEnergy": value}
```

## StreamingTxLen

Description:
  Size of superpacket when streaming or uploading.
Data Type
  int

Minimum Value
  0.0
Maximum Value
  8192.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"StreamingTxLen int 0 }
{"Command":"SetValue","Arguments":"StreamingTxLen int 8192.0 0 }
```

Return:
```
{"StreamingTxLen": value}
```

## SystemMode

Description:
System Mode 0-DataModem, 1-SSB , 2-DataModem+SSB, 3-SMA IN to Tx

Data Type
int

Minimum Value
0.0

Maximum Value
4.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"SystemMode int 0 }
{"Command":"SetValue","Arguments":"SystemMode int 4.0 0 }
```

Return:
```
{"SystemMode": value}
```

## TCPecho

Description:
    0-disable TCP echo in telnet Tx stream; 1 enable TCP echo in telnet Tx stream
Data Type
    int

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"TCPecho int 0 }
{"Command":"SetValue","Arguments":"TCPecho int 1.0 0 }
```

Return:
```
{"TCPecho": value}
```

## Temp_Ambient

Description:
Ambient bottle temperature in degrees C
Data Type
float

Minimum Value
0.0
Maximum Value
0.0

Permissions
Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"Temp_Ambient float 0 }
{"Command":"SetValue","Arguments":"Temp_Ambient float 0.0 0 }
```

Return:
```
{"Temp_Ambient": value}
```

## TxChirpMode

Description:
Transmit chirps prior to packets 0-disable 1-enable
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"TxChirpMode int 0 }
{"Command":"SetValue","Arguments":"TxChirpMode int 1.0 0 }
```

Return:
```
{"TxChirpMode": value}
```

## TxEnable

Description:
enable (1) or disable (0) transmit processing
Data Type
int

Minimum Value
0.0
Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"TxEnable int 0 }
{"Command":"SetValue","Arguments":"TxEnable int 1.0 0 }
```

Return:
```
{"TxEnable": value}
```

## TxPower

Description:
Tx power in watts
Data Type
int

Minimum Value
0.0
Maximum Value
100.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"TxPower int 0 }
{"Command":"SetValue","Arguments":"TxPower int 100.0 0 }
```

Return:
```
{"TxPower": value}
```

## TxPowerWatts

Description:
TX output power in watts
Data Type
float

Minimum Value
0.0
Maximum Value
1000.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"TxPowerWatts float 0 }
{"Command":"SetValue","Arguments":"TxPowerWatts float 1000.0 0 }
```

Return:
```
{"TxPowerWatts": value}
```

## TxTimeout_mS

Description:
  Transmit timeout in ms
Data Type
  int

Minimum Value
  0.0
Maximum Value
  60000.0

Permissions
  Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"TxTimeout_mS int 0 }
{"Command":"SetValue","Arguments":"TxTimeout_mS int 60000.0 0 }
```

Return:
```
{"TxTimeout_mS": value}
```

## UPCONVERT_Carrier

Description:
Upconverter Carrier Frequency in Hz
Data Type
int

Minimum Value
20000.0
Maximum Value
59750.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"UPCONVERT_Carrier int 0 }
{"Command":"SetValue","Arguments":"UPCONVERT_Carrier int 59750.0 0 }
```

Return:
```
{"UPCONVERT_Carrier": value}
```

## UPCONVERT_OutputScale

Description:
Upconverter Output Scale
Data Type
float

Minimum Value
0.0
Maximum Value
10.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"UPCONVERT_OutputScale float 0 }
{"Command":"SetValue","Arguments":"UPCONVERT_OutputScale float 10.0 0
}
```

Return:
```
{"UPCONVERT_OutputScale": value}
```

## UnitTestMode

Description:
0 or 1: If 1 Pump data in a deterministic way from a socket. This disables timeouts on recordings and Play

Data Type
int

Minimum Value
0.0

Maximum Value
1.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"UnitTestMode int 0 }
{"Command":"SetValue","Arguments":"UnitTestMode int 1.0 0 }
```

Return:
```
{"UnitTestMode": value}
```

## brdState

Description:
    Board State State
Data Type
    int

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"brdState int 0 }
{"Command":"SetValue","Arguments":"brdState int 0.0 0 }
```

