Popoto Modem

Popoto User's Guide
PMM5021

delResearch LLC

Document Versions

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1.20	Add Interface board and Battery Mux	J DellaMorte	3.x	9/2022

Contents

List of Tables

List of Figures

1 Getting Started

In this section we will explore how to configure, cable, and try the Popoto hardware and software system.

1.1 In the box:

A complete Popoto system consists of the following hardware components:

1. Transducer

2. Analog board

3. Digital board

4. SD card

1.1.1 Transducer

The Popoto transducer consists of a potted ceramic piezo ring. It is designed to efficiently convert mechanic signal energy to and from electrical analog signals in the 25 KHz region. A picture of the transducer is shown in Figure 1.1.1

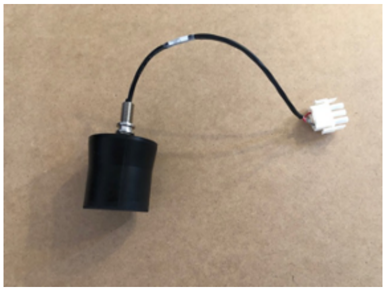


Figure 1.1: The Popoto 25 Khz Transducer

1.1.2 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 1.1.2:

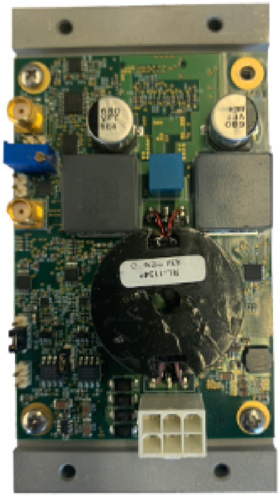


Figure 1.2: The PMM5021 Analog board

1.1.3 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.

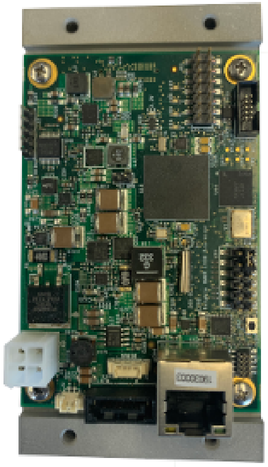


Figure 1.3: The PMM5021 Digital board

1.1.4 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.

1.1.5 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.

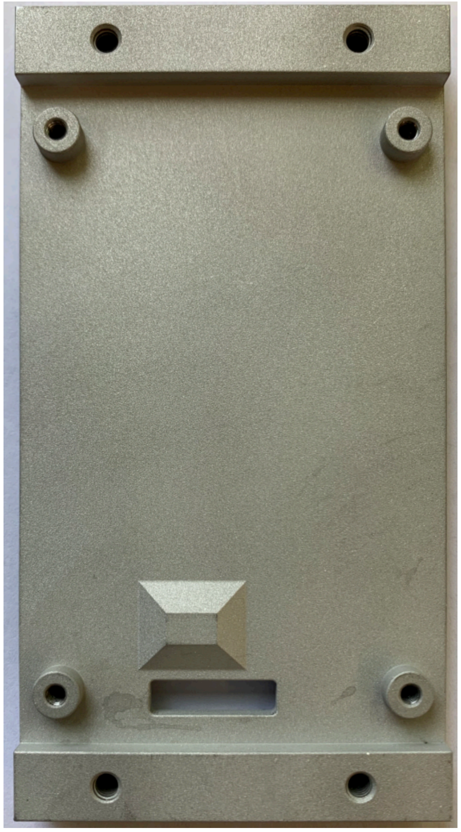


Figure 1.4: The PMM5021 Mounting Tray with M4 mounting screws

1.2 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 2.7
- Serial Port Terminal software

1.3 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.

1.3.1 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.

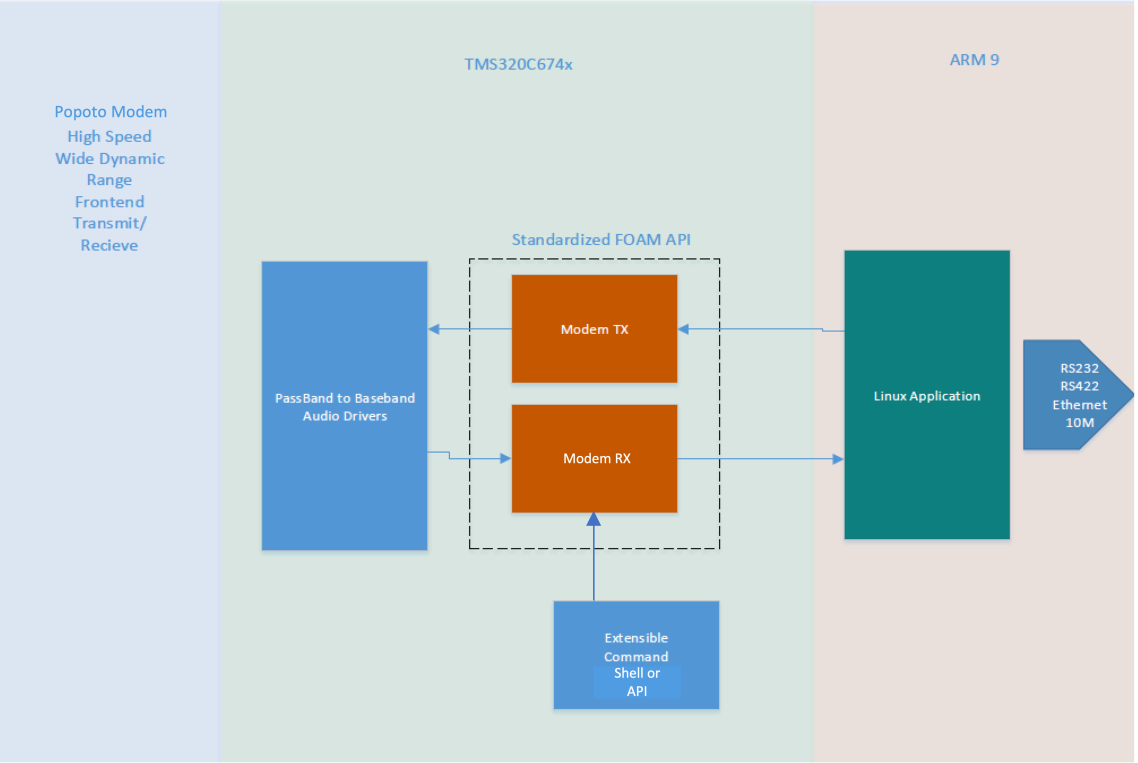


Figure 1.5: High Level Popoto Block Diagram

Configuration of the analog section for an air test is quite simple. First ensure that the Jumper J2 is inserted between positions 1-2. This sets the analog input to driven by the acoustic signals picked up by the transducer.

Once J2 is set, all that is necessary is plugging in the transducer into the J9 connector of the analog board.

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.3.5 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.

1.3.6 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.

1.3.7 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.

1.3.8 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.

1.3.9 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.

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

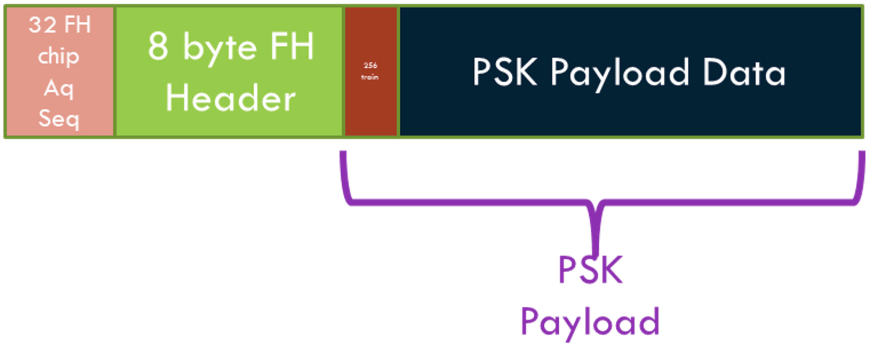


Figure 1.6: PSK Payload Message Structure

- 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 0. Freqeuncy Hop FSK 80 Bits/sec 1. PSK 5120 BPS 2. PSK 2560 BPS 3. PSK 1280 BPS 4. PSK 640 BPS 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) **

1.3.10 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.

