

openHPSDR

# ANDROMEDA/ ANAN-7000DLE MKII with Integrated PC

User Guide



This document contains the words Apache, ANDROMEDA, ANAN in reference to the Apache Labs Transceiver products.

<http://www.apache-labs.com>

In cooperation with VK6PH, NRØV, W5WC, K5SO, LA2NI, G8NJJ and the OpenHPSDR Hardware and Software Projects <http://openhpsdr.org>

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The ANDROMEDA complies with FCC Part 97 rules for the Amateur Radio Service. It has been confirmed by the relevant authorities that the ANDROMEDA DOES NOT require FCC certification. Under rule 97 Amateur radio equipment with the exception of amplifiers and scanning receivers are exempt from certification, however, must conform to rule 97 which states that harmonic and spurious emissions must be below 43dB of the transmitted out up to 30MHz and 60dB beyond that.

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CE & EC Radio and telecommunications terminal equipment [RTTE] Certification.

We are pleased to announce that the ANAN series HF & 6M SDR transceivers including ANDROMEDA is now CE and RTTE certified as per EU trade directives, ANDROMEDA is RoHS compliant as well, we ensure that our products are of the highest quality and meet international standards of quality and compliance.

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# 1 Key Features

The ANDROMEDA/ ANAN-7000DLE MKII i5/i7 Amateur Radio Transceiver is a modern direct-down-conversion [DDC] receiver, and direct-up-conversion [DUC] transmitter, Software Defined HF transceiver plus 6 Meters. ANDROMEDA has a proud heritage from the TAPR Hermes Transceiver introduced in 2012. It is based upon the established 7000DLE mk2 RF, DSP and PC, plus an integrated front panel with radio controls and touch screen display.

The ANAN-7000DLE MKII i5/i7 model is without the Andromeda front panel, it is capable of being upgraded with the Andromeda Front panel. This model supersedes the previous Integrated PC ANAN-7000DLE MKII and includes a number of improvements and upgrades to the hardware.

ANDROMEDA firmware updates can be easily installed via the radio's standard Ethernet connection, eliminating the need for special mechanical or programming adapters. It is not necessary to open the ANDROMEDA cabinet to update the firmware. A "Bootloader" switch has been added to the back panel of the ANDROMEDA for ease of future updates.

The ANDROMEDA transceiver has been designed for the THETIS PC Software Defined Radio program. THETIS has the latest SDR processing from the OpenHPSDR line and is based on the proven WDSP libraries. It has full support for dual receivers, antenna diversity and PureSignal TX linearization. However, other SDR programs could be used including those written for Windows®, Linux, MacOS/X®, Android, RaspberryPi, and other operating systems. The command interfaced to the front panel uses simple published CAT commands and other programs could be adapted to support it.

## 1.1 Benefits

ANDROMEDA – Second to none!

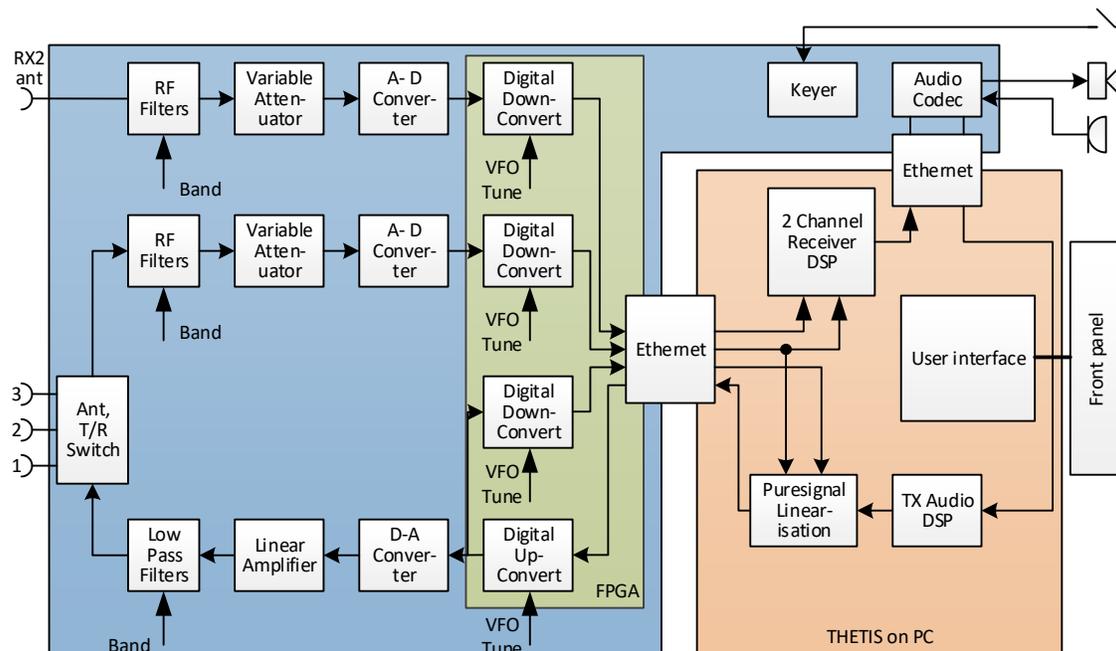
- Using Direct Down Conversion with an ultra low phase noise clock yields an RMDR of 116dB @ 2KHz separation, this means that close in weak signals will not be masked by the receiver's phase noise.
- The transmitter specifications are also off the chart, use of a new 16-bit DAC with an ultra low noise clock source results in transmit phase noise better than any other product available in the market.
- Use of LDMOS drivers and an optimized final Amplifier stage with adaptive Predistortion Algorithm (PureSignal) yields transmit IMD of better than 60dB, this is at least 20dB better than any Class A transmitter and over 30dB better than the competition.
- Use of two 16-bit phase synchronous ADCs allow for advanced applications such as Diversity reception for ultimate noise mitigation and effects of signal fading.

The ANDROMEDA HF & 6M 100W SDR Transceiver offers top of the line performance in a rugged package, it is based on the work of the OpenHPSDR community.

The new PA board incorporates the following updates over the previous 100W generation:

- PA Gain redistribution for better IMD
- Thermally compensated Bias
- Current/Voltage/Temp Sensors
- Temperature controlled internal fan and option for external fan
- Independent BPFs and 6M LNAs for each ADC; option to ground ADC2 on TX
- Improved TX SNR and higher duty cycle TX

## 1.2 Architecture



1. Your radio hardware provides a transmit/receive path. There are two fully separate RX paths each with its own signal conditioning, digitising and processing.
2. Received signals are filtered, attenuated then digitised using two high performance analogue-to-digital converter. The A-D converters cover the whole HF band. Digital processing in the Field Programmable Gate Array (FPGA) converts a part of the HF band to zero centre frequency, and transfers the data to the PC via Ethernet. The bandwidth provided can be selected, but is usually in the range 48KHz – 1.536MHz.
3. The PC runs the THETIS program. THETIS has two halves: a user interface, and PC based signal processing.
4. THETIS connects to the receiver data streams and provides further signal processing to reduce noise, to select the signals of interest and demodulate them. Its user interface provides a view of the band activity in the downconverted signal is shown, and controls to tune to the required signal and demodulate it successfully.
5. Received audio is routed to the internal speakers. Additional PC connected speakers are also possible.
6. On transmit, THETIS provides the initial signal processing to optimise the transmit signal. Audio processing is available to enhance a voice signal. A CW keyer is provided. Sampled data is sent to the radio hardware via Ethernet.
7. The radio hardware upconverts the TX signal to the required frequency, sets its signal level, amplifies and filters it. Amplifier linearization is available: a sample of the signal from the linear amplifier is downconverted back through the receiver, and compared with the “intended” TX signal. The difference is processed by THETIS to apply pre-distortion so that the final output from the linear amplifier has approximately 20dB lower spurious signal content than a “normal” HF transmission.

### 1.3 Writing Style

In this manual:

- A control / setting name is highlighted **bold**
- The user setting for that control is underlined.
- Menu > Equalizer means open the “Equaliser” setting on the program’s menu
- Menu > Setup > DSP > RX2 means open the setup form using Setup on the menu, then select the DSP tab, RX 2 sub-tab

So for example this instruction would indicate a gain control setting: Set the **RX1 AF** encoder to 30.

### 1.4 ANDROMEDA Design Team

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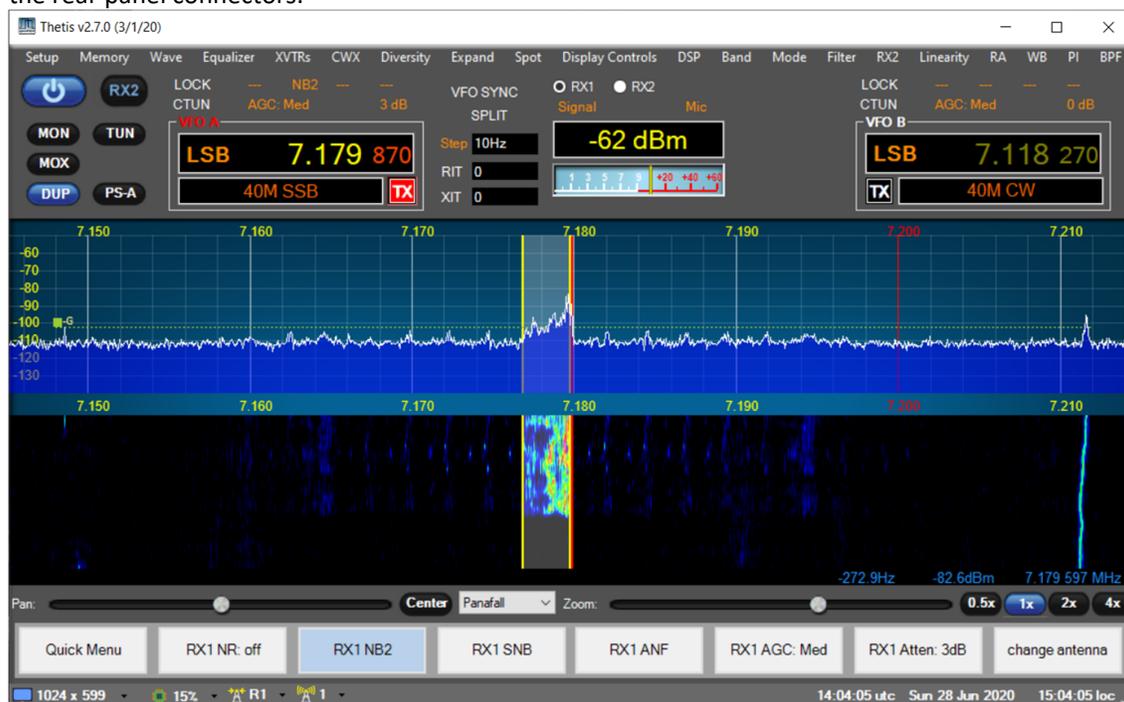
Laurence Barker G8NJJ

## 2 Front Panel Functions

The front panel provides the first port of call to control your radio. A touchscreen display provides a PC display from the PC control application; rotary encoders and pushbuttons provide access to the most commonly used controls.

### 2.1 Touchscreen

The touchscreen is a full function PC display with capacitive touch sensing. It provides the front panel display for Thetis. Additional displays can be connected via USB-C hub devices connected to the rear panel connectors.

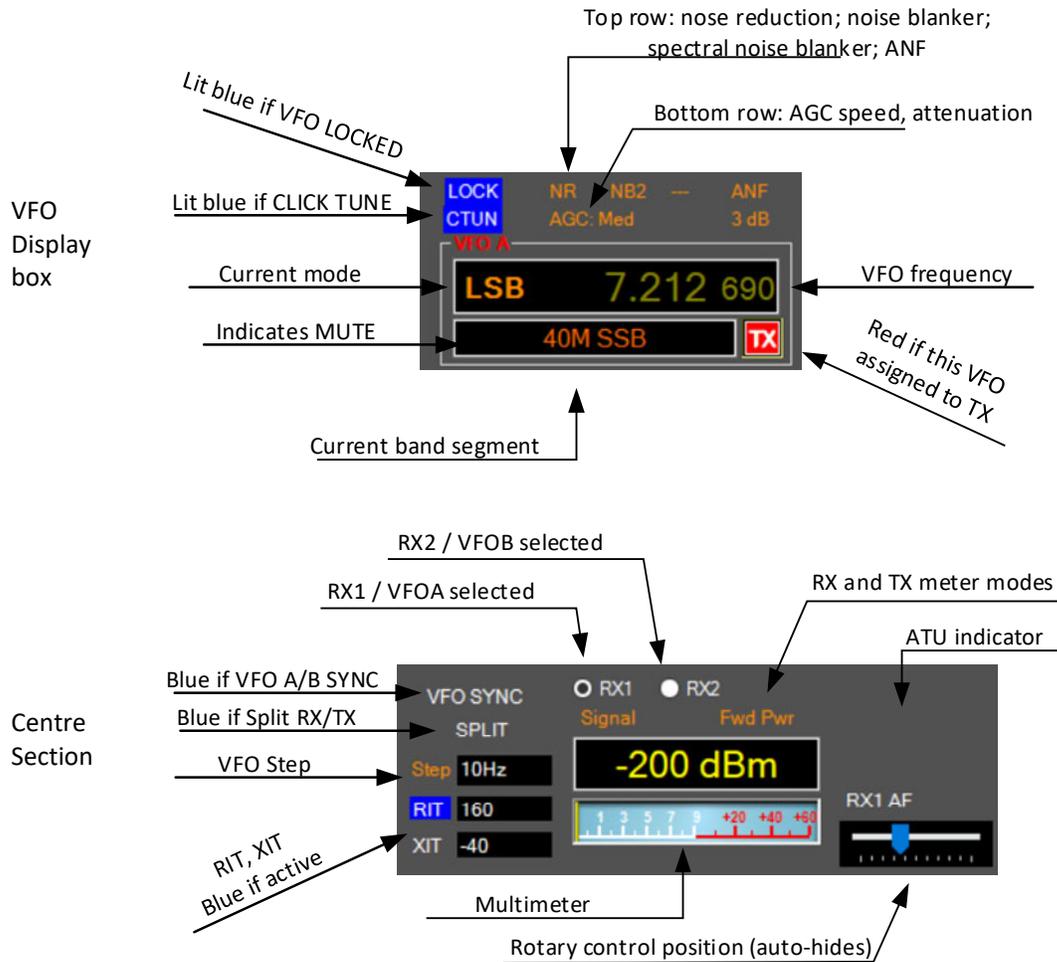


The Thetis “ANDROMEDA” display screen layout is as follows:

1. At the top is a normal PC application title bar and menu bar.
2. At the bottom of the screen is a status bar. It shows screen size, CPU load, power supply voltage and current, RX and TX antenna, multifunction control setting and the current data and time.
3. Above the status bar is a set of 8 softkey menu buttons. These provide access to many of the radio's features. These are activated by clicking the screen button, or the pushbutton below it.
4. Above that are controls for the central screen area.
5. The central screen area can be user configured but normally provides waterfall, panadapter or a combined panadapter & waterfall display. RX 1 can be shown alone, or both receivers can be shown.
6. The top area provides various controls and displays:
  - a. At the left, buttons show the status of several major functions.
  - b. The VFO A display shows the mode, frequency & band segment for VFO A together with RX1 noise reduction, AGC and attenuation settings
  - c. RIT, XIT, VFO tune step, VFO sync and band split are to the right of VFO A

- d. The configurable multimeter display can show several RX and TX indications; the currently selected RX and TX settings are shown.
- e. To the right of the multimeter, the ATU settings are shown. There is a slider that pops up if a rotary control is turned, to show its current position.
- f. Finally the VFO B / RX2 display is at the right of the bar.