Return:
```
{"brdState": value}
```

## rxState

Description:
    Present Receiver State
Data Type
    int

Minimum Value
    0.0
Maximum Value
    0.0

Permissions
    Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"rxState int 0 }
{"Command":"SetValue","Arguments":"rxState int 0.0 0 }
```

Return:
```
{"rxState": value}
```

## tpaState

Description:
Power Amplifier State
Data Type
int

Minimum Value
0.0
Maximum Value
0.0

Permissions
Read Only

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"tpaState int 0 }
{"Command":"SetValue","Arguments":"tpaState int 0.0 0 }
```

Return:
```
{"tpaState": value}
```

# 21 TIPE

## 21.1 TIPE Commands

### pshell Command: range

---

Description:

Sends a two-way range request using approximately <Power> watts. This command issues a range request and sends it to the specified module (modem, echosounder, transponder) at the configured remoteID. The remote module holds the request for a predetermined amount of time, and then replies with a range response. Popoto will then send back a range report consisting of the distance between the devices, the configured speed of sound, and the computed round trip time.

**Modem:** The first modem requests a range response, and the second modem sends a range reply after it receives the request. The round trip time is computed, and then scaled with the configured speed of sound to come up with a time of flight range.

**Transponder:** This algorithm works similarly to the modem; however, rather than exchanging digital messages, the signaling is done via tones.

**Echosounder:** The echosounder sends a chirp (as configured in the TIPE configuration settings) and listens for its echo reflection to determine the distance to the surface or bottom.

Note that the speed of sound, and the ranging hold time are configurable parameters. If you change the ranging hold time, it is imperative that you configure both the local and remote modules to have the same hold time. Otherwise, Popoto will give erroneous range reports.

Invocation

```
range <power> [module]
```

## Examples

```
range 20
range 20 transponder
range 20 echosounder
{"Range":500.002441,"Roundtrip Delay":666.669922,"SpeedOfSound":1500.000000,"Units":"m,
ms, meters per second"}

Or if there is a timeout
{"Alert":"Timeout"}
```

## pshell Command: ping

Description:

Send an acoustic test message. This API sends the text ”Popoto Test Message” using the configured data rate and the approximate specified power level when the module is set to ‘modem‘. For the ‘pinger‘ module, it sends a tonal ping as configured with the ‘pinger:<configuration variables>‘. It is important to note that calling ping with a power level latches that power level in the transmitter, to be used for subsequent transmissions.

**Modem (default):** Sends the text ”Popoto Test Message.”

**Pinger:** Sends a tonal ping as configured with the ‘pinger:<configuration variables>‘.

Invocation

```
ping <power level> [module]
```

Examples

```
ping 10
ping 10 pinger
Sends a test message (Popoto Test Message) using approximately 10 watts
of power
```

## 21.2 TIPE Variables

### echosounder:mode

Description:
    Echo Sounder Modes of operation. Default value: 0 = Off).
Data Type
    int

Minimum Value
    0
Maximum Value
    1

Permissions
    Read Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"echosounder:mode int 0 }
{"Command":"SetValue","Arguments":"echosounder:mode int 1 0 }
```

Return:

```
{"echosounder:mode": value}
```

## echosounder:carrier

Description:
Center frequency of echo sounder. Default value: 10000.

Data Type
int

Minimum Value
5000

Maximum Value
45000

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"echosounder:carrier int 0 }
{"Command":"SetValue","Arguments":"echosounder:carrier int 45000 0 }
```

Return:
```
{"echosounder:carrier": value}
```

## echosounder:hfmchirpbw

Description:
 HFM chirp bandwidth. Default value: 5 khz.
Data Type
 int

Minimum Value
 1000
Maximum Value
 8000

Permissions
 Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"echosounder:hfmchirpbw int 0 }
{"Command":"SetValue","Arguments":"echosounder:hfmchirpbw int 8000 0
}
```

Return:
```
{"echosounder:hfmchirpbw": value}
```

## echosounder:hfmchirplength

Description:
HFM chirp length. Default value: 0.032.
Data Type
float

Minimum Value
0.1
Maximum Value
0.01

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"echosounder:hfmchirplength float 0
}
{"Command":"SetValue","Arguments":"echosounder:hfmchirplength float 0.01
0 }
```

Return:
```
{"echosounder:hfmchirplength": value}
```

## echosounder:timeout

Description:
Echo sounder timeout. Default value: 10.