1.3.11 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 Communicating with Popoto

2.1 Introduction

The Popoto system consists of several components working together to create an acoustic digital communication system. Refer to Figure 2.1. 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.

2.2 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.

2.2.1 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

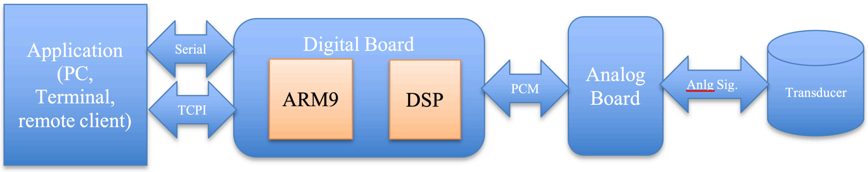


Figure 2.1: Popoto System Overview.

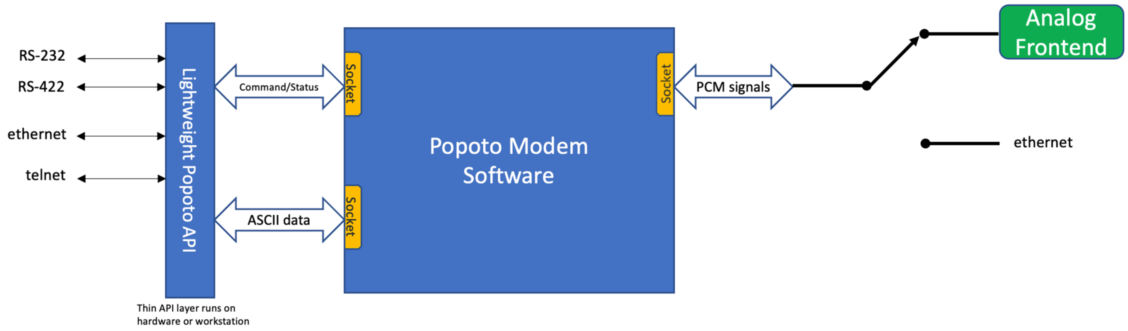


Figure 2.2: Popoto Modem Socket interfaces.

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)

2.2.2 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.

2.2.3 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:

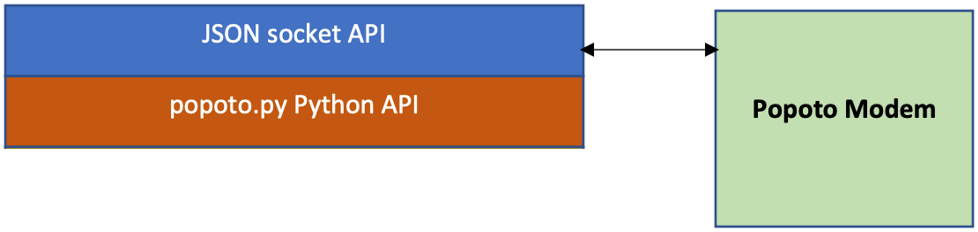


Figure 2.3: JSON API Interfacing to Python.

```
{"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"}
```

2.2.4 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.

2.2.5 System Level Variables

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

2.3 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.

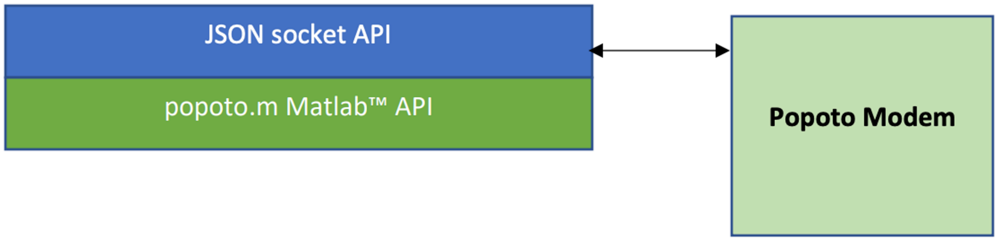


Figure 2.4: Popoto Modem Matlab and JSON API.

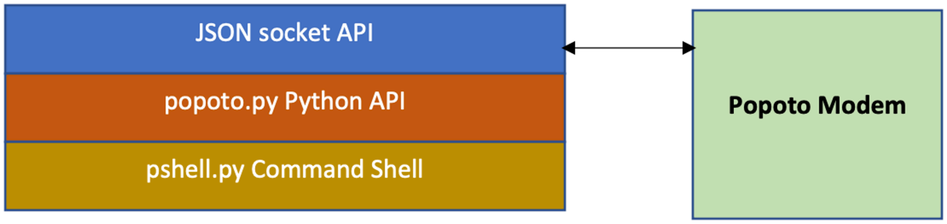


Figure 2.5: Popoto pshell to Popoto.py to JSON.

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:

3 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.

3.1 RS-422 4 wire serial

3.1.1 Reasons to use it

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

3.1.2 Reasons to avoid it

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

3.2 RS-232 Uart

3.2.1 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.

3.2.2 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.

3.3 10/100BaseT

3.3.1 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

3.3.2 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.

3.4 TTL (3.3V) UART

3.4.1 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.

3.4.2 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.

3.5 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.

3.5.1 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 3.1 shows local pshell processing.

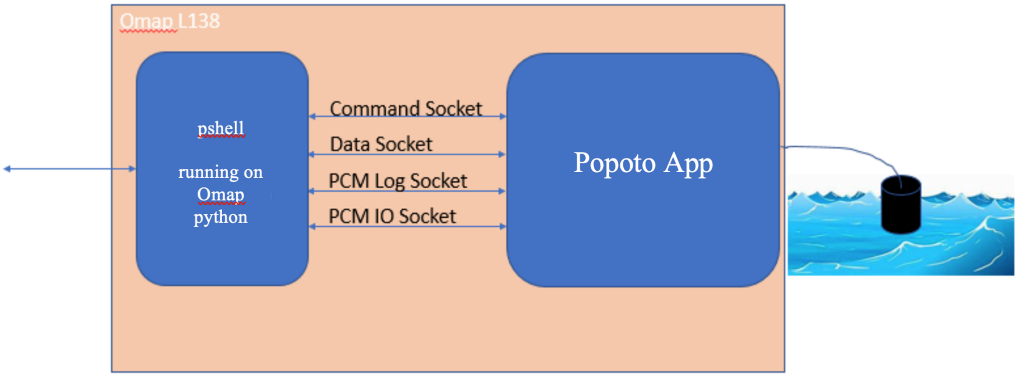


Figure 3.1: Local Pshell operation.

3.5.2 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 3.2. 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.

3.5.3 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

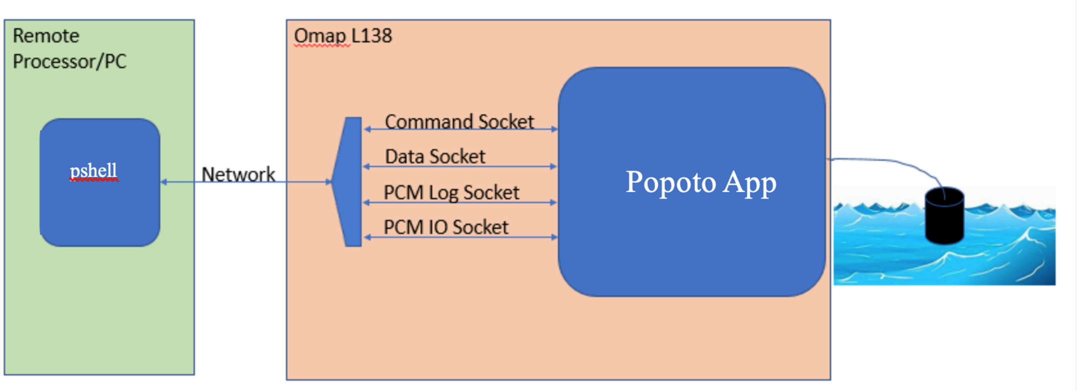


Figure 3.2: Connecting to Popoto using a remote pshell

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.