The top bar indications are as follows:



## 2.2 Rotary Encoders

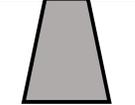
6 dual encoders provide a range of RX and TX controls.

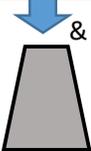
### 2.2.1 VFO

The VFO encoder can be selected to control VFO A or VFO B. In most cases VFO A will operate RX1 while VFO B will operate RX2. The VFO controlled by the encoder is selected using the **A/B** pushbutton. The indicator by the button is lit if VFO A is selected.

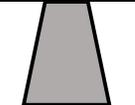
The encoder provides 480 steps per revolution. With 10Hz steps selected for VFO tuning, that corresponds to 4.8KHz per revolution which is ideal for SSB and CW operation.

### 2.2.2 RX1 AF/RF Gain

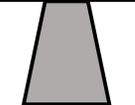
	Pressing the upper knob toggle <b>RX1 Mute</b> on/off
	Turning the upper knob adjusts the <b>RX1 AF gain</b> or “volume”. A slider pops up to the right of the multi-meter to indicate the current position.
	Turning the lower knob adjusts the <b>RX1 AGC</b> , which behaves similarly to RF gain in an analogue receiver. A green bar is normally shown in the spectrum view, which should be adjusted to sit just above the noise floor. A slider pops up to the right of the multi-meter to indicate the current position.

	If the RX1 AF encoder knob is pressed down and turned while held down, the PC display brightness is changed. The brightness setting will be saved and restored every time the radio is powered up.
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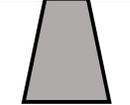
### 2.2.3 RX2 AF/RF Gain

	Pressing the upper knob toggle <b>RX2 Mute</b> on/off
	Turning the upper knob adjusts the <b>RX2 AF gain</b> or “volume”. A slider pops up to the right of the multi-meter to indicate the current position.
	Turning the lower knob adjusts the <b>RX2 AGC</b> , which behaves similarly to RF gain in an analogue receiver. A green bar is normally shown in the spectrum view, which should be adjusted to sit just above the noise floor. A slider pops up to the right of the multi-meter to indicate the current position.

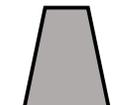
### 2.2.4 Drive/Multifunction

	Pressing the upper knob toggles the multifunction knob between selecting the value of a setting, and choosing which setting is operated. Press the knob to begin selecting another function. Turn the knob to choose the function required (it is shown in the status bar). Press again to select that function.
	The <b>multifunction</b> knob can be selected to operate one of many functions. The currently selected function is shown in the Thetis status bar.
	Turning the lower knob adjusts the <b>TX Drive</b> level setting the maximum output power. This is expressed as a % of full power. A slider pops up to the right of the multi-meter to indicate the current position.

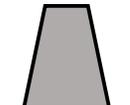
### 2.2.5 Filter High/Low Cut

	Pressing the upper knob resets the centre frequency of the filters.
	The <b>filter high cut</b> knob adjusts the upper audio frequency passband of the RX filter. This is useful to remove QRM from the passband. If you hear a high audio frequency interfering signal, use this knob to remove it.
	The <b>filter low cut</b> knob adjusts the lower audio frequency passband of the RX filter. This is useful to remove QRM from the passband. If you hear a low audio frequency interfering signal, use this knob to remove it.

### 2.2.6 Diversity Gain/Phase

	Pressing the upper knob toggles between fine and coarse adjustment of the diversity gain and phase. In most cases coarse will be OK.
	Diversity uses both receivers with separate antennas to maximise a weak signal, or to cancel interference. The <b>Diversity Gain</b> control adjusts the gain of RX2 to optimise the enhancement of a wanted signal or rejection of QRM. Open the Diversity screen to see the effect.
	The <b>Diversity Phase</b> control adjusts the phase of RX2 to optimise the enhancement of a wanted signal or rejection of QRM. Open the Diversity screen to see the effect.

### 2.2.7 RIT/Unallocated

	Pressing the upper knob clears the <b>RIT</b> frequency.
	The <b>RIT/XIT</b> knob selects a frequency offset for the receiver (RIT) or transmitter (XIT) from that displayed in the VFO window. Commonly used to optimise reception of a signal where the other operator has not exactly matched your frequency. RIT or XIT is selected according to the RIT/XIT pushbutton.
	This knob is unassigned. It can be assigned to any rotary encoder function in the ANDROMEDA settings editor.

Any encoder can be reassigned to any function, and the “multifunction” encoder can be set to any function. The functions available are Master AF gain; RX1 & RX2 AF gain; RX1 & RX2 stereo balance; AGC level (behaves like RF gain); attenuation; Filter high & low cut; drive; mic gain; VFO a and B tune; VOX gain; VOX hold time; CW sidetone; CW speed; squelch; Diversity gain & phase; COMP threshold; RIT & XIT; display pan & zoom.

## 2.3 Pushbuttons and Indicators

The front panel pushbuttons operate on/off or “press to change” functions. All buttons except Power can be reallocated using the ANDROMEDA settings editor window. Some pushbuttons have LED indicators to indicate the current state.

### 2.3.1 Left hand buttons

<b>Power</b>	Press to turn on power to the radio. The PC will boot up. Press and hold to turn off power. This should only be undertaken after the PC has safely shut down.
<b>SDR On</b>	Press to commence execution of the radio’s algorithms. Press again to halt processing.
<b>MOX</b>	Toggles between RX mode and TX mode. An indicator lights during TX.

<b>TUNE</b>	Toggles between RX mode and TUNE mode. In tune a low power carrier is transmitted to facilitate ATU matching. An LED indicator lights for TUNE.
<b>PS ON</b>	Turns on or off the Puresignal TX linearization algorithm. An LED indicator is lit if Puresignal is enabled.
<b>TWO TONE</b>	Initiates a “two tone” TX test to allow Puresignal to optimise linearity.

### 2.3.2 Softkey buttons

F1-F8 operate the 8 “softkey” menu buttons at the bottom of the ANDROMEDA display. These could be reconfigured to other functions if you prefer to use the touchscreen softkey buttons.

### 2.3.3 Band Buttons

The group of buttons above the VFO tuning knob can be used as “band select” buttons when “SHIFT” is selected. Shift is activated by pressing the SHIFT button, and an indicator lights. To select a new band, simply press its button when SHIFT is lit.

These buttons also have other functions when SHIFT is not lit:

<b>Mode Settings</b>	Opens the “mode dependent settings” form for quick access to settings important for the current operating mode.
<b>RX2</b>	Turns on/off the second receiver channel.
<b>Mode +</b>	Selects the next higher operating mode. Press and hold for more than 2 seconds to open the “mode select” form.
<b>Mode -</b>	Selects the next lower operating mode. Press and hold for more than 2 seconds to open the “mode select” form.
<b>Filter +</b>	Selects the next higher variable bandwidth filter. Press and hold for more than 2 seconds to open the “filter select” form.
<b>Filter -</b>	Selects the next lower variable bandwidth filter. Press and hold for more than 2 seconds to open the “filter select” form.
<b>A&gt;B</b>	Copies the settings from VFO A to VFO B
<b>B&gt;A</b>	Copies the settings from VFO B to VFO A
<b>SPLIT</b>	Toggles split frequency operation on/off. When split frequency is active the radio will transmit on one VFO frequency and receiver on the other. The TX VFO has a red “TX” symbol.
<b>User 1</b>	Available for user re-assignment
<b>User 2</b>	Available for user re-assignment
<b>User 3</b>	Available for user re-assignment

### 2.3.4 VFO Buttons

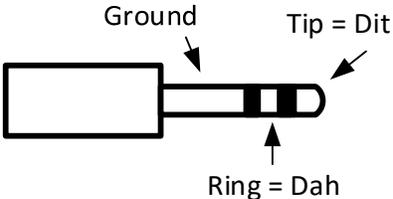
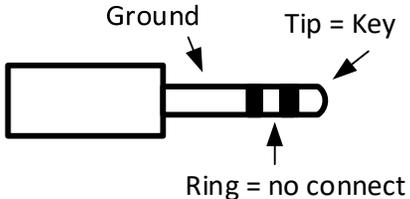
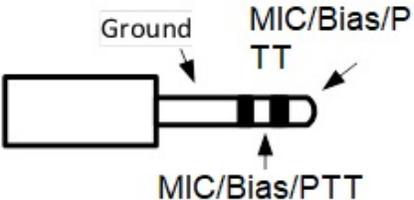
<b>RIT/XIT</b>	Toggles between RIT on, XIT on, or no independent tune enabled. Indicators light if RIT or XIT are selected
<b>A/B</b>	Selects whether the VFO tuning knob and other front panel functions operate VFO A / RX1 or VFO B / RX2. An indicator is lit if VFO A is selected.
<b>LOCK</b>	Selects the VFO “lock” mode. When selected the VFO will not be tuned for example by the tuning knob. An indicator is lit if lock is selected.
<b>CTUNE</b>	Selects the “click tune” mode. In this mode the spectrum display centre frequency is unaffected by tuning action and instead the VFO frequency is scrolled left or right within the display. This may be useful if you are keeping a watch on certain frequencies in the spectrum displays. Indicator lit if Click Tune selected.

### 2.3.5 Editing the Front Panel control Assignments

The functions for each encoder and pushbutton (with the exception of the Power button) can all be changed by the user. Also the menu bar buttons on the PC screen can be changed. See section 7.3 for details of how to do this.

### 2.3.6 Front Panel Connections

<b>CW Key</b>	3.5mm stereo jack socket. Connect a CW (morse) key: this may be a “straight” key or iambic keyer. <b>Do not use a mono jack plug: TX mode will be continuously asserted!</b>
<b>Phone</b>	Connect stereo headphones. This is a standard 3.5mm stereo jack socket. The internal speakers will be muted when connected.
<b>MIC</b>	Connect a microphone with 8 pin RJ45 connections.
<b>USB</b>	A USB socket from the internal PC; useful to connect memory sticks etc.

<p>CW Key</p>	 <p><b>3.5mm Stereo Jack: Paddle Connections</b></p>	 <p><b>3.5mm Stereo Jack: Straight Key Connections</b></p>
<p>Mic</p>	 <p><b>3.5mm Stereo Jack:</b></p> <p>Both the TIP and Ring can be configured via Thetis for Mic/Bias PTT.</p>	<p><b>Please Note the i5/i7 Version without the Andromeda Front panel uses 6.25mm Audio Barrel Connectors</b></p>

### 3 Rear Panel Connections



RF	GND	RF earthing stud
	ANT 1 - 3	3 independent TX & RX1 Antenna connectors
	RF Bypass	RX input bypassing RX filtering. Puresignal feedback input for an external PA
	EXT1	RX input bypassing the T/R switch
	XVTR In	Transverter RF input
	ADC2	RX2 Antenna
	XVTR	Low power TX signal to Transverter
	10MHz in	10MHz reference input
Power	Ext Fan	DO NOT USE
	13.8V DC	PowerPole® 13.8V DC, 30A power supply input
PC	3.5mm Audio	PC 3.5mm "TRRS" audio connector
	USB3, USB-C and Thunderbolt	PC USB3.1 Type A and Type C connectors. A keyboard and mouse can be connected. A USB3 hub will provide HDMI for an external display
	Wi-Fi	Wi-Fi antenna connection
Aux Radio	OC Out	7 user configurable Open Collector Outputs
	Dig In 1	User digital input 1
	Dig In 2	User digital input 2
	L Line in	Left TX audio line input
	R Line in	Right TX audio line input
	PTT In	PTT Input: short this signal to ground to initiate PTT
	PTT Out	PTT output: grounded if TX active (eg to key external equipment)
	L SPK	Connection for left speaker
R SPK	Connection for right speaker	
	Bootloader switch (top left)	When set to "On" the DSP board will boot up after power up into the "BOOT Loading" state, and be ready to receive firmware updates using the HPSDR bootloader. Set to "Off" for normal operation.

Open collector pinouts:		<p>GND = 0V            OC1-OC7 are separate open collector outputs. Each connects to 0V when active.</p> <p>REF should be connected to the highest supply voltage used by OC1-OC7 (typically 5V or 12V)</p>
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## 4 Installation

### 4.1 Important Operation tips

Do not cover rear or bottom ventilation holes. Proper air circulation throughout the ANDROMEDA Transceiver is necessary to prevent possible overheating and failure.

The radio is factory calibrated to 100W into a 50 ohm Dummy Load. Operating at higher levels will damage the radio. Please review CCW and ICAS specifications.

Data/AM/FM and other continuous duty modes must be operated at 30W or less to remain within the operational limits of the radio.

Input voltage must be 13.8vdc +/- 5%, well regulated at 30A Peak and proper POLARITY must be observed.

DISCONNECT the Antenna during Thunderstorms or when not in use.

Please ensure that you select the correct hardware model during software setup: ANAN-7000DLE.

Install the supplied rubber feet on the bottom of the case for proper cooling.

### 4.2 Heat Dissipation

ANDROMEDA uses a heavy duty Aluminium heat sink to dissipate heat with temperature controlled internal and optional external fan.

ICAS [100W] operation

SSB, CW and all ICAS modes [Intermittent Commercial/Amateur Service] 100W PEP

The Power Amplifier MOSFET transistor has characteristics that far exceed the needs of normal Transceiver operation.