Data Type
float

Minimum Value
1

Maximum Value
60

Permissions
Read Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"echosounder:timeout float 0 }
{"Command":"SetValue","Arguments":"echosounder:timeout float 60 0 }
```

Return:

```
{"echosounder:timeout": value}
```

## echosounder:speedofsound

Description:
  Speed of sound. Default value: 1500.
Data Type
  float

Minimum Value
  300
Maximum Value
  2000

Permissions
  Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"echosounder:speedofsound float 0 }
{"Command":"SetValue","Arguments":"echosounder:speedofsound float 2000
0 }
```

Return:
```
{"echosounder:speedofsound": value}
```

## transponder:mode

Description:
Transponder modes of operation. Default value: 0 = Off.
Data Type
int

Minimum Value
0
Maximum Value
1

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"transponder:mode int 0 }
{"Command":"SetValue","Arguments":"transponder:mode int 1 0 }
```

Return:
```
{"transponder:mode": value}
```

## transponder:carrier

Description:
Transponder carrier frequency. Default value: 8087.

Data Type
float

Minimum Value
45000

Maximum Value
5000

Permissions
Read Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"transponder:carrier float 0 }
{"Command":"SetValue","Arguments":"transponder:carrier float 5000 0 }
```

Return:

```
{"transponder:carrier": value}
```

## transponder:detecttonef

Description:
Detect tone frequency. Default value: 1997.

Data Type
float

Minimum Value
-5000

Maximum Value
5000

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"transponder:detecttonef float 0 }
{"Command":"SetValue","Arguments":"transponder:detecttonef float 5000
0 }
```

Return:
```
{"transponder:detecttonef": value}
```

## transponder:detecttonelength

Description:
Detect tone length. Default value: 0.032.
Data Type
float

Minimum Value
0.01
Maximum Value
0.1

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"transponder:detecttonelength float
0 }
{"Command":"SetValue","Arguments":"transponder:detecttonelength float
0.1 0 }
```

Return:
```
{"transponder:detecttonelength": value}
```

## transponder:turnaroundtime

Description:
    Turnaround time. Default value: 0.116.
Data Type
    float

Minimum Value
    0.01
Maximum Value
    5

Permissions
    Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"transponder:turnaroundtime float 0
}
{"Command":"SetValue","Arguments":"transponder:turnaroundtime float 5
0 }
```

Return:
```
{"transponder:turnaroundtime": value}
```

## transponder:respondtonef

Description:
Respond tone frequency. Default value: 1251.
Data Type
float

Minimum Value
-5000
Maximum Value
5000

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"transponder:respondtonef float 0 }
{"Command":"SetValue","Arguments":"transponder:respondtonef float 5000
0 }
```

Return:
```
{"transponder:respondtonef": value}
```

## transponder:respondtonelength

Description:
    Respond tone length. Default value: 0.032.
Data Type
    float

Minimum Value
    0.01
Maximum Value
    0.1

Permissions
    Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"transponder:respondtonelength float
0 }
{"Command":"SetValue","Arguments":"transponder:respondtonelength float
0.1 0 }
```

Return:
```
{"transponder:respondtonelength": value}
```

## transponder:timeout

Description:
Transponder timeout. Default value: 10.

Data Type
float

Minimum Value
1

Maximum Value
60

Permissions
Read Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"transponder:timeout float 0 }
{"Command":"SetValue","Arguments":"transponder:timeout float 60 0 }
```

Return:

```
{"transponder:timeout": value}
```

## pinger:mode

Description:
Pinger mode. Default value: 0 = Off.
Data Type
int

Minimum Value
0
Maximum Value
1

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"pinger:mode int 0 }
{"Command":"SetValue","Arguments":"pinger:mode int 1 0 }
```

Return:
```
{"pinger:mode": value}
```

## pinger:carrier

Description:
  Pinger carrier frequency. Default value: 8087.
Data Type
  float

Minimum Value
  5000
Maximum Value
  45000

Permissions
  Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"pinger:carrier float 0 }
{"Command":"SetValue","Arguments":"pinger:carrier float 45000 0 }
```