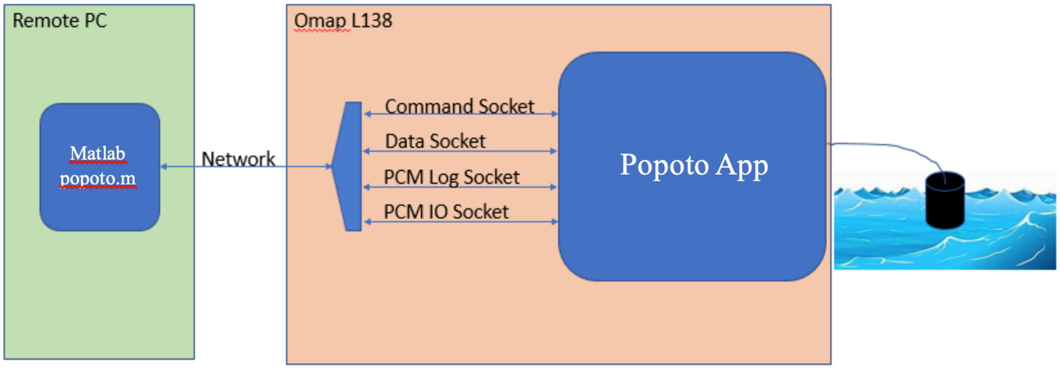


Figure 3.3: Connecting to Popoto Over Matlab™.

3.5.4 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 3.4 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.

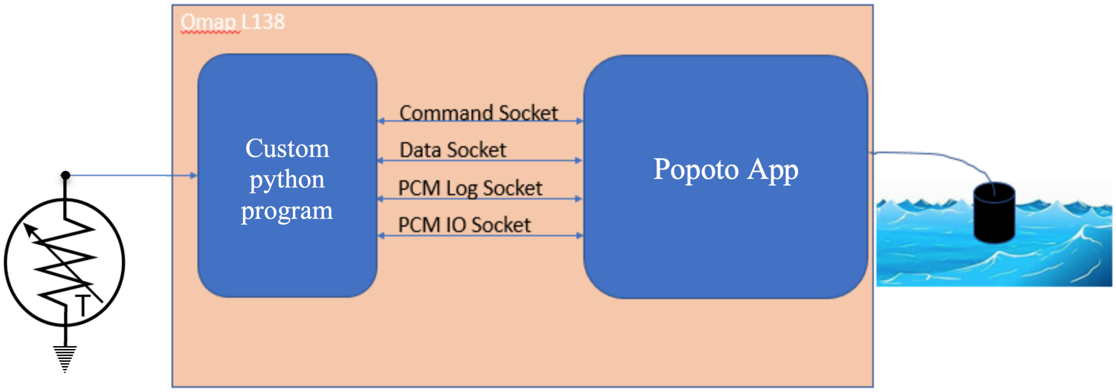


Figure 3.4: Popoto Modem implementing a custom application. In this picture, a Popoto modem is configured to measure a temperature sensor, and report its measurements via the acoustic channel.

3.6 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.

4 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.

4.1 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.

4.2 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)

4.3 Invoking pshell

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

4.3.1 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.

4.3.2 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.

4.4 Invoking commands

4.4.1 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.

4.4.2 Tab Completion

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

4.4.3 Commands

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

4.5 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.

5 Single Side Band Voice Operation

5.1 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.

5.2 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

5.2.1 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.

5.2.2 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.

5.2.3 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.

5.2.4 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 5.1: 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 **

5.2.5 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.

5.3 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.

5.3.1 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.

5.3.2 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 5.2. 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.

5.4 Return to data mode

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

5.5 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 5.2: 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

6 Janus Operation

6.1 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.

6.2 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 6.1. 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.

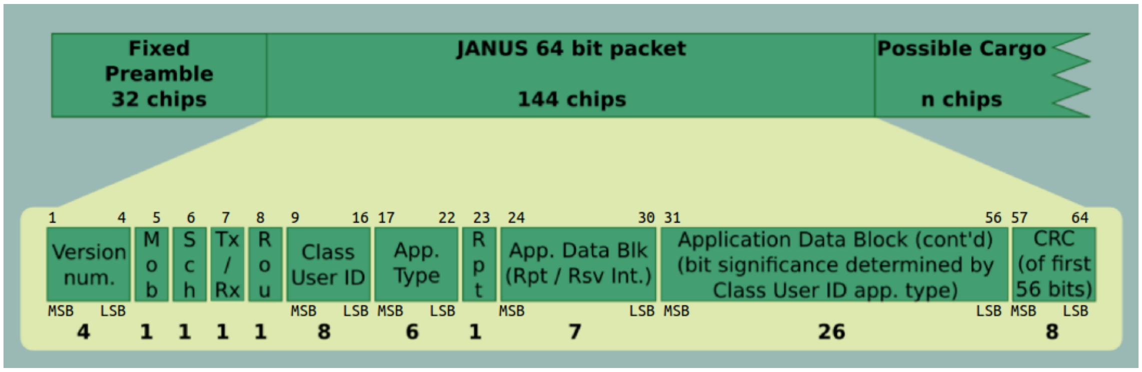


Figure 6.1: Janus Baseline Bit Aloocation. (from the Januswiki.com webiste)

6.3 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.

6.3.1 Class User Id: 000 Emergency

6.3.1.1 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"
}
```

6.3.1.2 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"
}
```

6.3.1.3 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"
}
```

6.3.2 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"
    }
  ]
}
```