### 4.3 Quick Start

Make sure that you have the following equipment and accessories:

- A 13.8v 30A Power Supply
- 50 Ohm Dummy load capable of at least 100W load capacity
- DC Power Cable (Supplied)
- Optional Keyboard/Mouse (either USB or Wireless)
- USB 3.0 HUB

With the Radio switched off:

1. Connect the Keyboard/Mouse to one of the USB ports, if required
2. Connect the DC power cable to the Power Pole connector. Please ensure that the RED side corresponds with the Positive supply.
3. Connect the provided USB 3.0 hub to the Thunderbolt connector on the back panel, the USB HUB has an HDMI/Ethernet and further USB ports.
4. Connect the monitor to the HDMI port on the USB 3.0 HUB
5. Connect the Dummy Load to the ANT1 connector.
6. Switch on the Radio, you should see the power button light up and then the internal PC booting. Once windows 10 boots and is ready double click on the Thetis icon to launch the SDR.
7. The Software is preconfigured and the database file is backed up in "My Documents".

8. Once you have tested basic functionality you may remove the Dummy load and connect the Antenna ensuring good SWR before you are ready to go on Air!

It is possible to connect additional external displays if required using a USB hub connected to the rear USB3 connectors. **Do we need to cover AIPA setup for network connection to Orion?**

## 5 Getting Started

This section gives a simple guide to standard operations using the Thetis program. As with many complex programs there are several ways to achieve most outcomes. This manual concentrates on the “front panel” functionality of Thetis. More information is available in the separate Thetis manual which covers the whole application.

### 5.1 Powering Up, Running Thetis

1. Switch on the radio by pressing the Power button momentarily. This will activate the power supply and the PC will boot. Its display will appear on the touchscreen.
2. Double click the Thetis icon to run the Thetis program.
3. Click the on-screen “power” button to start Thetis operation.
4. The radio will spring into life; audio will be heard from the speakers.

To power down:

1. Shut down the windows PC
2. Press and hold the Power button for a couple of seconds until the red power LED is unlit.

Check what I've written for power down!

### 5.2 VFO Selection & Tuning

The VFO knob will operate either VFO A or VFO B, depending on which is selected. As the knob turns the tuned frequency is displayed and the panadapter/waterfall display will be updated.

To switch between VFO A and VFO B, use the **A/B** button. The LED is lit when VFO A is selected.

Tuning can also be accomplished by clicking on the touchscreen.

### 5.3 Band Selection

To change band, the group of buttons above the VFO encoder have a “band select” function.

1. Press the **SHIFT** button. Its indicator will light up
2. Press a button corresponding to the required band. The radio will change band, and select the operating mode and filter setting last used on that band.
3. To cancel a **SHIFT**: press **SHIFT** again and its indicator will go out.

There is also a band select form that can be invoked from the softkey menus.

If the same band is selected: the radio will select the next in a sequence of bandstacks. A bandstack is a kind of local memory for different parts of the band. More details will be found in the Thetis manual.

### 5.4 Mode Selection

The radio's operating mode can be selected from the front panel in two ways:

1. Use the **Mode+** or **Mode-** buttons to sequence through the available modes;
2. Use the Mode select form which can be invoked from a softkey menu or by pressing and holding **Mode+** or **Mode-** for 2 seconds.

### 5.5 AF/RF Gain

The AF gain and AGC controls are available on encoders for both RX1 and RX2. The AGC control has similar behaviour to RF gain. When it is adjusted, a green horizontal line on the display moves up and down; it is normally adjusted to be just above the noise floor.

## 5.6 Panadapter displays

The centre of the screen provides a space to show the current spectrum activity for RX1 and, if enabled, RX2. There are several options available with the most popular being:

- Panadapter: a spectrum display showing amplitude (vertical) vs frequency (horizontal)
- Waterfall: a time history display. Amplitude is expressed by pixel colour; shows time (vertical) vs frequency (horizontal)
- Panafall: combined panadapter (top) and waterfall (bottom)

The current display can be selected using the **Display Menu** or the **Display Settings Form**.

## 5.7 Meter Mode

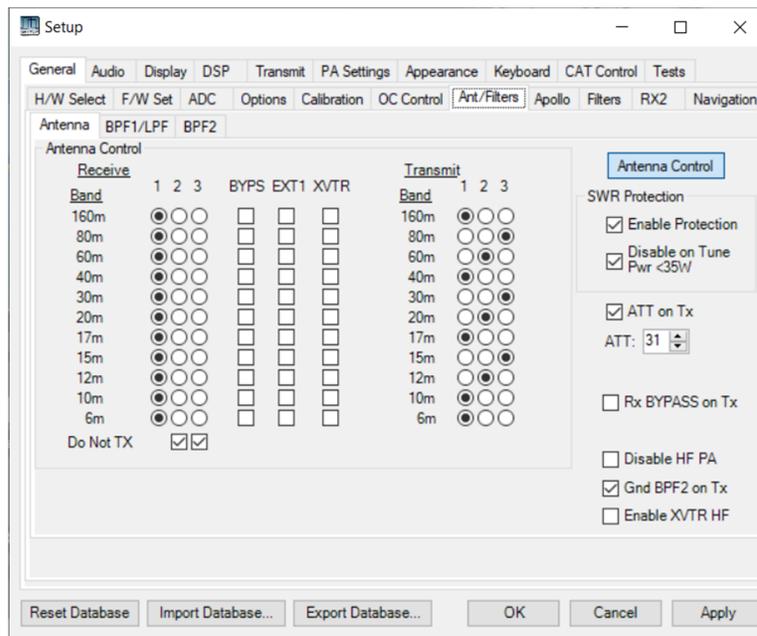
The multimeter is displayed in the top centre of the display. It can be assigned to several settings for each of RX and TX. The current settings are shown above it. To change the settings:

1. Press the left hand softkey button until **Display Menu** is shown.
2. Press the **RX1 Meter** softkey until the desired RX function is shown.
3. (note that if VFO B is selected, RX2 meter will be shown)
4. Press the **TX Meter** softkey until the desired TX function is shown.

The Display Settings Form can also be invoked from the display menu using the **Display Form** menu key. Combo boxes offer the settings for both TX meter and RX meter.

## 5.8 Changing antennas

You have three antenna connectors available. Additionally, RX signals can be routed to the Bypass, EXT1 and XVTR inputs. The Thetis program chooses which antenna to use from settings on the Setup form "ant/filters" tab. This shows the antenna selected for RX and for TX, for each of the amateur bands. If you have different preferred antennas for some bands, they can be automatically selected according to these settings.



To can also quickly change antennas from the main screen in two ways:

1. There is a button bar menu item to step the antenna. Each press will step both RX and TX through the sequence ANT1-ANT2-ANT3-ANT1 etc
2. By clicking on the antenna displays in the status bar you can select ANT1, ANT2, ANT3 for RX and TX independently.
3. If you need to use the other antenna input, you will need to use the setup form.

## 5.9 Using the Softkey Menus

The 8 softkey buttons on the bar at the bottom of the screen form a series of menus to access the functions of the radio. Each set of 8 buttons forms a menu, with the menu name at bottom left; pressing that button moves to the next menu in sequence.

After 10 seconds of inactivity, the “Quick” menu will be selected so that it is readily at hand.

The remaining 7 buttons either have a function, or show --- is there is no assigned function. Some will be highlighted if they control an on/off function which is currently enabled. Some show functions for RX1 or RX2, and the active receiver will be shown. The menus are as follows:

### 5.9.1 Quick Menu

Quick Menu	Press to advance to the next menu
NR	Noise reduction. Steps through off, NR and NR2 modes.
NB	Noise blanking. Steps through off, NB and NB2 modes.
SNB	Spectral Noise Blanker
ANF	Automatic Notch Filter
AGC	Steps through the available AGC speeds: fixed/long/slow/medium/fast/custom
Attenuation	Steps the RX attenuator in 6dB steps
Antenna Step	Steps through the 3 main antenna inputs

### 5.9.2 RX Menu

RX Menu	Press to advance to the next menu
Diversity	Enables or disables receiver diversity
Diversity Form	Opens the diversity form
Gain Form	Opens the gain form (showing settings for many controls)
Filter Form	Opens the filter bandwidth form
RX Mute	Toggles RX mute on or off
RX Ant	(not yet implemented)
---	Not assigned

### 5.9.3 VFO Menu

VFO Menu	Press to advance to the next menu
Band Form	Opens the band form for band changes
Mode form	Opens the mode form for mode changes
Bandstack Form	Opens the Bandstack form to edit the available Bandstack memories
Swap A <-> B	Swap the A and B VFO settings
Tune Step Form	Opens the Tune Step form to change the frequency per tune step
Bandstack	Steps through the available Bandstack memories for the current band
---	Not assigned

#### 5.9.4 TX Menu

TX Menu	Press to advance to the next menu
Mode Settings Form	Opens the Mode settings form to access a range of (mostly TX) settings for the current operating mode
Puresignal form	Opens the Puresignal form
Puresignal select	Selects Puresignal on or off
MOX	Toggles between TX and RX modes
TUNE	Toggles between TUNE and RX modes
PS 2 Tone Test	Initiates a 2 tone TX test to enable Puresignal to optimise linearity
---	Not assigned

#### 5.9.5 Display Menu

Display Menu	Press to advance to the next menu
RX Meter	Steps through the available RX meter modes; shows the current setting
TX meter	Steps through the available TX meter modes; shows the current setting
RX display	Steps through the available display modes for the centre part of the display
Centre Display	Centres the panadapter/waterfall display at the current VFO frequency
Display Form	Opens the Display form
Zoom	Steps through a series of zoom settings for the panadapter/waterfall display
---	Not assigned

#### 5.9.6 Audio Menu

Audio Menu	Press to advance to the next menu
Quick record audio	Initiates a "quick record" function to record RX or TX audio
Quick play audio	Initiates a "quick replay" or recorded audio to RX or TX
---	Not assigned
Audio rec/play form	Opens the audio record/replay form
VAC1	Toggles PC Virtual Audio Channel for RX1
VAC2	Toggles PC Virtual Audio Channel for RX2
---	Not assigned

#### 5.9.7 Setup Menu

Setup Menu	Press to advance to the next menu
Duplex	Toggles Duplex operation on/off
TX Monitor	Toggle TX monitor on/off
RX2	Toggle RX2 on/off
Sub RX	Toggles the RX1 sub-receiver on/off
Equaliser form	Opens the RX & TX equaliser form
Setup Form	Opens the Setup form
Extended Menu	Opens a further, rarely access menu

### 5.9.8 Extended Menu

Test Menu	Press to advance to the next menu
Quick save	Saves VFO frequency to a "quick access" memory
Quick restore	Loads the "quick access" memory to the current VFO
RX Filter Step Up	Steps up to the next RF filter bandwidth setting. Shows current b/w
RX Filter Step Down	Steps down to the next lower RF filter bandwidth setting. Shows current b/w
RX Band Step Up	Steps up to the next band
RX Band Step Down	Steps down to the next lower band
---	Not assigned

The filter and band menus items are not needed! Is any of this menu needed?

## 6 Detailed Operations

### 6.1 Voice Transmission

You will need a suitable microphone connected for these modes.

#### 6.1.1 TX Settings

The TX drive level is available on a front panel encoder. It sets drive as a percentage of full power available. Adjust to set the required TX power.

Microphone gain is available on the multifunction encoder.

1. Press the **MULTI** encoder knob;
2. Turn the **MULTI** encoder until **MIC Gain** is shown in the status bar;
3. Press the **MULTI** encoder knob again;
4. Now turn the **MULTI** encoder knob to set the desired microphone gain.

There is a meter setting for Microphone level; set **Mic Gain** for 0dB peaks.

#### 6.1.2 Microphone Setup

Before first transmission you must set up your microphone level. This is very important on first use!

1. Connect a suitably rated dummy load to your antenna connector.
2. Set the **Drive** level to a relatively low power (say 5-10, meaning approximately 5-10W of RF)
3. Select an appropriate audio mode. Begin with USB or LSB depending on your band.
4. Connect a suitable microphone to your radio.
5. Set the microphone connections on the Menu > Setup > Audio form.
6. Reset all of the TX audio path settings on the **Mode Settings Form** (from the **Mode Data button**):
  - a. Click the **MIC** button to on
  - b. Click the console **VOX**, **COMP**, **DEXP**, **TX EQ** buttons to off
  - c. Untick **20dB Mic Boost** on the Menu > Setup > Transmit form
  - d. Select **Mic In** as the input on that same form
  - e. Untick **CESSB Overshoot Control** on the same form
  - f. Tick **Use peak meter readings for TX COMP and ALC** on the same form
  - g. Tick **Auto Save TX profile on THETIS close** on the same form
  - h. Tick **Auto save TX profile on change** on the same form
  - i. Click **Save** by profile name and give it a new name: eg "PC Headset"
  - j. Untick **leveler** on the Menu > Setup > DSP > AGC/ALC form
  - k. Set **ALC max gain** to 0 on that same form
  - l. Untick **EER** on the Menu > Setup > DSP > EER form
  - m. Untick **CFC enable**, **Post-CFC EQ enable**, **phase rotator enable** on the Menu > Setup > DSP > CFC form
7. Select the **TX meter mode** to MIC (from the **Display menu**)
8. Key the radio by pressing **MOX** button on the front panel
9. Speak normally into the microphone
10. Adjust the **MIC gain** control until the TX meter consistently reads 0dB for speech peaks. (The meter is peak reading).
11. Return to RX mode by pressing **MOX** again.

12. If you were not able to reach 0dB: tick **20dB boost** in the Menu > Setup > Audio form and try again. (This may well be required for a dynamic microphone).
13. Assuming that has worked OK: you now have a working microphone connection.
14. Set the TX filter bandwidth appropriately. Min 200Hz, max 2800Hz suggested for SSB as a starting point.

### 6.1.3 Entering TX Mode

TX can be initiated in several ways:

1. Press PTT on an attached microphone. TX will be active until the PTT button released.
2. Press **MOX** on the front panel.
3. Click **MOX** on the screen. This toggles between TX and RX mode.
4. Press the **MOX** softkey on the **TX Menu**. This toggles between TX and RX mode.
5. Press spacebar on an attached keyboard, if there is one. This toggles between TX and RX mode.

There is a **TUNE** mode available to assist with antenna matching. This transmits a low power carrier. The **TUNE** power level is controlled in the Setup Form – see the Thetis manual.

**TUNE** can be initiated in three ways:

1. Press the **TUNE** button on the front panel.
2. Click **TUNE** on the screen. This toggles between TUNE and RX mode.
3. Press the **TUNE** softkey on the **TX Menu**. This toggles between **TUNE** and RX mode.

### 6.1.4 Transmission

Once you have done that, transmitting voice should be as simple as keying the radio and talking normally into the microphone. You will see a display of the transmitted spectrum; if you select **MON** (preferably using headphones rather than speakers) you will hear your transmitted audio.