Return:
```
{"pinger:carrier": value}
```

## pinger:pingtone

Description:
Ping tone frequency. Default value: -1000.
Data Type
float

Minimum Value
-5000
Maximum Value
5000

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"pinger:pingtone float 0 }
{"Command":"SetValue","Arguments":"pinger:pingtone float 5000 0 }
```

Return:
```
{"pinger:pingtone": value}
```

## pinger:tonelength

Description:
Tone length. Default value: 0.014.
Data Type
float

Minimum Value
0.01
Maximum Value
0.1

Permissions
Read Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"pinger:tonelength float 0 }
{"Command":"SetValue","Arguments":"pinger:tonelength float 0.1 0 }
```

Return:
```
{"pinger:tonelength": value}
```

# 22 Appendix A

## 22.1 The Acoustic Message Header

Every acoustic packet contains a header packet. Some types of acoustic packets are only a header, while others contain a subsequent payload packet. bits Field

Table 22.1: Header packet format

| Bits | Field | Purpose | Format |
|---|---|---|---|
| 0-7 | Message Type | Identify between Packet, Packet with payload, ranging etc.<br>**MessageIDs**<br>0 - Data<br>128 -Range Response<br>129 -Range Request<br>130 -Status | 8 Bit MessageID |
| 8-15 | SenderID | ID of the transmitting modem | 0x0 – 0xfe - ID<br>0xff Broadcast |
| 16-23 | ReceiverID | The intended ID of the destination receiver. | 0x0 – 0xfe - ID 0xff = Broadcast message |
| 24-31 | TxPower | The transmitted scale factor as entered by the transmitting modem | Transmit power level as a Q8 scale value |
| 32-47 | PayloadInfo | If the present message does not contain a payload, then this field is 0.<br>If a payload follows, the bits are assembled according to the payloadinfo fields described below. | See Section 22.2 |

## 22.2 Payload Structure

If header bytes 4 and 5 are not zero, modulated payload data will immediately follow the modulated header data. The payload is described by the 16 bits in the payload info field of the header as follows:

Table 22.2: Header Byte 4

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Plen7 | Plen6 | Plen5 | Plen4 | Plen3 | Plen2 | Plen1 | Plen0 |

Table 22.3: Header Byte 5

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Mod4 | Mod3 | Mod2 | Mod1 | Mod0 | Stream | Plen9 | Plen8 |

The length of the payload in bytes is set by the 10 bits of the Plen field. Although the field contains 10 bits, the payload size is capped by the software to a maximum of 256 bytes. Bits 11-15 of byte 5 of the header contain the modulation employed for the payload. Popoto uses the following enumerated modulations:

Table 22.4: Modulation Types (Mod Values)