6.3.3 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]}
}
```

7 Enclosure Connectors

7.1 M2000/S2000 Connectors

The M2000 and S2000 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.

7.1.1 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

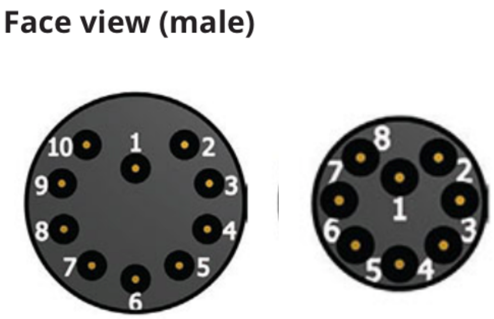


Figure 7.1: Pin Locations: 10 Pin and 8 Pin Connectors as viewed from the face of the male connector.

7.1.2 10 Pin Ethernet Option

Pin Number	Pin Function	Notes
1	Ethernet Tx+	T568A Green White T568B Orange White
2	Ethernet Tx-	T568A Green T568B Orange
3	Ethernet Rx+	T568A Orange & White T568B Green & White
4	Ethernet Rx-	T568A Orange 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

7.1.3 10 Pin RS-422 Option

Pin Number	Pin Function	Notes
1	RS 422 Rx +(FTDI)	J8-1 RS 422 TX+ (Popoto) Yellow
2	RS 422 Rx -(FTDI)	J8-2 RS433 TX- (Popoto) White
3	RS 422 Tx+(FTDI)	J8-3 RS422 Rx+ (Popoto) Orange
4	RS 422 Tx-(FTDI)	J8-4 RS 422 Rx- (Popoto) 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

7.1.4 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)

7.1.5 8 Pin Ethernet Option

Pin Number	Color	Pin Function	Notes
1	Red	Ethernet Tx+	T568A Green White T568B Orange White
2	Black	Ethernet Tx-	T568A Green T568B Orange
3	Yellow	Ethernet Rx+	T568A Orange & White T568B Green & White
4	Blue	Ethernet Rx-	T568A Orange 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

7.1.6 8 Pin RS-422 Option

Pin Number	Color	Pin Function	Notes
1	Red	RS 422 Rx +(Host)	J8-1 RS 422 TX+ (Popoto) Yellow
2	Black	RS 422 Rx -(Host)	J8-2 RS433 TX- (Popoto) White
3	Yellow	RS 422 Tx+(Host)	J8-3 RS422 Rx+ (Popoto) Orange
4	Blue	RS 422 Tx-(Host)	J8-4 RS 422 Rx- (Popoto) 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

7.1.7 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

8 OEM Interface Description

8.1 Popoto Digital Interface

8.1.1 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 interfaces include RS-232, RS-422, 10/100 Ethernet, Board On/Off control, and PPS input signal.

8.1.2 PDI Hardware Components

PDI is connected to using a Molex Microfit connector (P/N 0430251400) or equivalent. This connector is sold as a shell plus discrete pins. While Molex produces many different pins for use with the MicroFit series, the best pins for use with Popoto Modems 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 one of Molex hand crimp tools 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.

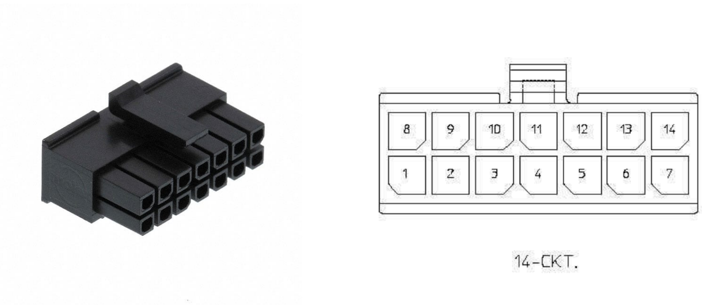


Figure 8.1: PDI User-Side Molex Connector. Interfacing to the PDI is accomplished with a Molex Microfit shell P/N 0430251400 and either Pre-pinned jumper wires, or Molex socket crimps.

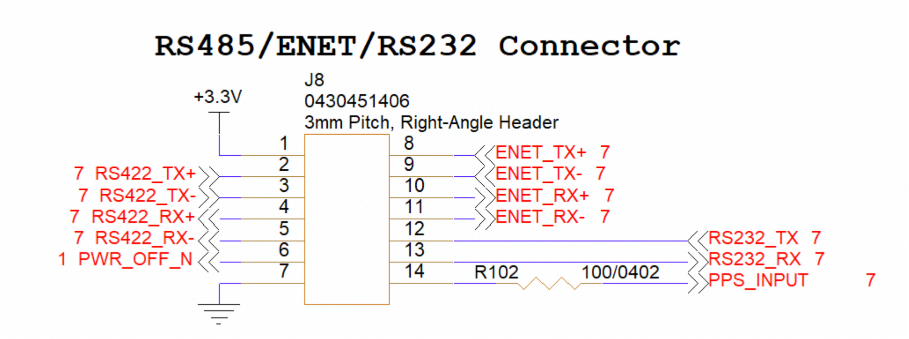


Figure 8.2: PDI Schematic connections.

8.1.3 Electrical Connections

Figure 8.2 shows the electrical connections for the the PDI interface. 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. PowerOFFN 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 8.1: 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

Table 8.2: 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 T568B Orange White
9	O	Ethernet Tx-	T568A Green T568B Orange
10	I	Ethernet Rx+	T568A Orange & White T568B Green & White