The console's multimeter can be configured to provide several possible displays during transmit. In the first instance the following three are most likely to be useful:

Fwd Pwr	Displays the TX power being generated.
Mic	Displays the microphone signal level; you should be achieving 0dB peaks.
SWR	Displays the VSWR presented by the selected antenna

VOX is available. Its settings are controlled from the **Mode Settings Form** accessed from the **Mode data button**. Click **VOX** to enable it. The ambient audio level is shown in a coloured bar below the **VOX** slider: adjust the **VOX** slider so that the audio level is shown as green to the left of the slider position, and not red to the right of the slider position. This means ambient audio will not trigger VOX. Then click the **VOX** button on the console. Thereafter speak normally; TX will be selected when you begin to speak, and will be released a short delay after you stop speaking.

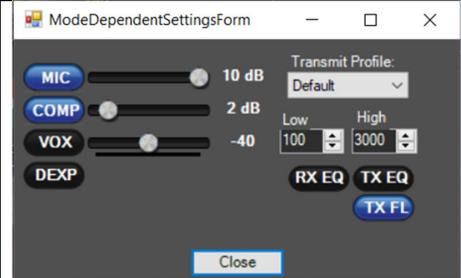
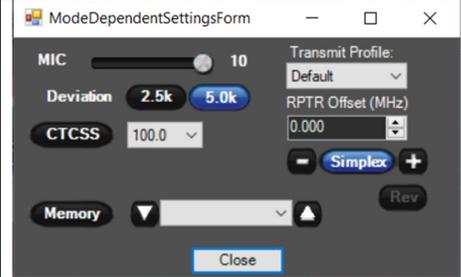
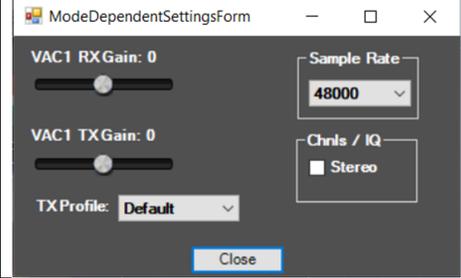
If you find the radio keys onto transmit, and stays there, press **VOX** again to turn it off!

For more comprehensive VOX adjustments, see the Thetis manual.

Thetis includes several high performance speech compression algorithms. For details of how to use these, please see the Thetis manual.

### 6.1.5 More TX Settings

There are several TX settings available on the “mode dependent settings” form. There are four different version of that form for SSB / AM audio, CW, FM and data modes.

	<p><b>For AM/SSB voice:</b> Mic gain and Mic Mute; Voice compressor; VOX; downward expander; TX profile selection; TX SSB filter width; RX, TX equaliser on/off; Show TX filter width in Panadapter display.</p>
	<p><b>For FM:</b> Mic gain; FM deviation; CTCSS tones; Memory channel select; TX profile selection; Repeater offset</p>
	<p><b>For Data modes:</b> PC audio (VAC) RX, TX gain; TX profile selection; Audio sample rate; Mono/stereo selection</p>

For more details, please see the Thetis manual.

## 6.2 CW operation

CW operations is enabled by selecting the CWL or CWU operating modes. They differ only in using lower or upper sideband, which makes no difference to your CW signal but affects the panadapter displays. It is suggested to begin with CWU.

### 6.2.1 Connecting a Key

A key can be connected to the radio. It can be a “straight” key, or an iambic keyer paddle.

### 6.2.2 Receiving CW

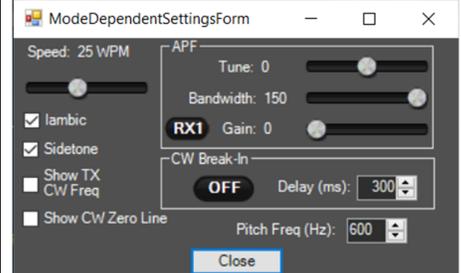
1. Select **CWU** mode.
2. Open the Mode Settings form from the **TX Menu**
3. Select the Iambic box if you use a paddle.
4. Select **Pitch Freq (Hz):** to 600
5. Select **Show CW Zero line**
6. Tune a signal using the VFO knob.
7. If the band is very busy and many signals are present, select RX1 in the **Mode Settings form** to enable the Audio Peaking Filter (APF). Set its **Tune** slider to 0, **Bandwidth** slider to 200, **Gain** slider to 10

### 6.2.3 Transmitting CW

1. Follow normal tuning procedures to tune your antenna.
2. Select Sidetone in the **Mode Settings Form**
3. Tick Semi Break-in and set its **delay(ms)** to 300
4. Set **Master AF** to 20. This sets the sidetone audio level. (This is available on the multifunction control).
5. Adjust the **Drive** knob to select the CW power level you want to transmit. It is suggested that you start at 50 for 50% of max power.
6. If you are using an iambic keyer, set **Speed** to the number of words per minute you wish to transmit at.
7. Press the key to begin transmission. The TX meter will indicate output power.
8. Adjust **Master AF** for a comfortable audio level.

Could someone with knowledge of CW contribute to this please?

### 6.2.4 CW Mode settings

	<b>For CW:</b> Keyer speed; Iambic Keyer select; Sidetone on/off; Display indications on panadapter; CW automatic peaking filter; CW break-in and QSK; Sidetone pitch frequency.
---	---

### 6.2.5 QSK

Thetis version 2.6.3 and onwards supports operating QSK in CW modes, and REQUIRES Protocol 2 firmware for the ANDROMEDA to be firmware version 1.7 or later.

A new button labelled QSK appears in the CW sub-panel of the main console when operating in CW modes (CWU or CWL). If the Protocol 2 firmware version currently loaded in your radio is older than that required (see above), the QSK button is disabled. With QSK (sometimes called “full break-in”) enabled, receiver audio can be heard between CW elements (dots and dashes). This enables monitoring activity while transmitting. It's very useful when working a split-frequency or simplex DX pileup, operating in a contest, or any time the ability to hear what's going on while sending is desired.

Clicking the QSK button to activate the QSK features causes several settings to take effect that enable optimal QSK operation. These include:

- AGC is set to Custom mode (more on this later)
- PTT is disabled (it's handled in the firmware on CW when QSK is engaged)
- Semi break-in mode is enabled, and its delay is set to zero (0).
- Since Thetis MOX is not active in QSK (necessary for quick response), there is no transmit spectral displays and NO TRANSMIT METERING. Simply turning off QSK will resume the display and metering of normal transmit behaviour, either with PTT or semi-break-in.

When the QSK button is clicked to disable QSK (or when changing to a non-CW mode, including when this happens as a result of clicking a band button), everything is set back to the way it was before QSK was enabled.

While operating QSK, the sidetone level becomes tied to the monitor level, which can be set in the Menu > Setup > Transmit, monitor sub-panel, with the control labelled "TX AF". Since it is a separate control from the receiver audio, the sidetone can be adjusted to be louder or softer than the receive audio according to preference. The setting remains in effect until QSK is disabled, at which time it returns to its previous value. TX AF levels will then switch back and forth between the QSK and non-QSK setting depending on the state of the QSK button.

With QSK enabled your own signal is heard in the receiver while transmitting. When operating with a single VFO (i.e. not split) the tone heard is identical to the CW pitch setting, since that determines the transmitter offset in CW when in tranceive mode. Depending on the sidetone volume, it may be possible to distinguish between the two tones due to a slight time difference between them. If the transmit frequency is moved slightly away from its transceiver offset, either by changing RIT/XIT or tuning the transmitter off frequency a bit using split mode, both tones will be clearly heard at different frequencies.

You will want to experiment with the Custom-mode AGC settings to tailor QSK behaviour to your liking. This is done by activating QSK, then going into Menu > Settings > DSP > AGC/ALC. The AGC settings are on the left. The following settings are a good starting place:

- Slope 5
- Max Gain 100
- Decay 1
- Hang 12.

Additional QSK Operating Notes:

1. Although semi-break-in can be manually enabled with a delay of 0 without QSK, this results in something less than true QSK. It will work but nothing will be audible between CW elements unless sending very slowly. The new QSK mode makes use of the AGC Custom mode setting and increases the AGC hang threshold to a high enough value so that AGC hang doesn't blank out the receiver between CW elements.
2. The key-down delay (Menu > Setup > General > Options) is now limited to permit a setting no shorter than 7ms to ensure a clean CW signal. Setting it lower than this would cause key clicks to be transmitted due to keying the CW signal before the relays have fully engaged. This is not healthy for the relays, and other operators on the band will not appreciate the resulting key clicks that are produced, which may extend up and down the band for 10s of KHz. Some external amplifiers may also need a longer delay, although this setting should work with most. Check your amplifier's manual and timing requirements before using its QSK capability. In the other direction, increasing key-down delay longer than about 10ms reduces the time available to hear signals between CW elements, defeating the purpose of QSK. Likewise, key-up delays longer than a few ms is unnecessary and you likely will find that the minimum of 1ms works fine.

When in QSK, the usual cycling of the MOX function in Thetis doesn't occur. As a result, checking for band boundaries doesn't happen and will not prevent you from transmitting out of band. Use caution! Prevention may come in the next release.

## 6.3 Other modes

### 6.3.1 FM Operation

Frequency Modulation is available. When FM is selected as the operating mode, It is suggested that the VFO tune step should be set to the FM channel spacing in use in your area. The Mode Settings form from the **TX Menu** has several settings for FM operation including narrow/wide deviation, repeater offset and CTCSS tones.

### 6.3.2 Digital Modes

Data modes can be used with ANDROMEDA. They will require an additional PC application, to act as the user interface and modulator / demodulator for an audio stream. There are many well-known programs available: for example DM780 (for PSK31, for example) and WSJT-X (for the JT65 like modes).

With an analogue transceiver, data modes are easy to configure. Simply connect the radio's audio in and out to a PC sound card via a transformer connection, connect the radio to the PC serial port, and the digital program will be able to access the radio through a sound card and control TX/RX by CAT commands.

With THETIS the process is similar. The key difference is: the audio is already "in" the PC. We need to connect the two programs internally to the PC. The solution is simple – use Virtual cables. These are software programs that run on the same PC as THETIS, and create a software interface for audio and serial. Both programs "see" a sound card and serial port connection. The Thetis manual covers how to configure the software and set up for data modes.

Remember that most data modes are high duty cycle. You will need to reduce the peak TX power to avoid overheating your PA.

## 6.4 Advanced Receiver Operation

### 6.4.1 Dual RX Operation

The radio has two fully independent receivers. If RX2 is enabled you can listen on a different frequency or different band from RX1 at the same time. RX2 is wired to a separate antenna input.

### 6.4.2 Attenuation

RF attenuators are available on the RX path before the A-D converters. In the presence of exceptionally strong signals, attenuation may be needed to prevent ADC overload. ADC overload will be indicated clearly in the display if it happens.

The attenuators for each receiver can be set using the **RX Menu**.

### 6.4.3 Filter High/Low Cut

Each receiver has fully variable receiver filter bandwidths. Whenever the mode is changed, the receiver filter bandwidth is set to that last used for the mode. A series of filter bandwidth are available and can be stepped through using **Filter+** and **Filter-** buttons.

The filter **Low Cut** and **High Cut** encoders provide a way to "dial" the filter settings quickly. If you are listening to a weak station and begin to hear QRM, these controls can help you to remove the QRM.

- If the QRM is at a low audio frequency: use the **Low Cut** knob to adjust the filter to reject it
- If the QRM is at a high audio frequency: use the **High Cut** knob to adjust the filter to reject it

The filter bandwidth is shown on the panadapter display as a grey bar.

#### 6.4.4 Noise Blanking & reduction

Various means to reduce noise are available. Thetis has modern, powerful algorithms available to optimise its performance. These controls can be accessed through the **RX Menu**.

- NR** Activates noise reduction, to minimise random noise. This attempts to reduce the noise in the channel while preserving signal content.
- Off: Noise reduction inactive
  - NR: Activates the LMS noise reduction algorithm
  - NR2: Activates the spectral noise reduction algorithm
- NB** Activates the wideband noise blanker, to remove impulse interference.
- Off: Noise Blanker inactive
  - NB: Noise Blanker active, and sets receiver input to zero during impulse
  - NB2: Noise Blanker active, and estimates the signal the receiver would have seen during an impulse.
- ANF** Activates the Automatic Notch Filter. This filter will attempt to notch out interfering carrier signals within the receiver passband.
- SNB** Activates the spectral Noise Blanker. The SNB detects impulse interference and attempts to estimate the “correct” receiver signal during the presence of the impulse.

#### 6.4.5 Diversity

Diversity allows the radio to implement beamforming. This requires two fully independent inputs, one through each A-D converter, from two antennas. This can be used to enhance a weak signal, or to steer a null towards an interference source. Diversity improves the received signal for RX1, but is independent of the operation of RX2. RX2 can be used on a different band if desired; the only constraint is if it is on a different band, its RX filters will need to be disabled.

To use diversity:

1. Select the Menu > Diversity menu item to open the Diversity form or use the **Diversity** button on the **RX menu**.
2. Set **Receiver source** to RX1 + RX2
3. Set **reference Source** to RX1
4. To minimise interference:
  - a. Use the **Diversity Phase** (lower) encoder to move the dot around the display
  - b. You should see the panadapter noise floor move up and down as you drag
  - c. Find the angle giving minimum noise floor
  - d. Keeping the mouse at that angle, Use the **Diversity Gain** encoder to find the optimum amplitude with minimum noise
  - e. If you aren't able to get a minimum: Set **reference Source** to RX2 and try again
5. To maximise strength of one signal:
  - a. Use the **Diversity Phase** (lower) encoder to move the dot around the display
  - b. Find the angle giving maximum signal on the panadapter for the wanted signal
  - c. Keeping the mouse at that angle, Use the **Diversity Gain** encoder to find the optimum amplitude with maximum signal
  - d. If you aren't able to get a maximum: Set **reference Source** to RX2 and try again
6. To turn diversity off, Click **Enabled** and it will turn to a red **Disabled** button.

#### 6.5 RIT, XIT

RX and TX independent tuning allows you to adapt the radio to remote stations that are not tuned to the exact same frequency. RIT and XIT are controlled by an encoder whose function can be set to off, RIT or XIT. Indicators show which is active.

RX Independent Tuning: the encoder shifts the receiver up or down in frequency from the VFO setting, leaving the TX unchanged. Pressing the encoder button clears the RIT offset.

TX Independent Tuning: the encoder shifts the transmitter up or down in frequency from the VFO setting, leaving the RX unchanged. Pressing the encoder button clears the RIT offset.

## 6.6 Split Frequency Operation

Split frequency operation is enabled using the **SPLIT** button. An indicator on the display is activated when **SPLIT** is enabled.