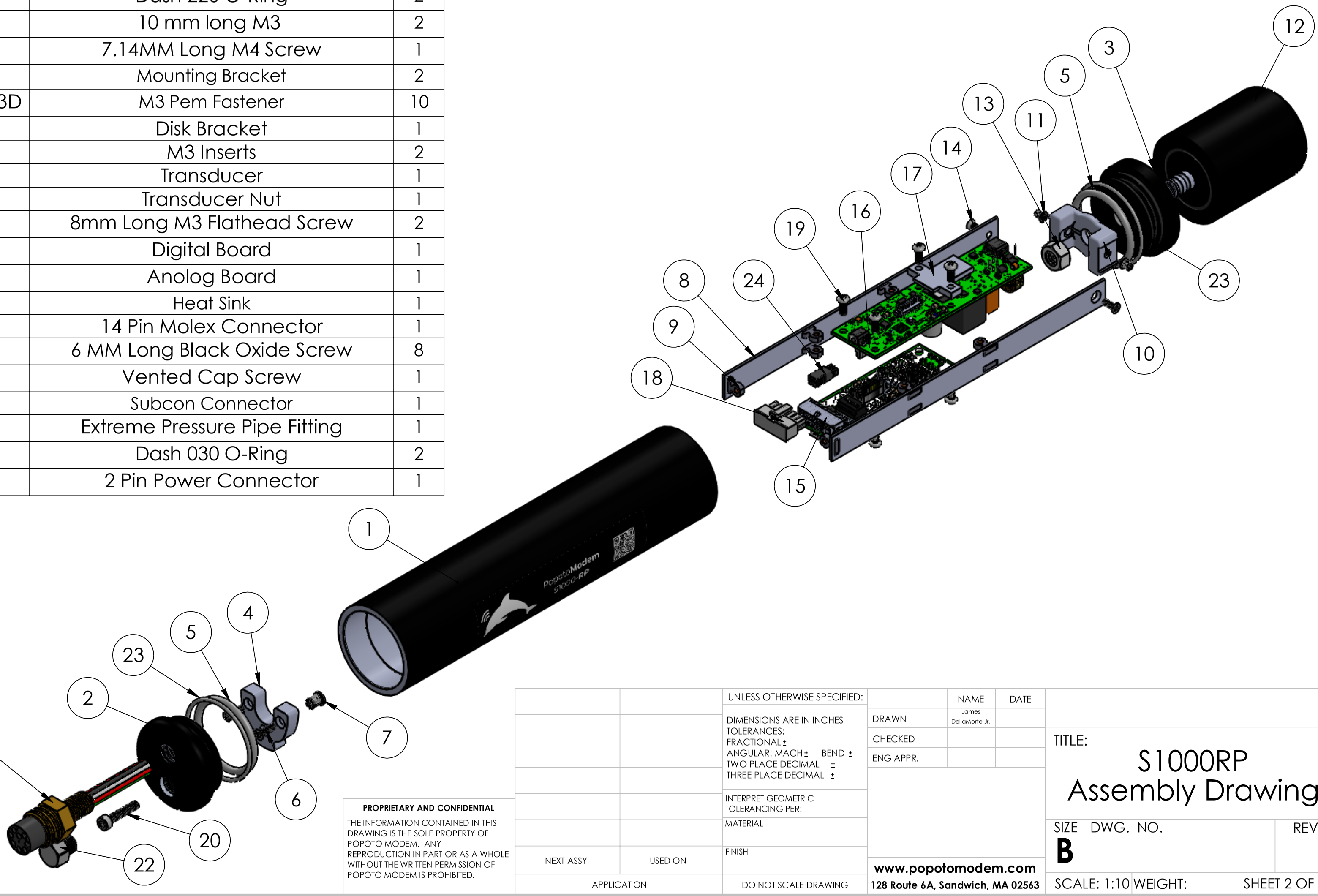
| Modulation Bitfield | Modulation Scheme | Data Rate |
|---|---|---|
| 0 | Frequency Hopped FSK | 80 bps |
| 1 | Phase Shift Keying | 5120 bps |
| 2 | Phase Shift Keying | 2560 bps |
| 3 | Phase Shift Keying | 1280 bps |
| 4 | Phase Shift Keying | 640 bps |
| 5 | Phase Shift Keying | 10240(uncoded) bps |

When large files are transmitted, it is more efficient to transfer the file in streaming mode. When streaming mode is invoked, the bit 10, of header byte 5 is set to indicate streaming mode. In streaming mode, the payload length Plen indicates the number of 255 byte frames which follow before another header transmission. All 255 byte packet remainders are handled by the software automatically.

# 23 Appendix B

## 23.1 Assembly Drawings

| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | 371-302-01 | Minislim Circuit Board Tube, no battery | 1 |
| 2 | 371-300-00 | Minislim Subcon Endcap | 1 |
| 3 | 371-301-00 | Minislim Transducer Endcap | 1 |
| 4 | 371-303-00 | Rainbow Bracket | 1 |
| 5 | 9557K489 | Dash 220 O-Ring | 2 |
| 6 | 92010A120 | 10 mm long M3 | 2 |
| 7 | 90741A250 | 7.14MM Long M4 Screw | 1 |
| 8 | 371-311-00 | Mounting Bracket | 2 |
| 9 | RASM3-7-3ZI-PennEngineering-3D | M3 Pem Fastener | 10 |
| 10 | 371-305-00 | Disk Bracket | 1 |
| 11 | 94510A240 | M3 Inserts | 2 |
| 12 | BTech Transducer | Transducer | 1 |
| 13 | 95505A602 | Transducer Nut | 1 |
| 14 | 92010A118 | 8mm Long M3 Flathead Screw | 2 |
| 15 | 051-0010-20 | Digital Board | 1 |
| 16 | 051-0029-20 | Anolog Board | 1 |
| 17 | heat sink minislim | Heat Sink | 1 |
| 18 | 430251410 | 14 Pin Molex Connector | 1 |
| 19 | 95836A207 | 6 MM Long Black Oxide Screw | 8 |
| 20 | 93235A326 | Vented Cap Screw | 1 |
| 21 | mcbh8f | Subcon Connector | 1 |
| 22 | 51205K286 | Extreme Pressure Pipe Fitting | 1 |
| 23 | 9557K670 | Dash 030 O-Ring | 2 |
| 24 | ptsm_0.5-2-p-2.5.stp | 2 Pin Power Connector | 1 |