11	I	Ethernet Rx-	T568A Orange 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 Max Voltage 3.3V for PMM3511 5V for PMM5021

8.1.4 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.

8.1.4.1 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 8.3 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 8.3: 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

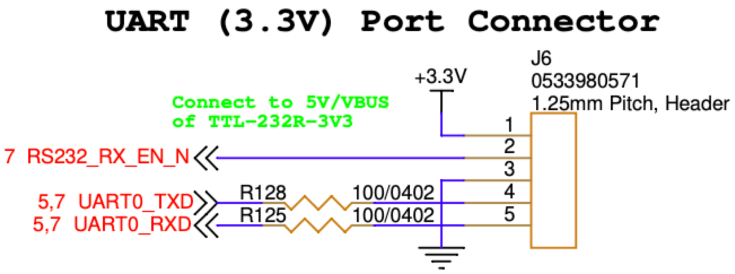


Figure 8.3: Popoto TTL Uart Plug. This port allows 3.3V Logic level uart connections

Table 8.4: 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

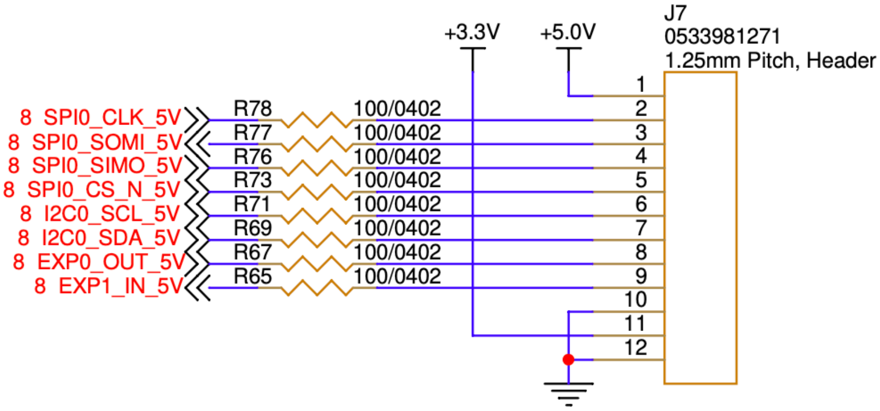


Figure 8.4: Popoto Expansion Header. This connector allows access to I2C, SPI and General purpose I/O from the Popoto Modem.

8.1.4.2 Expansion Header

Figure 8.4 shows the schematic diagram of the expansion header. This header is used to access peripherals from the Popoto Modem when running applications locally on the SOC. It supports a General Purpose input and General Purpose output pin, as well as SPI and I2C interfaces. Signals from this connector are used for PTT and volume control in SSB mode(PMM5021). This connector is a 12 Pin Picoblade connector, and the parts required for its use are listed in Table 8.5

Table 8.5: 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

8.1.4.3 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.

8.1.4.4 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.

8.2 PMM5021 Specific Interfaces

8.2.1 Power

Power is provided to the PMM5021 OEM Boardset via connector J1 on the Digital Board. This connector is a 4 pin Molex MiniFit Jr connector, and has provisions for 2 V+ pins and 2 Ground pins. Acceptable input voltages are between 12 and 40 Volts. Table 8.7 and Figure 8.5 show the connections required for powering the PMM5021. Table 8.6 shows the parts required for attaching to the power connector on the PMM5021. 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.

Table 8.6: PMM5021 Power 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 8.7: PMM5021 Power Connector Pinout

Pin Number	I/O	Pin Name	Notes
1	P	V+	12-40 Volts 150 Watts
2	P	V+	12-40 Volts 150 Watts
3	G	GND	Ground
4	G	GND	Ground

8.2.2 Analog Interfaces

The Analog interfaces to the PMM5021 can be found on the analog board. This board has the large round pot-core inductor, and can be seen in Figure 8.7

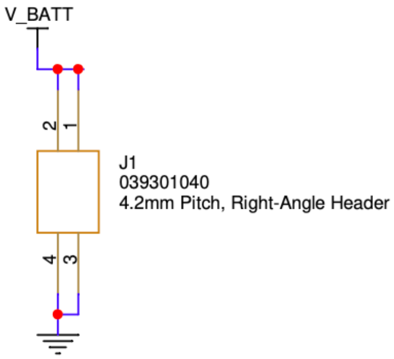


Figure 8.5: PMM5021 Power Schematic.

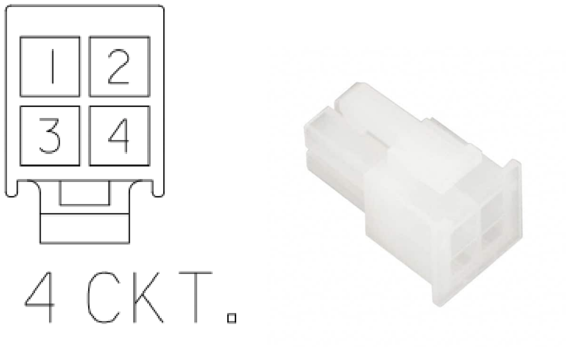


Figure 8.6: PMM5021 Power Connectors and pinout.

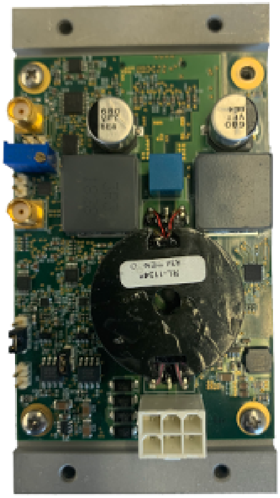
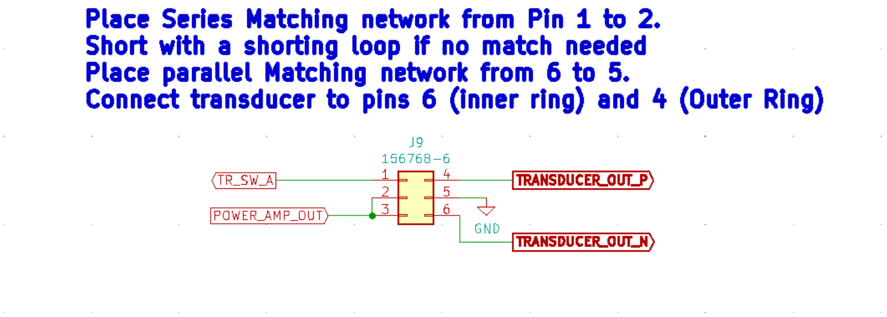


Figure 8.7: The PMM5021 Analog board

8.2.2.1 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 8.8 and 8.9 for the pinout for this connector.



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)

Figure 8.8: The PMM5021 Transducer connector schematic.

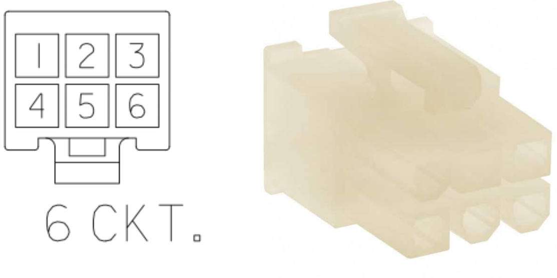


Figure 8.9: PMM5021 Transducer connector and pinout.

Table 8.8: PMM5021 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 8.9: PM5021 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

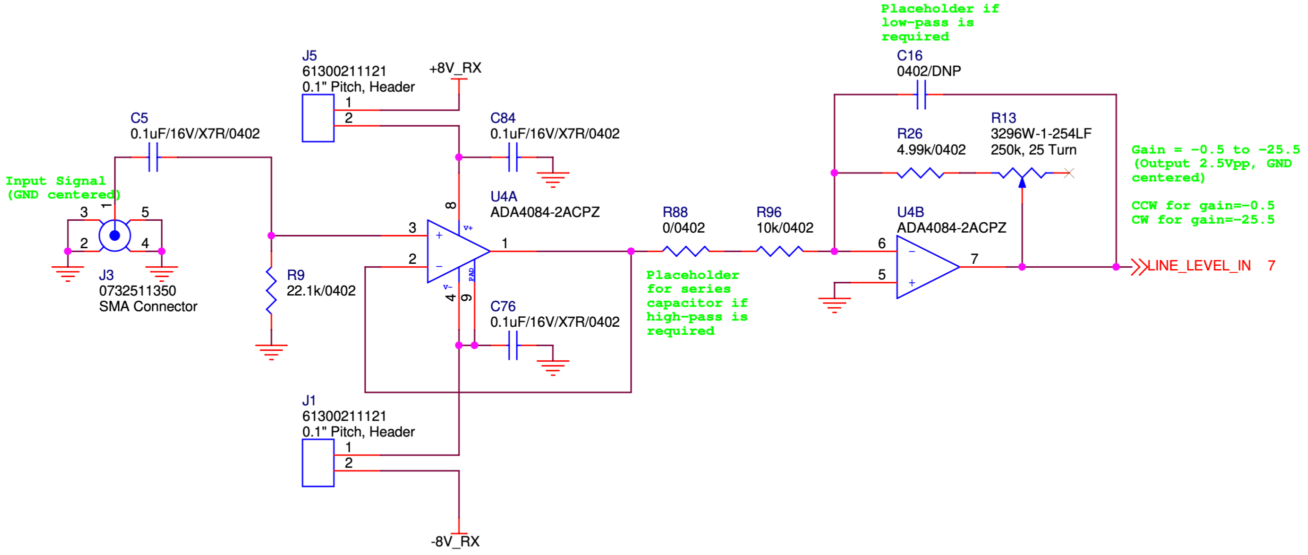


Figure 8.10: PMM5021 Analog input schematic excerpt. This circuit conditions the input signal and is used for SSB voice input or for applications providing line level analog input.