- If RX2 is disabled: VFO A will be used for RX, and VFO B will be used for TX
- If RX2 is enabled: VFO A provides both. The RX frequency is displayed as normal; the TX frequency is displayed in the band segment display.

## 6.7 Puresignal

Puresignal provides an algorithm to correct the non-linearity. It does that by measuring the difference between the *actual* output and the *intended* output, and correcting the TX samples to allow for the difference. This algorithm was designed by Warren Pratt NROV and leads to TX signals 20-30dB “cleaner” than those with no correction. This all happens in the background, once it has been initialised.

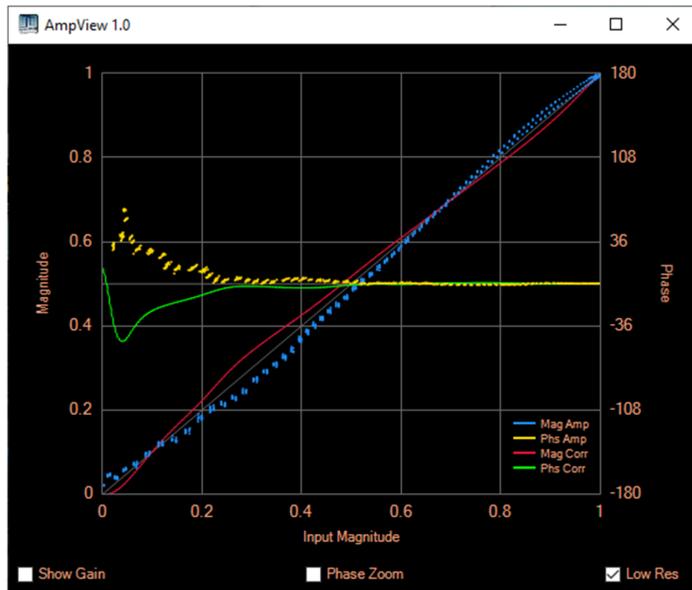
Puresignal takes a sample of the TX signal after the high power amplifier. ANDROMEDA includes a suitable signal coupler. If you use an external linear amplifier, then you will need add a suitable coupler (which could be built into your amplifier).

### 6.7.1 Setting Up Puresignal

1. Follow the guidance to set up your microphone, drive, antenna and filter selection for “normal” TX.
2. Select the Menu > Linearity form. The Puresignal Control form will be shown.
3. Click the **AmpView** button. You will see the AmpView form, ready to show linearity corrections.
4. Use the **Drive** encoder to select the power level you want to operate at.
5. Connect a dummy load with appropriate power rating to your antenna connector (ANT1, unless you have selected a different antenna).
6. Click the left menu button until **Setup** is displayed. Set Duplex to on.
7. Click The console display zoom **2X** button

Click the **Two-tone** button on the front panel. You will see your TX signal as two tones in the panadapter display area. Puresignal will rapidly adapt the signal to reduce intermodulation to much lower values.

8. After a few seconds the TX display should be stable. Click **Two-tone** to off to complete the calibration test.
9. The **AmpView** button will have updated to show the amplitude and phase behaviour of the amplifier, and the correction that has been made.



### 6.7.2 Operating with Puresignal

Once enabled, Puresignal will automatically apply corrections during transmission. It is important to have your microphone properly adjusted – you need to be getting 0dB speech peaks to drive Puresignal hard enough!

A green box “Feedback” under the panadapter indicates that a good signal level is being received from the feedback path. To its right a green box “Correcting” indicates that corrections are being made.

Further calibration is not normally required.

### 6.7.3 External Linear Amplifier

If you are using an external linear amplifier, you will need an appropriate coupled output from the TX signal back to ANDROMEDA. See section 8.1.4.

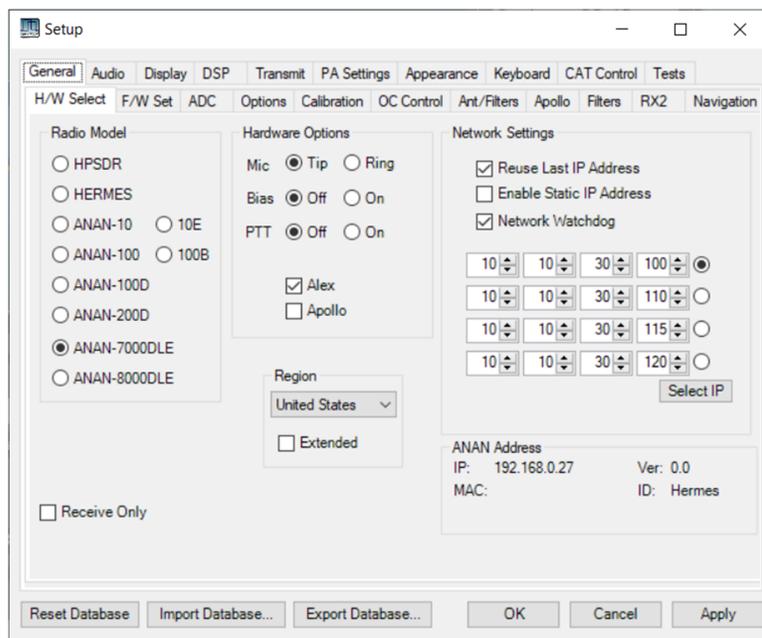
## 6.8 ATU

Come back when we have finished it!

## 7 Configuring Thetis and ANDROMEDA/ANAN-7000dle MKII i5/i7

### 7.1 Thetis Setup Screen

There are an immense number of settings for the radio that can be accessed through the Setup Menu. Clicking Setup on the application menu opens the setup form. See the Thetis manual for more details.



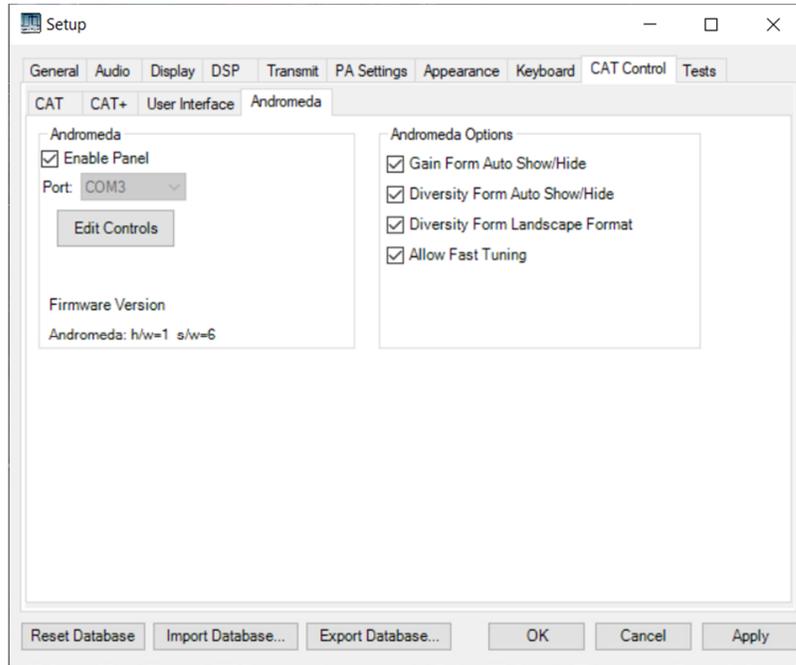
For those that want to explore, the tabs available are described here. Be aware that more tables do get added occasionally!

General -> H/W Select	Basic HPSDR radio hardware settings, IP address selection
General -> F/W set	Sample rate and RX options for DSP firmware
General -> ADC	Selects which ADC assigned to which firmware downconverters
General -> Options	Many general options for the program
General -> Calibration	Frequency and signal level calibration options
General -> OC Control	Sets how the “open collector” output are driven on a per-band basis
General -> Ant/Filters Filter tabs	Sets the TX and RX antenna selection on a per-band basis The filter tabs allow the default RX and TX filters to be overridden
General -> Apollo	Settings for the Aries ATU
General -> Filters	User input limit settings for the DSP IF filters
General -> RX2	Mis-named – RX1 and RX2 blanking options during TX
General -> Navigation	Options for other user interface devices for tuning
Audio	Options for RX1 and RX2 audio including PC routing of audio
Display	Various settings for how the RX and TX displays are generated
DSP	Many sub-tabs with settings for how the DSP functions operate.
Transmit	Many TX options including audio DSP and mic gain controls
PA Settings	PA gain adjustments. These should have been factory pre-set.
Appearance	Settings for colours and other aspects of the Thetis display.
Keyboard	Keyboard shortcuts for some commands
CAT Control	Settings for accessories including the ANDROMEDA front panel controller.

Tests	Controls various signal generator and TX tests.
-------	---

## 7.2 ANDROMEDA Setup screen

This form is found at the Menu > Setup > CAT control > ANDROMEDA page. It allows the PC serial (CAT) port to be set, and various options to be selected.



Port	Selects the COM port for connection to ANDROMEDA
Enable Panel	When clicked, a connection is established
Edit Controls	Brings up the ANDROMEDA Settings Editor form (see section 7.3). This allows the assignments for rotary controls, pushbuttons, indicators and softkey menus to be edited
Firmware version	Shows the hardware and software version reported by the ANDROMEDA panel controller.
Gain Form Auto Show/Hide	If ticked, the gain settings form will automatically be shown if a rotary control is turned that controls a setting that is on the form. If there is no activity it will auto hide after 10 seconds. It gives a quick way to see all the gain settings.
Diversity Form Auto Show/Hide	If ticked, the Diversity form will automatically be shown if a rotary control for diversity gain or phase is turned. If there is no activity it will auto hide after 10 seconds.
Diversity Form Landscape format	If ticked, the diversity form is shown in a landscape (wide) format. This fits better to small screens.
Allow Fast Tuning	If ticked, the VFO knob tune rate increases as it is turned faster. Above approx. 1 turn per second, its speed increases to allow fast movement across the band.

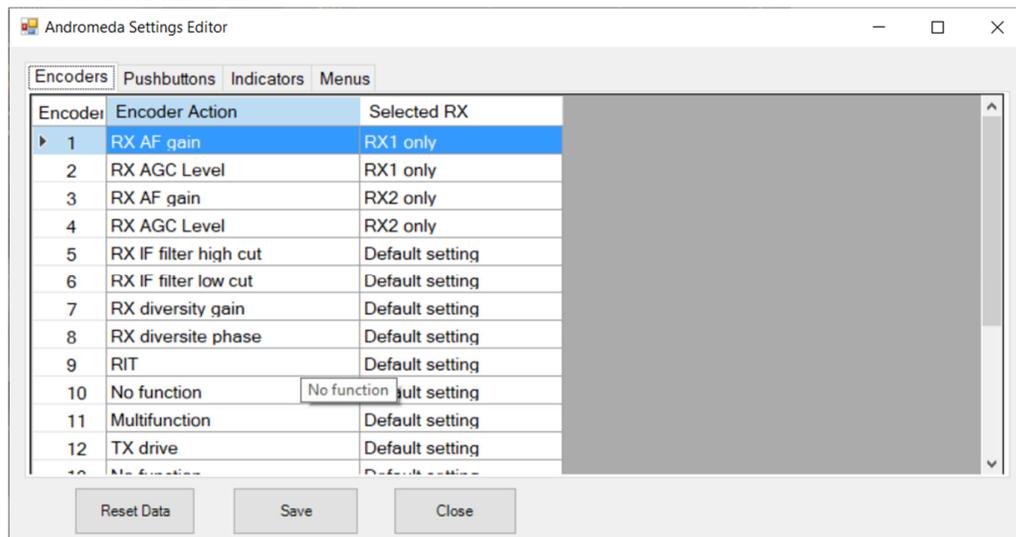
## 7.3 Changing Front Panel Control Assignments

This form is invoked from the setup form to change the control assignments for ANDROMEDA front panel pushbuttons, encoders and indicators. Also the softkey menus at the bottom of the ANDROMEDA display layout can be edited.

This form is involved from the **Edit controls** button on the Menu > Setup > CAT control > ANDROMEDA page. It has four display tables: one for each of Encoders, Pushbuttons, Indicators & Menus. Up to 5 command buttons may be visible:

Reset Data	Reset all configuration data to default settings. This may be useful if the settings have been very badly messed up by accident.
Save	Save the changes made. This saves the ANDROMEDA settings file.
Close	Close the editor form
Insert Menu	Insert a menu with 8 menu commands at the selected location. (If the selection arrow is toward the end of a menu, it will insert after the current menu. If toward the start, it inserts before the current menu). This is only visible when the Menu tab is selected.
Delete Menu	Delete the menu (with 8 menu commands) at the currently selected location. This is only visible when the Menu tab is selected.

### 7.3.1 Encoder Tab



This form edits settings assigned to rotary encoder controls. If you have “dual shaft” encoders with two controls, the uppermost control will be the first control (eg encoder 1) and the lower knob will be the next one (eg encoder 2). The VFO encoder cannot be reconfigured using this form.