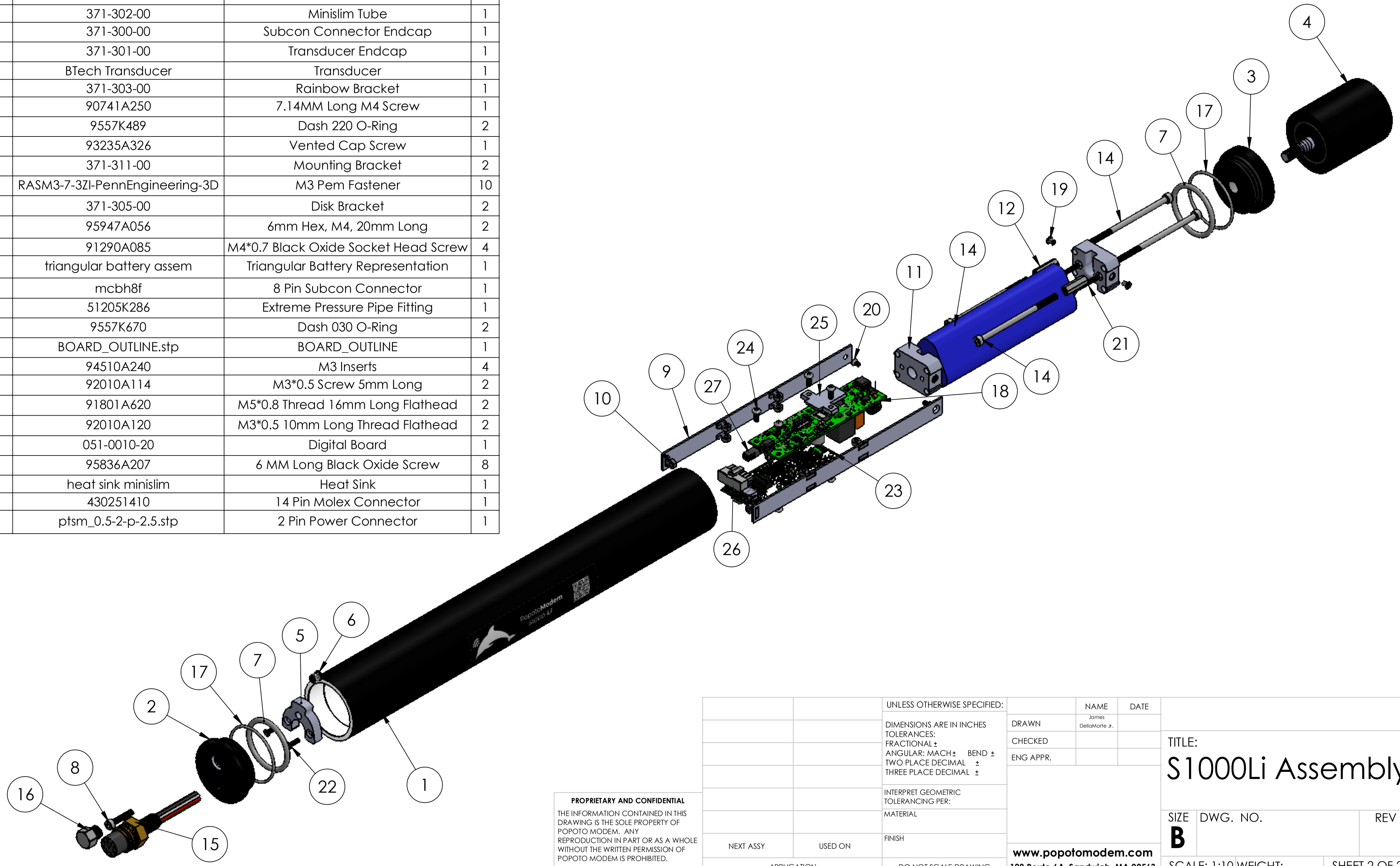


| | | | | | |
|---|---|---|---|---|---|
| | | UNLESS OTHERWISE SPECIFIED: | | NAME | DATE |
| | | DIMENSIONS ARE IN INCHES<br>TOLERANCES:<br>FRACTIONAL ±<br>ANGULAR: MACH ± BEND ±<br>TWO PLACE DECIMAL ±<br>THREE PLACE DECIMAL ± | DRAWN | James DellaMorte Jr. | |
| | | | CHECKED | | |
| | | | ENG APPR. | | |
| | | INTERPRET GEOMETRIC TOLERANCING PER: | | | |
| | | MATERIAL | | | |
| NEXT ASSY | USED ON | FINISH | **www.popotomodem.com**<br>**128 Route 6A, Sandwich, MA 02563** | | |
| APPLICATION | | DO NOT SCALE DRAWING | | | |

TITLE:
S1000RP
Assembly Drawing

| SIZE | DWG. NO. | REV |
|---|---|---|
| **B** | | |
| SCALE: 1:10 | WEIGHT: | SHEET 2 OF 2 |

| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | 371-302-00 | Minislim Tube | 1 |
| 2 | 371-300-00 | Subcon Connector Endcap | 1 |
| 3 | 371-301-00 | Transducer Endcap | 1 |
| 4 | BTech Transducer | Transducer | 1 |
| 5 | 371-303-00 | Rainbow Bracket | 1 |
| 6 | 90741A250 | 7.14MM Long M4 Screw | 1 |
| 7 | 9557K489 | Dash 220 O-Ring | 2 |
| 8 | 93235A326 | Vented Cap Screw | 1 |
| 9 | 371-311-00 | Mounting Bracket | 2 |
| 10 | RASM3-7-3ZI-PennEngineering-3D | M3 Pem Fastener | 10 |
| 11 | 371-305-00 | Disk Bracket | 2 |
| 12 | 95947A056 | 6mm Hex, M4, 20mm Long | 2 |
| 14 | 91290A085 | M4*0.7 Black Oxide Socket Head Screw | 4 |