8.2.2.2 Analog In

The PMM5021 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 8.10. 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.

8.2.2.3 Analog Out

The PMM5021 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 to +/-5V. An excerpt of the schematic, showing the input amplifier topology is shown in Figure 8.11. The full scale output voltage on the SMA is +/- 2.0 Vpp. The maximum output current is 145mA and is ground centered.

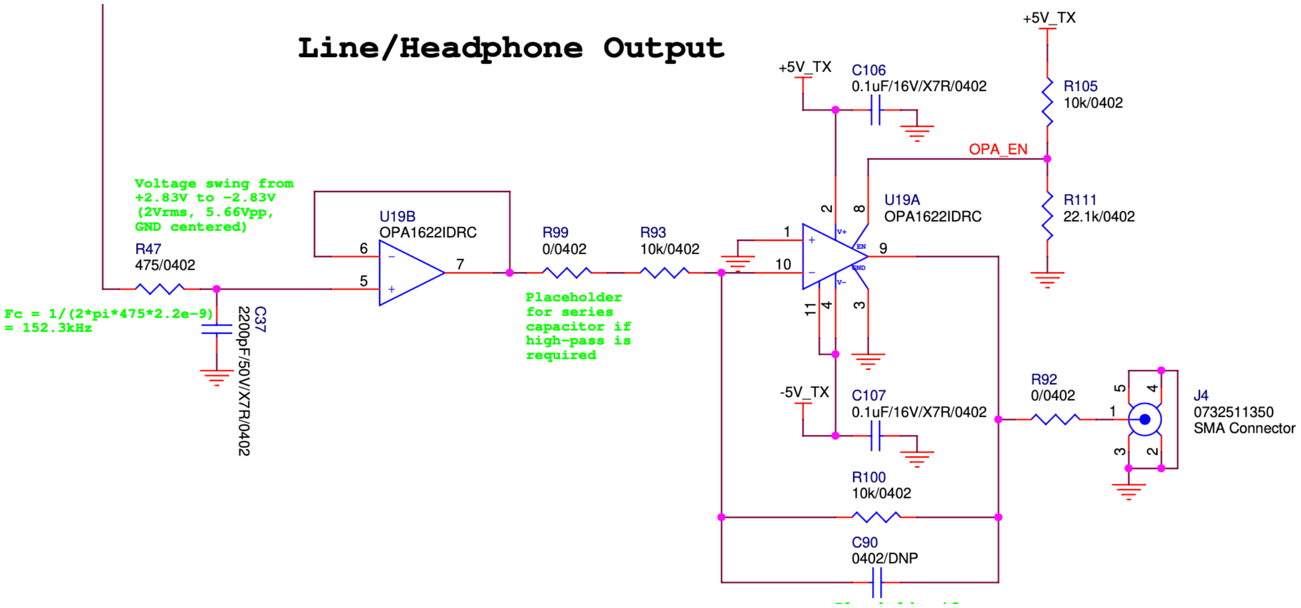


Figure 8.11: PMM5021 Analog output schematic excerpt. This circuit provides a +/- 5V signal to the SMA output port. This signal is used for the headphones output during SMA voice mode, or for a diagnostic port or to drive an external power amplifier if needed.

9 Battery Multiplexer

9.1 Battery Multiplexer

9.1.1 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

9.1.2 Power Connectors

Table 9.1: 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 9.2: 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

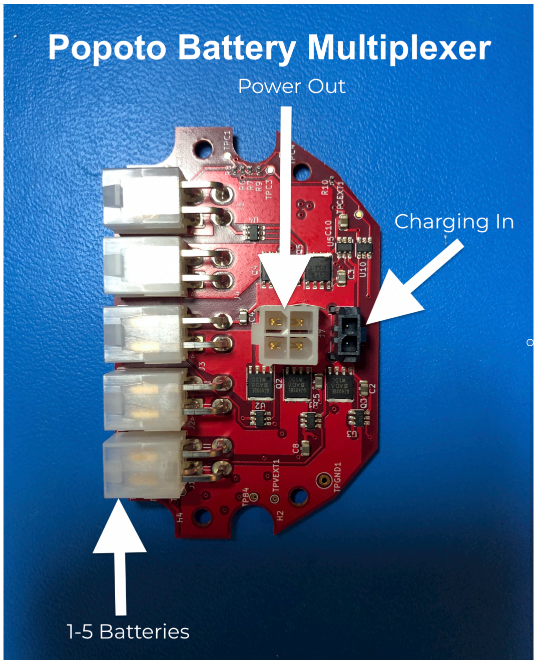


Figure 9.1: Popoto Battery Mux Board. Power is provided by 1-5 6S Lithium Ion Batteries provided on the Molex MiniFit Jr 4 pin connectors on the left. Power is drawn from the Minifit Jr 4 port connector on the top, and charging is accomplished by connecting the charger to the 2 port microfit connector on the right side of the diagram.

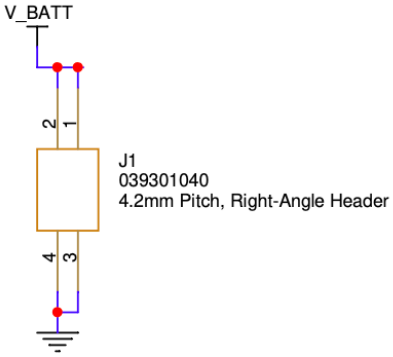


Figure 9.2: Battery Mux: Battery in Power out Schematic.

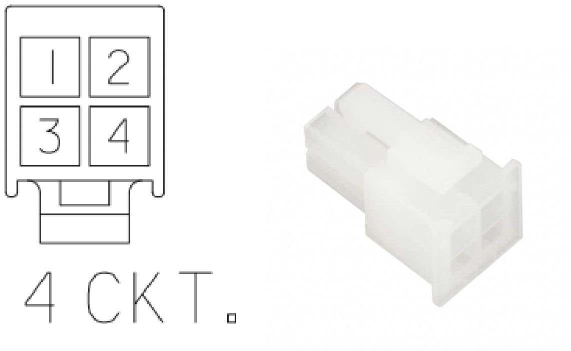


Figure 9.3: PMM5021 Power Connectors and pinout.

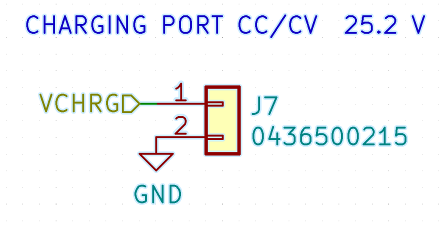


Figure 9.4: Battery Mux: Charging Port Schematic. Use a constant current/-constant voltage lithium ion charger for 6S Battery Packs. (1.875A)

9.1.3 Charging Connectors

The charging connector, J7, on the Battery Multiplexer (see Figure 9.4) will charge all battery packs in parallel using the standard Popoto CC/CV charger.

Table 9.3: 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

10 Popoto Interface Board

10.1 Popoto Interface Board

10.1.1 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.

10.1.2 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, ...

10.1.3 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 10.1: USB Ports

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

10.1.4 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.

10.1.5 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.

10.1.6 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 10.2: 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

10.1.7 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 10.3: 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 10.4: 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 10.5: Headphone/Microphone Connector J5

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

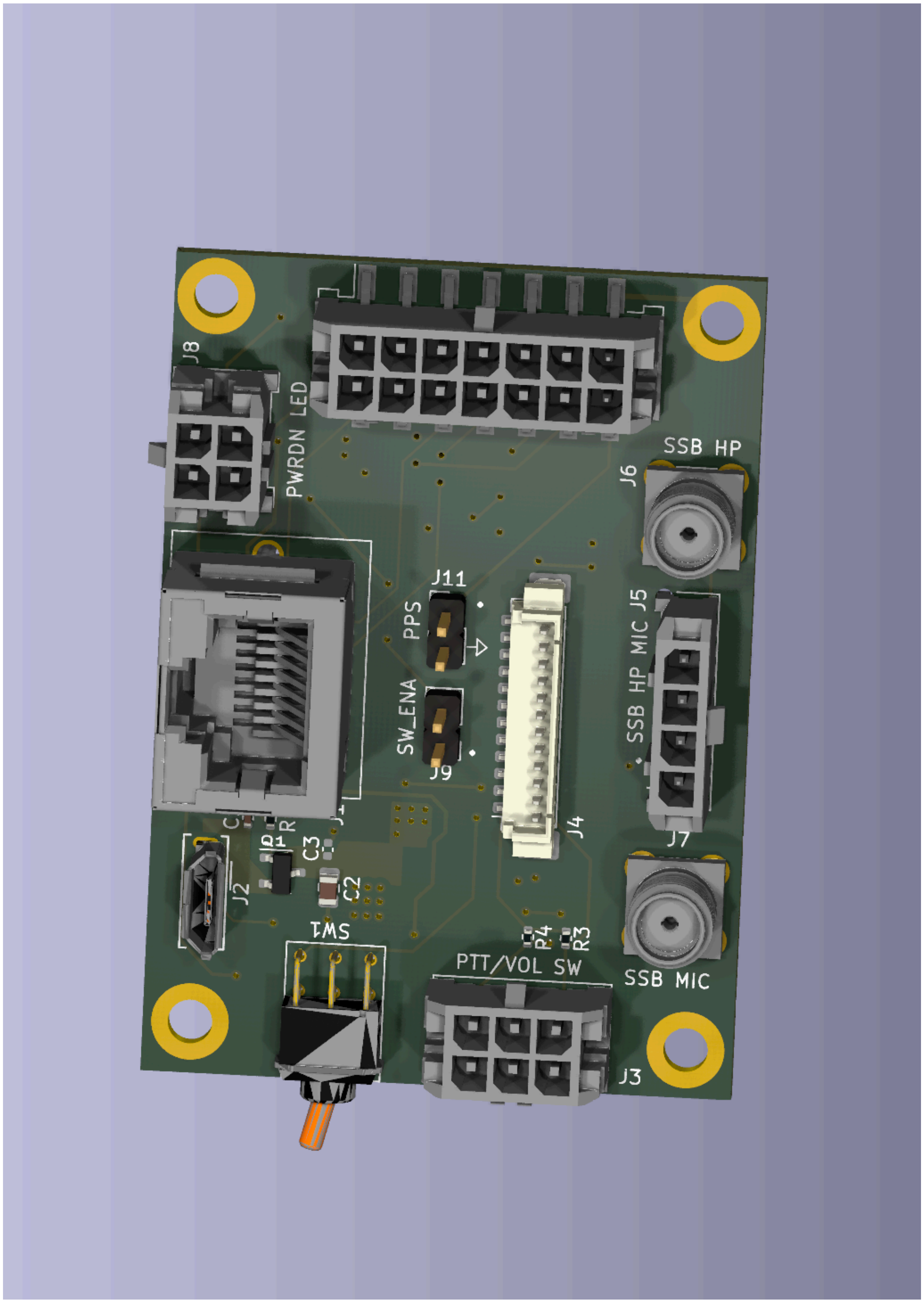


Figure 10.1: Popoto Interface Board

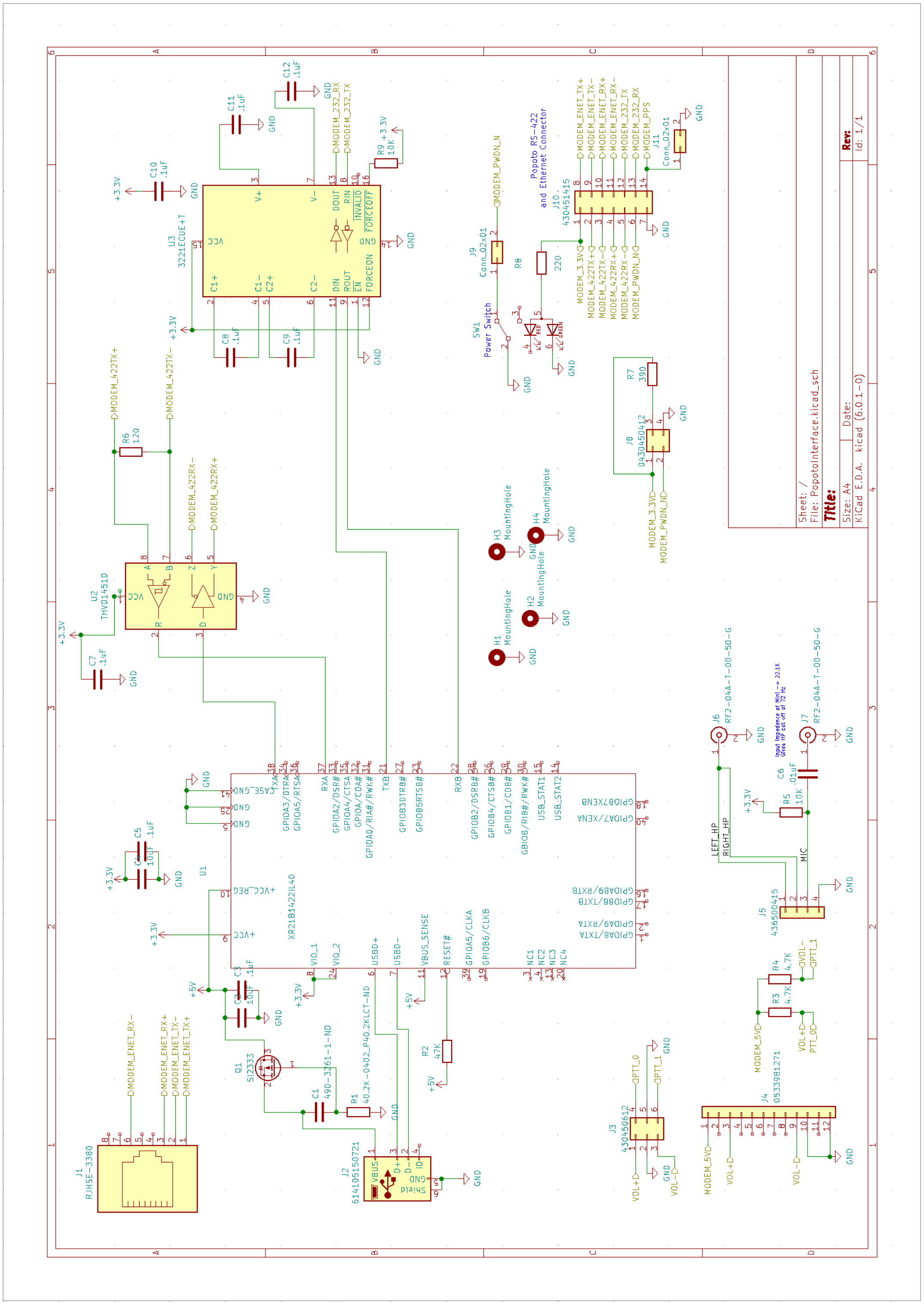


Figure 10.2: Popoto Interface Board Schematic

11 Upgrading the Firmware

11.1 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

11.1.1 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

11.2 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> "}
```