Encoder number	<p>Displays all the possible encoder numbers. To select settings for a particular encoder, either:</p> <ul style="list-style-type: none"> <li>• Use the mouse to click in the number for that encoder, or</li> <li>• Turn the encoder and the appropriate row will be selected.</li> </ul>
Encoder action	<p>Displays the action that has been assigned to this encoder.</p> <p>To change the control action: click in the cell, twice. A combo box control will appear. Click its down arrow to show a list of the options that can be assigned. Click an option to select it.</p>
Selected RX	<p>This setting allows the control to be assigned to a specific receiver. This control is also a combo box and is used in the same way.</p> <ul style="list-style-type: none"> <li>• Some controls are not associated with a receiver (eg “TX Mic Gain”) and “default setting” should be selected</li> <li>• Receiver controls can be assigned to RX1 only, RX2 only, or if “default setting” is chosen the control will choose RX1 if VFO A is selected, or RX2 if VFO B is selected.</li> </ul>

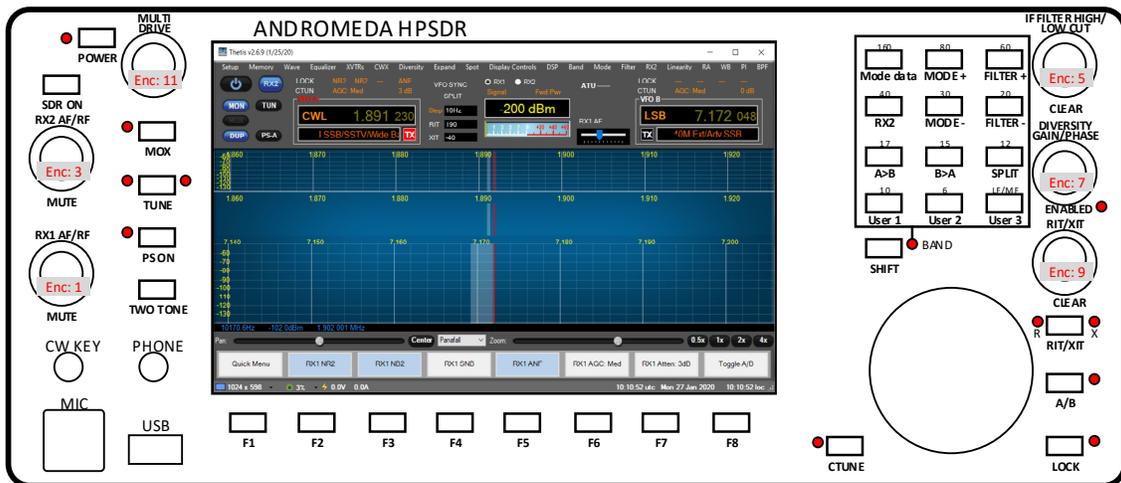


Figure 1: ANDROMEDA front panel showing encoder numbers (red)

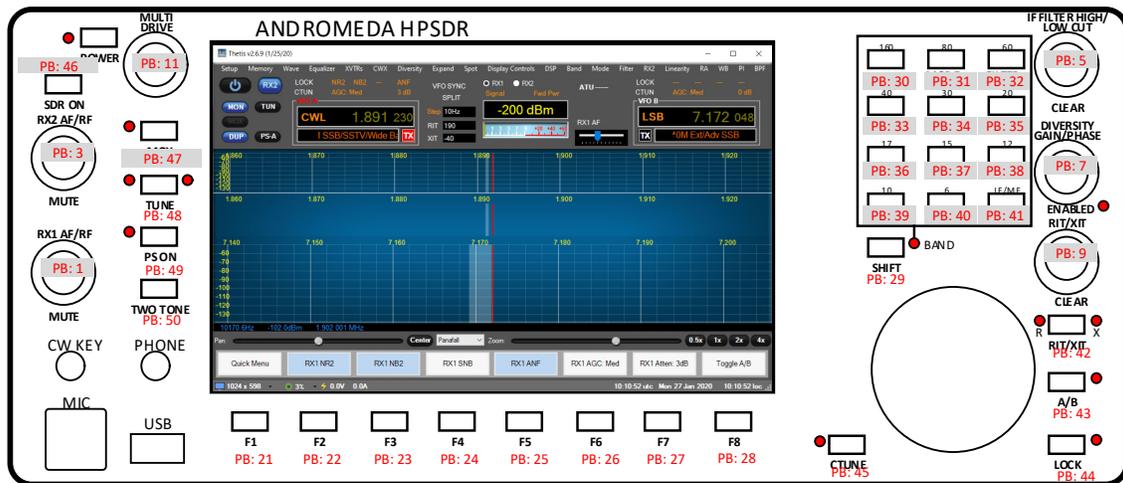
### 7.3.2 Pushbutton Tab

Andromeda Settings Editor

Encoders Pushbuttons Indicators Menus

Button	Pushbutton Action	Selected RX
1	RX Mute on/off	RX1 only
2	No function	Default setting
3	RX Mute on/off	RX2 only
4	No function	Default setting
5	Reset variable filters	Default setting
6	No function	Default setting
7	RX Diversity on/off	Default setting
8	No function	Default setting
9	Clear RIT & XIT	Default setting
10	No function	Default setting
11	Multi Encoder pushbutton	Default setting
12	No function	Default setting

Reset Data Save Close

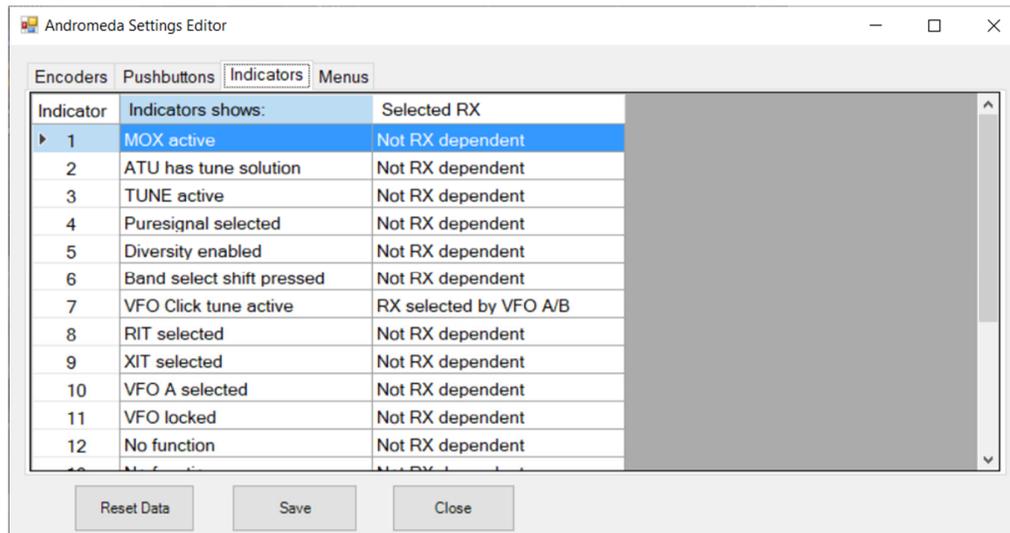


Pushbutton numbers in RED

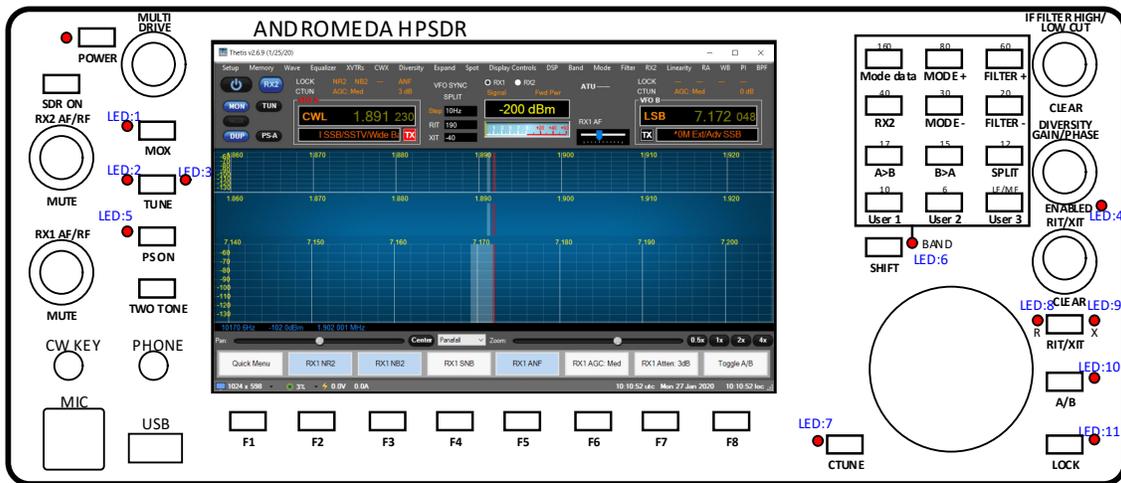
Figure 2: ANDROMEDA front panel showing pushbutton numbers (red)

Button number	<p>Displays all the possible pushbutton numbers (1-50).</p> <p>To select settings for a particular pushbutton, either:</p> <ul style="list-style-type: none"> <li>• Use the mouse to click in the number for that pushbutton, or</li> <li>• Press the pushbutton on the front panel to select the row.</li> </ul>
Pushbutton action	<p>Displays the action that has been assigned to this pushbutton.</p> <p>To change the control action: click in the cell, twice. A combo box control will appear. Click its down arrow to show a list of the options that can be assigned. Click an option to select it.</p>
Selected RX	<p>This setting allows the control to be assigned to a specific receiver. This control is also a combo box and is used in the same way.</p> <ul style="list-style-type: none"> <li>• Some controls are not associated with a receiver (eg “Clear RIT”) and “default setting” should be selected</li> <li>• Receiver controls can be assigned to RX1 only, RX2 only, or “default setting”. For the latter Thetis will choose RX1 if VFO A is selected, or RX2 if VFO B is selected.</li> </ul>

### 7.3.3 Indicator Tab



Indicator number	<p>Displays all the possible indicator numbers (1-20).</p> <p>To select settings for a particular indicator: Use the mouse to click in the number for that pushbutton</p>
Indicator Shows:	<p>Displays the indication that has been assigned to this indicator.</p> <p>To change the indication: click in the cell, twice. A combo box control will appear. Click its down arrow to show a list of the options that can be assigned. Click an option to select it.</p>
Selected RX	<p>This setting allows the indicator to be assigned to a specific receiver. This control is also a combo box and is used in the same way.</p> <ul style="list-style-type: none"> <li>Some controls are not associated with a receiver (eg “MOX Active”) and “Not RX dependent” should be selected</li> <li>Receiver controls can be assigned to RX1 only, RX2 only, or if “RX selected by VFO A/B” is chosen the control will choose RX1 if VFO A is selected, or RX2 if VFO B is selected.</li> </ul>



LED numbers in BLUE

Figure 3: ANDROMEDA front panel showing indicator numbers (blue)

### 7.3.4 Menu Tab

Menu	Menu button action	Button Text:	Selected RX	Link to Menu:
1	Change menu row	Quick Menu	Default setting	2
1	Noise Reduction	NR	Default setting	0
1	Noise Blanker	NB	Default setting	0
1	Spectral Noise Blanker	SNB	Default setting	0
1	Auto Notch Filter	ANF	Default setting	0
1	RX AGC step	AGC Step	Default setting	0
1	Step RX attenuator	Atten Step	Default setting	0
1	Toggle A/B VFO	Toggle A/B	Default setting	0
2	Change menu row	RX Menu	Default setting	3
2	RX Diversity on/off	Diversity	Default setting	0
2	Show Diversity form	Diversity Form	Default setting	0
2	Show slider form	Gain Form	Default setting	0

In this form, the softkey menus at the bottom of the screen in ANDROMEDA view can be edited. A menu consists of a set of 8 softkey settings.

Menu number	<p>Displays all the current menu entries. Menus (with a set of 8 softkey settings) can be inserted and deleted.</p> <p>To select settings for a particular menu, use the mouse to click in the number for that menu.</p>
Menu button action	<p>Displays the action that has been assigned to this softkey.</p> <p>To change the softkey action: click in the cell, twice. A combo box control will appear. Click its down arrow to show a list of the options that can be assigned. Click an option to select it.</p>
Button Text	<p>The text that will be shown on the softkey. This is selected automatically when a new softkey setting is chosen.</p> <p>Some menu types have the text altered to indicate RX1/RX2 and the current state. However for some controls it may be appropriate to edit the default text. For example “Change menu row” softkey is used to step between menus; it may be appropriate to edit its text to show the name of the current menu or new menu, according to preference.</p>
Selected RX	<p>This setting allows the softkey to be assigned to a specific receiver. This control is also a combo box and is used in the same way.</p> <ul style="list-style-type: none"> <li>• Some softkeys are not associated with a receiver (eg “Clear RIT”) and “default setting” should be selected</li> <li>• Receiver controls can be assigned to RX1 only, RX2 only, or if “default setting” is chosen the control will choose RX1 if VFO A is selected, or RX2 if VFO B is selected.</li> </ul>
Link to Menu	<p>This gives a destination menu number for the “change menu row” softkey.</p>

**Insert Menu** and **Delete Menu** inset and delete, respectively, groups of 8 controls. Using these you can make your own menu structure. Note that the form tries to alter “link to menu” values if a menu is inserted or deleted. It will try to leave the link to the row that had been linked before the insertion or deletion. However it is important to check that the links are what you intend!

## 8 Connecting Accessories

### 8.1 Linear Amplifier

#### 8.1.1 PTT Out

Most modern Linear Amplifiers have a connection for keying the amplifier. The radio includes a back panel RCA connection for this purpose.

The PTT Out feature is best used to switch 25vdc and 1A. Exceeding these values may damage the PTT OUTPUT circuit.

How to test your PTT Linear Amplifier circuit BEFORE connecting your Apache Transceiver:

1. Power your Linear, connect the control cable to your linear but do not connect the other end to your Apache Transceiver.
2. Using a DC Voltmeter, measure the voltage between the center pin and the outer connection of the cable. This must be less than 25vdc.
3. Connect a DC Ammeter between the center pin and the exciter connection of the cable. This should ACTIVATE the Linear Amplifier and give you a clear measurement of the current requirements. The ANDROMEDA PTT circuit should not draw more than 1A.
4. If either of these values are out of the required range, then use an external keying interface. There are many keying interfaces available from many sources such as MFJ, Elecraft, DX Engineering.

Important: Connecting a Linear Amplifier that does not meet the above voltage and current requirements is likely to cause damage to the Apache Transceiver linear switching transistor and extreme cases, serious damage to other parts. Damage to the radio caused in this manner is not covered by Warranty.

Linear Amplifier Keying ISOLATION adapters

<http://www.dxengineering.com/search/product-line/kd9sv-products-sv-kr-keying-relays>

<http://www.ameritron.com/Product.php?productid=ARB-704>

<http://www.sultantronics.com/product.html>

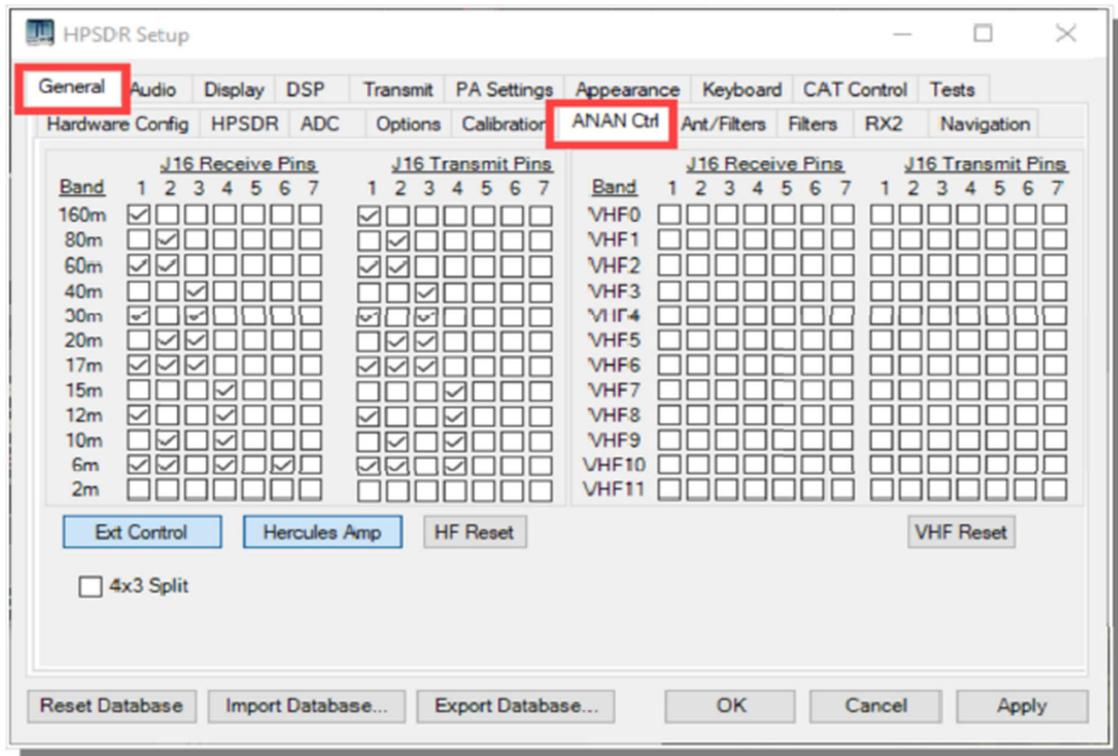
#### 8.1.2 ALC

ANDROMEDA does not offer ALC control for an external amplifier. It is important to set the drive level so that the amplifier is not driven into saturation. Drive shows a % of ANDROMEDA full power; setting the PA gain in the setup form is the best way to achieve this.