| 14 | triangular battery assem | Triangular Battery Representation | 1 |
| 15 | mcbh8f | 8 Pin Subcon Connector | 1 |
| 16 | 51205K286 | Extreme Pressure Pipe Fitting | 1 |
| 17 | 9557K670 | Dash 030 O-Ring | 2 |
| 18 | BOARD_OUTLINE.stp | BOARD_OUTLINE | 1 |
| 19 | 94510A240 | M3 Inserts | 4 |
| 20 | 92010A114 | M3*0.5 Screw 5mm Long | 2 |
| 21 | 91801A620 | M5*0.8 Thread 16mm Long Flathead | 2 |
| 22 | 92010A120 | M3*0.5 10mm Long Thread Flathead | 2 |
| 23 | 051-0010-20 | Digital Board | 1 |
| 24 | 95836A207 | 6 MM Long Black Oxide Screw | 8 |
| 25 | heat sink minislim | Heat Sink | 1 |
| 26 | 430251410 | 14 Pin Molex Connector | 1 |
| 27 | ptsm_0.5-2-p-2.5.stp | 2 Pin Power Connector | 1 |



| | | | | |
|---|---|---|---|---|
| UNLESS OTHERWISE SPECIFIED: | | NAME | DATE | |
| DIMENSIONS ARE IN INCHES<br>TOLERANCES:<br>FRACTIONAL ±<br>ANGULAR: MACH ± BEND ±<br>TWO PLACE DECIMAL ±<br>THREE PLACE DECIMAL ± | DRAWN | James DellaMorte Jr. | | TITLE: |
| | CHECKED | | | S1000Li Assembly |
| | ENG APPR. | | | |
| INTERPRET GEOMETRIC TOLERANCING PER: | | | | SIZE B |
| MATERIAL | | | | DWG. NO. |
| FINISH | www.popotomodem.com<br>128 Route 6A, Sandwich, MA 02563 | | | REV |
| DO NOT SCALE DRAWING | | | | SCALE: 1:10 WEIGHT: SHEET 2 OF 2 |

| | |
|---|---|
| NEXT ASSY | USED ON |
| APPLICATION | |