12 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.

12.1 Popoto log

12.1.1 Introduction

The Popoto.log is a diagnostic logfile which is 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.

12.1.2 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:

12.1.3 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
```

12.1.4 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
```

12.2 PCM Logging

12.2.1 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

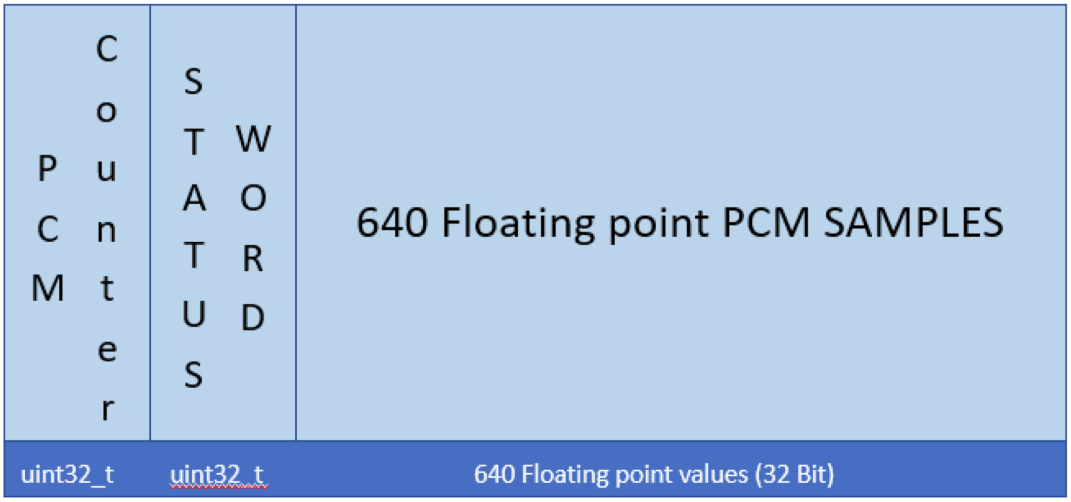

PCM Counter
STATUS WORD
640 Floating point PCM SAMPLES
uint32_t
uint32_t
640 Floating point values (32 Bit)

Figure 12.1: 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 12.1: 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.

12.2.2 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 12.2: 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
```

12.2.3 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.

12.2.4 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.

12.3 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.

13 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 FFFFFFFFFFFFFFFFFFFFF"}
```

14 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 14.1: Argument List format

Variable	Data Type	Value	Channel
BBAND_DownCarrier	int	Value	0

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

Table 14.2: 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}
```

APP_SystemMode

Description:
System Mode 0-DataModem, 1-SSB Tx, 2-SSB Rx

Data Type
int

Minimum Value
0.0
Maximum Value
0.0

Permissions
Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"APP_SystemMode int 0 }
{"Command":"SetValue","Arguments":"APP_SystemMode int 0.0 0 }
```

Return:

```
{"APP_SystemMode":  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}
```

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}
```

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}
```

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}
```

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}
```

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}
```

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}
```

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

70.0

Permissions

Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"PSK_BnTaps int 0 }
{"Command":"SetValue","Arguments":"PSK_BnTaps int 70.0 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
70.0

Permissions
Read and Write

JSON API Syntax:
```
{"Command":"GetValue","Arguments":"PSK_FnTaps int 0 }
{"Command":"SetValue","Arguments":"PSK_FnTaps int 70.0 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, 1-5120bps, 2-2560bps, 3-1280bps,4-640bps, 5-10240bps

Data Type

int

Minimum Value

0.0

Maximum Value

5.0

Permissions

Read and Write

JSON API Syntax:

```
{"Command":"GetValue","Arguments":"PayloadMode int 0 }
{"Command":"SetValue","Arguments":"PayloadMode int 5.0 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

3000.0

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

Data Type
    int

Minimum Value
    0.0
Maximum Value
    1.0

Permissions
    Read and Write

JSON API Syntax:

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

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_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_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_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_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}
```

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}
```

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_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}
```

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}
```