#### 8.1.3 OpenCollector BCD keying

Automatic Band Selection can be accomplished using the Open Collector Outputs available on the OC DB-9F connector on the back panel.

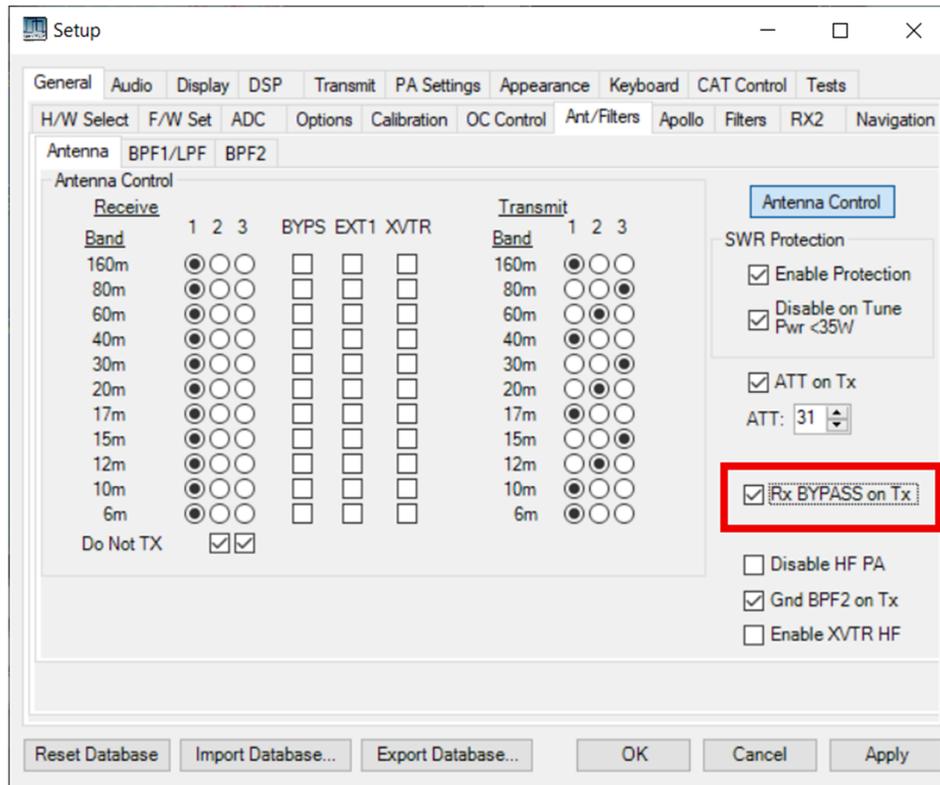
This is an example shows how to prepare Open Collector Outputs for BCD [binary coded decimal] for control of external devices [such as band information for a Hercules Linear Amplifier].



4x3 Split – When enabled the 7 OC outputs are split into 1x4 and 1x3. The first 4-bits are controlled by VFOA band data and the upper 3 are controlled by VFOB band data.

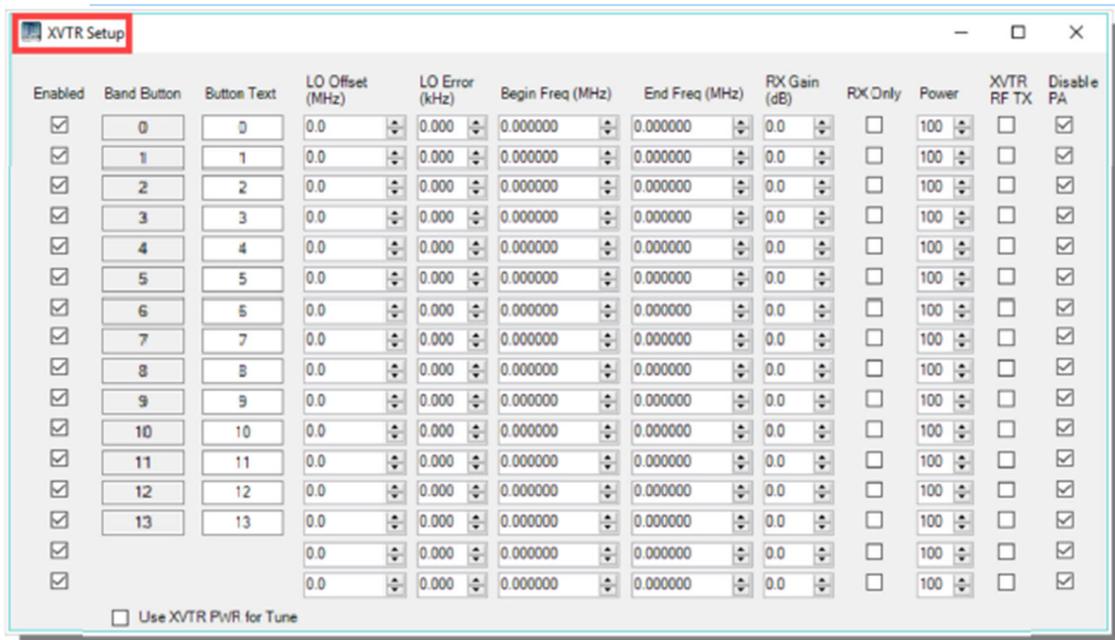
#### 8.1.4 Puresignal

To get Puresignal linearization your amplifier will need a coupler to take a sample of the TX signal and provide it back to ANDROMEDA. It should be just above 0dBm at normal operation. The signal should be connected to the RX Bypass input connector. That input needs to be enabled on the Antenna tab of the Setup form:



## 8.2 Transverter

The transverter setup form allows the user to configure up to 14 external transverters.



- Enabled: Enables a particular Band Button on PowerSDR with the options selected.
- Band Button: Band button to use for the particular transverter that is being configured.

- Button Text: The text that will be shown on the Band Button.
- LO Offset (MHz): The difference between the transverter low frequency and the IF frequency. For example, on 2m, you might use 144-28 MHz = 116.
- LO Error (kHz): This setting allows the user to correct for any error in the transverter's oscillator.
- Begin Frequency (MHz): The lower frequency bound for the transverter.
- End Frequency (MHz): The upper frequency bound for the transverter.
- RX Gain (dB): Amount of gain to apply to the incoming signals to compensate for gain within the transverter. Please note that this is still in development.
- RX Only: If this box is checked, the radio will not transmit while in this configured band.
- Power: Sets the Drive control on PowerSDR to this value whenever the VFO is within the configured band.
- XVTR RF TX:
- Disable PA: Disables the internal 100W Power Amplifier. Low level RF is sent via the XVTR TX SMA connector on back panel.
- The user must make careful adjustments using the PA Gain By Band using the VHFxx spinners and the Drive level to insure the transverter sees the proper level. With the PA Gain by Band spinners set to their default value of 65.0 and the Drive slider to 100 the RF output is approximately 10mW at the XVTR RF SMA connector.

### 8.3 CAT control

Computer Aided Transceiver (CAT) commands were created to allow PCs to control radios. They allow most of the settings of a radio to be accessed using simple serial commands. Many different kinds of program use them, and many external devices are available (e.g. auto tuners) that use them.

THETIS supports CAT commands, and can have 4 connections open at any time. These are accessed through the Setup form, CAT Control tab.

Establishing a connection is simple:

1. Connect an external device, if you have one.
2. If you are connecting to another program on the same PC, you will need a virtual COM port program
3. Choose the CAT connection on THETIS (THETIS has one CAT connection on the primary tab, and three more on the "CAT+" form. They are all the same).
4. Set the **port** to the port number of your device or VAC cable
5. Set the **baud rate**, **parity**, **data** and **stop** bits appropriately (there should be documentation for the product you are connecting to)
6. Click **Enable**
7. And that's it – connection will be established.

The list of CAT commands used by THETIS and PowerSDR mrx ps can be downloaded from the TAPA HPSDR github repository [5]. That document explains the format of the commands.

Take care if your remote device includes an "Arduino" based processor: **NEVER** open the connection with the baud rate set to 1200. That will cause the device to erase its firmware, requiring it to be reprogrammed.

## 9 Specifications

### General Specifications:

- Architecture: Direct Sampling DDC/DUC Transceiver
- Interface: Ethernet
- Phase Noise (Clock): -149dB @ 10Khz
- TCXO Stability (Typical): +/- .1 PPM
- Modes: CW, SSB, NFM, AM, Digital
- Antenna Ports: Three BNC 50 ohms Software Configurable Ports, Three BNC ADC1 Bypass and Loop in ports, One BNC for RX2
- Frequency Resolution: 1 Hz

### Electrical Specifications:

- 13.8v DC @ 25A, 3A Receive/25A Transmit

### Mechanical Specifications:

- 5Kg (approx. Weight)
- Dimensions: 276MM (L) x 79MM (H) x 265MM (W) (Not including extrusions)
- Rugged Aluminum Extrusion with Temperature controlled internal/External (Optional) Fan.

### Receiver Specifications:

- Receiver Architecture: Direct Down Conversion
- Dual 16 bit Phase Synchronous ADCs
- Independent filter banks for each ADC
- 6M LNAs
- Frequency Coverage: 9Khz to 60Mhz
- Attenuator: 1-30dB step attenuator
- Reciprocal Mixing Dynamic Range (RMDR): 116dB @ 2Khz offset
- Receiver Phase noise: -149dB @ 10Khz
- Image rejection: 90dB
- Hardware support for 7 independent receivers assignable to either ADC

### Transmitter Specifications:

- Transmitter Architecture: Direct Up Conversion
- DAC Resolution: 16 bit
- RF Output Power: 100W PEP SSB, FM, RTTY, Digital; 1-30W AM, 100W CW
- IMD: IMD3 typically -68dB below PEP @ 100W output on 20M
- Harmonics: Typically better than -43dBc on HF and -60dBc on 6M
- Carrier and Opposite Sideband Suppression: Better than -80dBc
- Transverter IF Output: 0db to 15dB

### Front Panel Specifications:

- 7" touchscreen display, 1024x600 pixels
- 1 high resolution VFO encoder (480 steps per revolution)
- 6 dual encoders for analogue controls, with user programmable functions
- 30 user programmable pushbuttons

## 10 Maintenance

### 10.1 PC Maintenance

An Intel NUC PC provides the processing within the radio's chassis. This is a normal PC and requires normal PC maintenance and precautions. It is the user's responsibility to ensure that it is adequately protected from viruses or other malicious attacks, and that it is backed up adequately.

A mouse and keyboard can be connected to the rear panel USB socket using a simple hub if required. A USB-C hub can be used to provide a wired Ethernet and HDMI connection for an external monitor. A suitable hub can be supplied by Apache-Labs if required.

### 10.2 PC Networking

ANDROMEDA includes an Intel NUC PC which has an Ethernet connection to the Orion mk2 SDR board. As shipped, a Wi-Fi interface within the NUC provides a network connection. You may also want to add a wired Ethernet connection: this can be achieved by using a USB-C hub attached to the rear of ANDROMEDA. The hub can also provide an HDMI interface and further USB connectors.

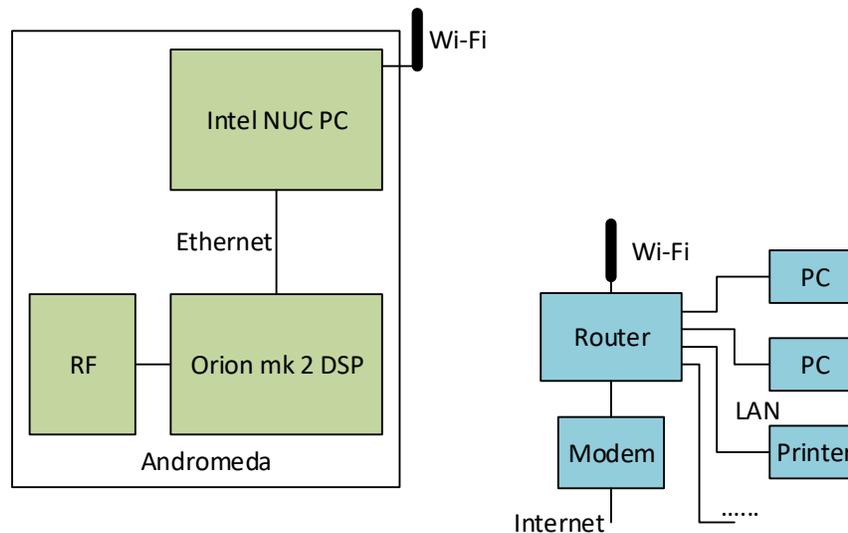


Figure 4: ANDROMEDA with Wi-Fi connection to Local Network

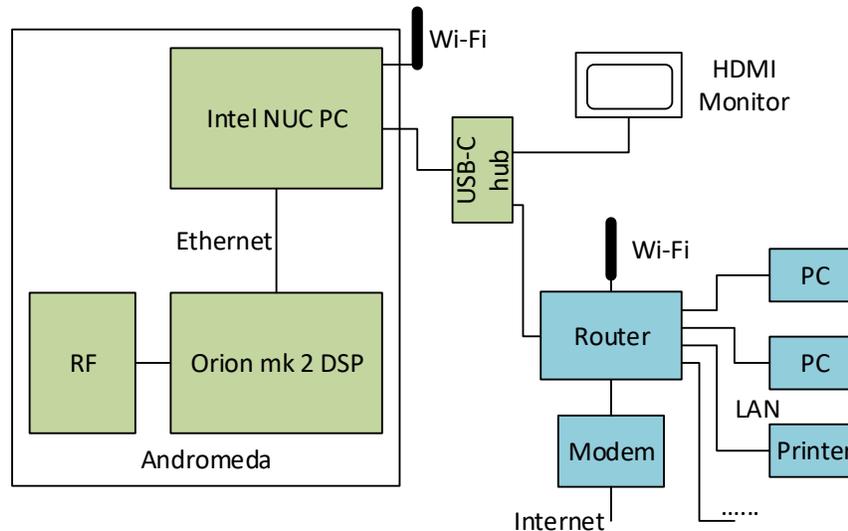


Figure 5: ANDROMEDA with wired connection to Local Network

In either case, it will be necessary to set up the windows networking so that the PC is properly a member of your local network, and the Orion mk2 board has an IP address.