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}
```

15 Appendix A

15.1 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 15.1: Header packet format

Bits	Field	Purpose	Format
0-7	Message Type	Identify between Packet, Packet with payload, ranging etc. **MessageIDs** 0 - Data 128 -Range Response 129 -Range Request 130 -Status	8 Bit MessageID
8-15	SenderID	ID of the transmitting modem	0x0 – 0xfe - ID 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. If a payload follows, the bits are assembled according to the payloadinfo fields described below.	See Section 15.2

15.2 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 15.2: Header Byte 4

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

Table 15.3: 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 15.4: Modulation Types (Mod Values)

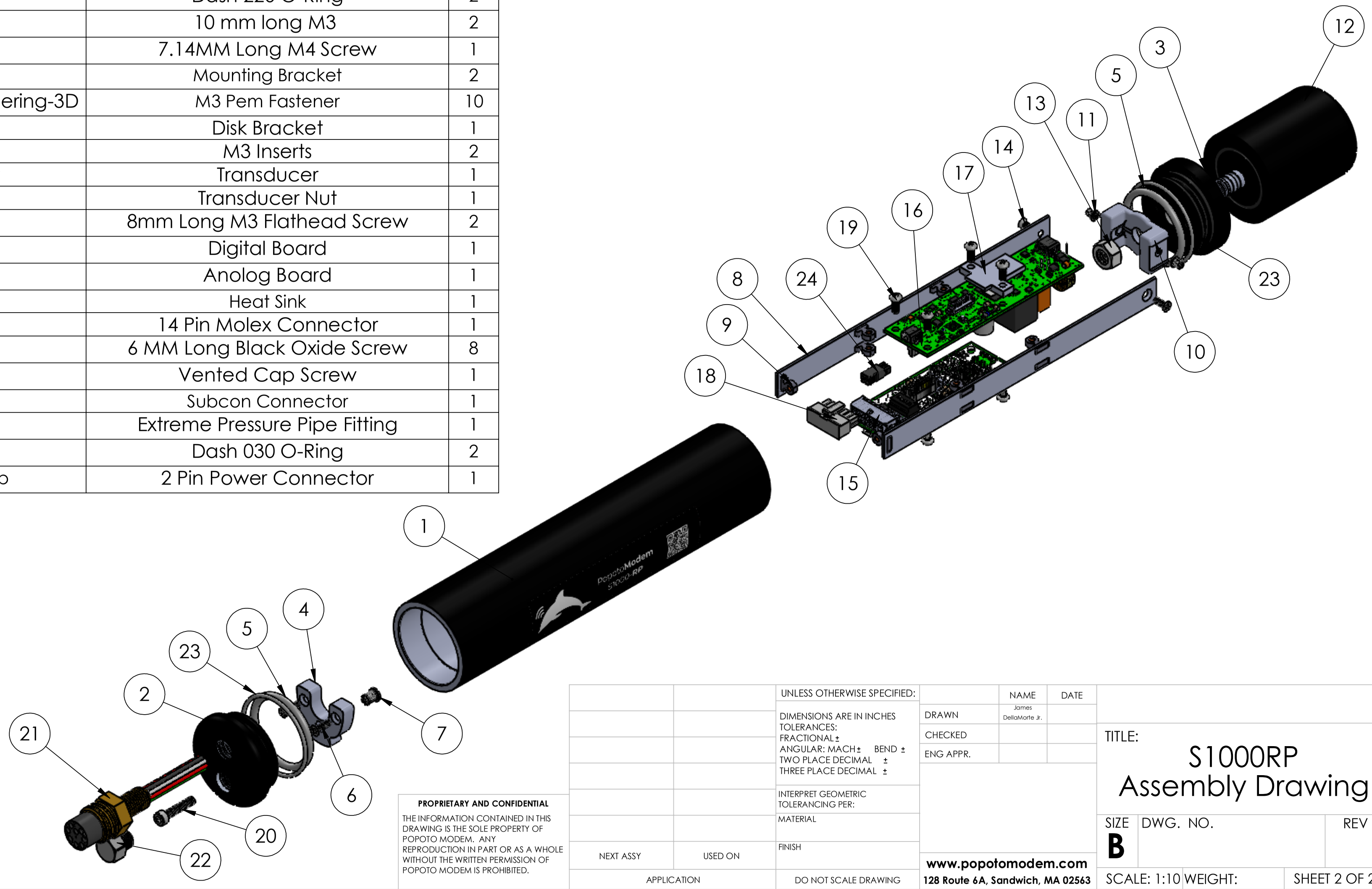
Modulation Bitfield	Modulation Scheme	Data Rate
0	Frequency Hopped FSK	80 bps
1	Phase Shift Keying	5120 bps
2	Phase Shift Keying	2560 bps
3	Phase Shift Keying	1280 bps
4	Phase Shift Keying	640 bps
5	Phase Shift Keying	10240(uncoded) bps

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.

16 Appendix B

16.1 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



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NEXT ASSY	USED ON		
APPLICATION			

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	James DellaMorte Jr.	
CHECKED		
ENG APPR.		

www.popotomodem.com
128 Route 6A, Sandwich, MA 02563

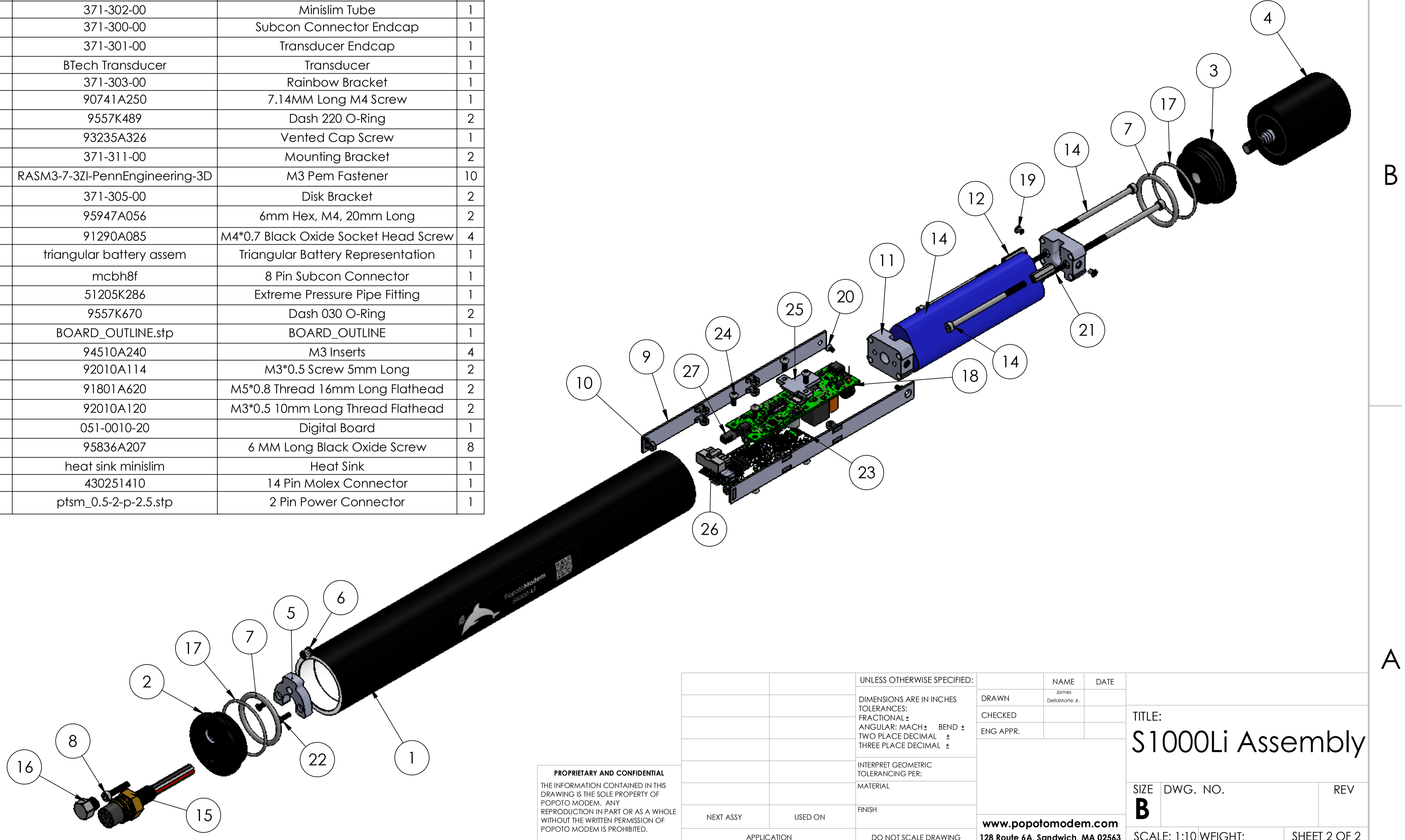
TITLE:

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



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TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

	NAME	DATE
DRAWN	James DellaMorte Jr.	
CHECKED		
ENG APPR.		

NEXT ASSY	USED ON
APPLICATION	

DO NOT SCALE DRAWING

www.popotomodem.com
128 Route 6A, Sandwich, MA 02563

TITLE:

S1000Li Assembly

SIZE **B** DWG. NO. REV

SCALE: 1:10 WEIGHT: SHEET 2 OF 2