How. I assume IPIPA for Orion?

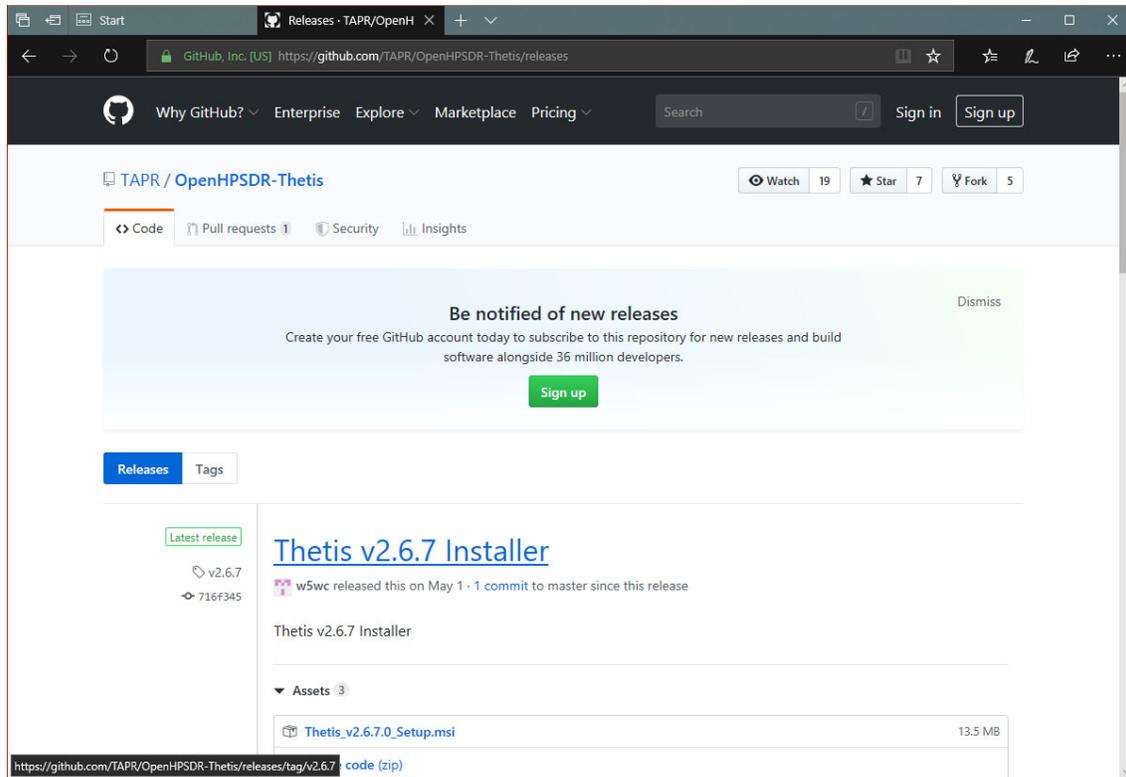
### 10.3 File Locations

Need to write these down from a NUC once everything is installed in the right places!

### 10.4 Thetis Installation

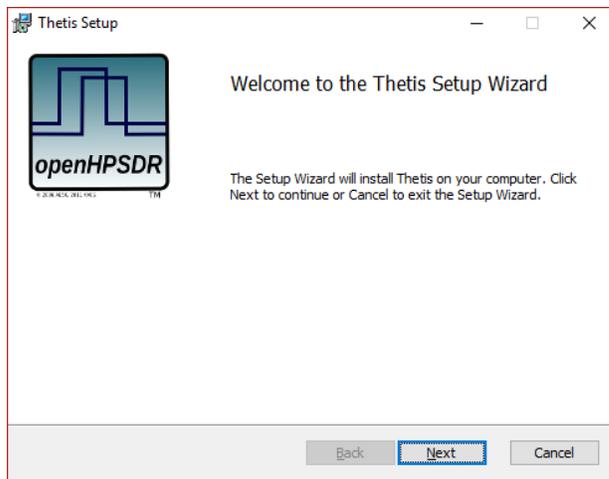
If it is necessary to re-install Thetis, please follow these steps. Firstly, begin by downloading the installer. THETIS releases are available from the internet at: <https://github.com/TAPR/OpenHPSDR-Thetis/releases>

1. Click on the installer (this will be a file with extension “.msi”) and select RUN.

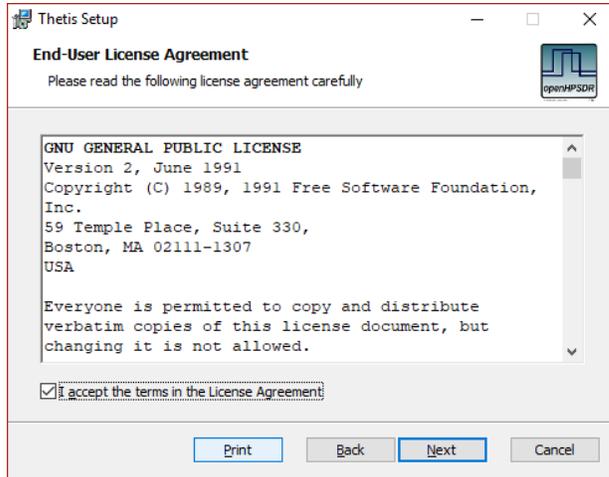


(You may get warnings from windows security products at this point)

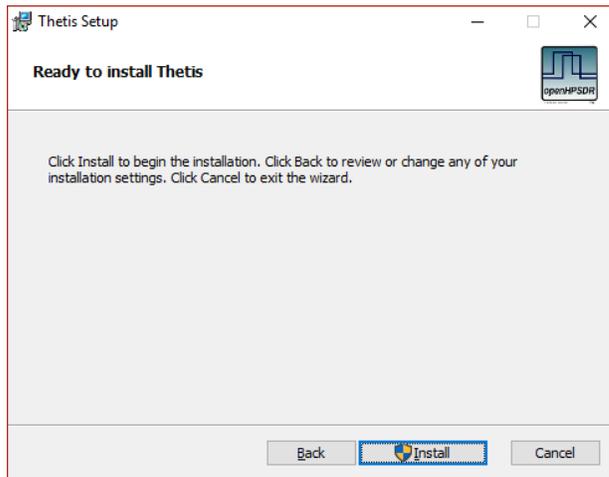
2. The install script will start. Click Next.



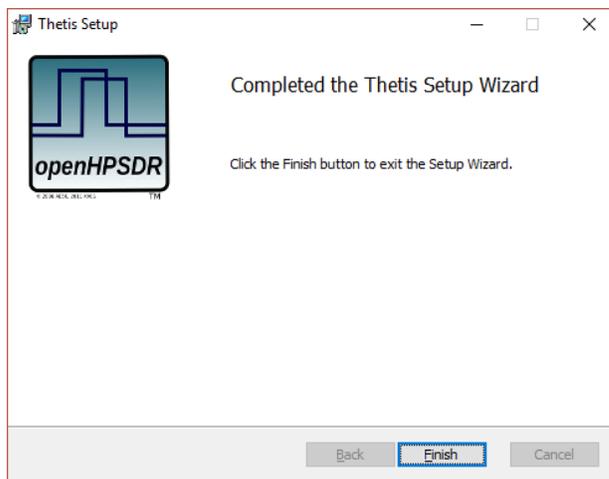
3. (Assuming that you agree with it) click to accept the terms of the license agreement and press Next



4. Select the typical option and press Install. You may get a windows User Account Control form asking **do you want this program to make changes to your PC** – press Yes if that pops up.



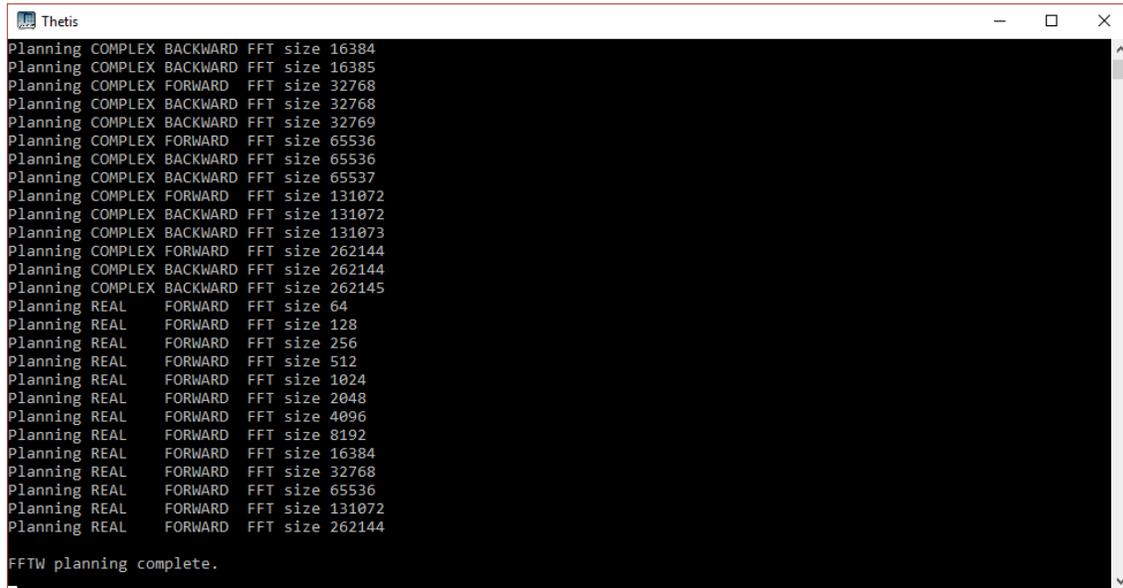
5. The installer copies THETIS onto the PC (this is very quick!). When complete click Finish



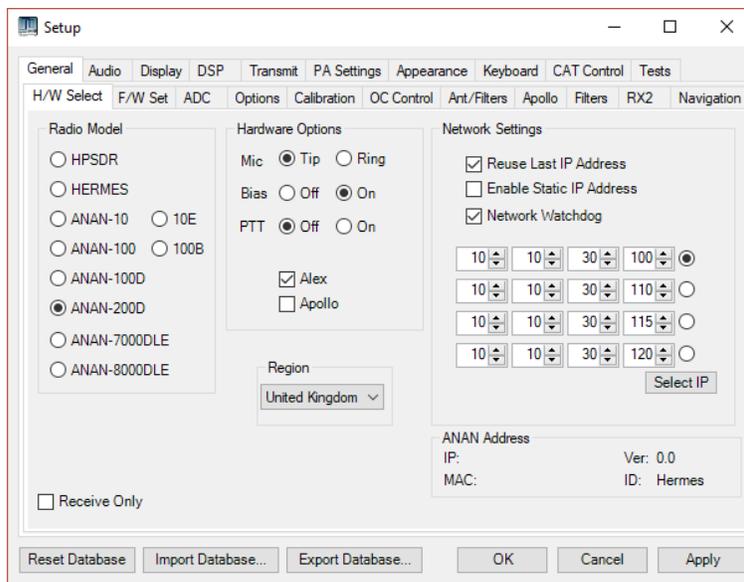
6. THETIS is now installed on your PC. You should have a new desktop icon.



7. Double click the Icon to run THETIS for the first time. A window will open up, saying that it is running a series of tests for how to conduct Fast Fourier Transform (FFT) operations. This may take 10-30 minutes to complete; when complete the window will look like this:



8. THETIS “proper” will now start, bringing you to the “expanded” display screen. You will need to import a saved version of the database file which has been provided in the “my documents” folder.
9. Click Menu > Setup. Click Import database, navigate to the file and open it.



## 10.5 Thetis Upgrades

Installing updates is simply the same process as a clean install. However at the end of the process, THETIS will not need to re-run the FFT tests. You will get a message saying that the database will be updated to a new version; let this run to completion, then re-run THETIS.

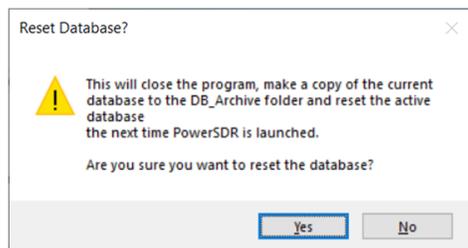
## 10.6 Database Reset

Occasionally it is recommended to carry out a database reset. This resets all settings to initial, “safe” values. There are two occasions when this could be needed: after a major update, which has changed too many settings to be individually described; and if you have edited settings in a way that turned out to be inappropriate, and you cannot recover.

To prepare for this consider the following actions to preserve changes that you want to reinstate:

- Make screenshots of important or complex settings, for instance amplifier calibration values.
- Use Menu > Setup > Transmit > Export Current Profile to export important and/or complex transmit profiles.
- Use Menu > Setup > CAT > Configure MIDI > Manage Mappings > Export Mappings to export MIDI settings.

You can now carry out the database reset. Open the Menu > Setup form and click the **Database Reset** button at bottom left. It will issue a warning; click **Yes** to proceed.



To restore any saved settings:

- For each transmit profile exported it can be imported using Menu > Setup Import Database. It will require a separate import cycle for each profile.
- MIDI settings can be imported using the “Import Mappings” function that was adjacent to the “Export Mappings” function referred to above.

A copy of an initialised database will be provided in “my documents”. This can be imported in the setup form to reset settings to those appropriate to ANDROMEDA. This includes factor adjusted PA gain.

## 10.7 Reflashing firmware

The FPGA bootloader code resides in protected portion of lower segments of flash memory. The FPGA firmware fits in the address range above the bootloader code. Depending on the position of the bootloader switch, either the bootloader code or the radio firmware is transferred to the FPGA for execution.

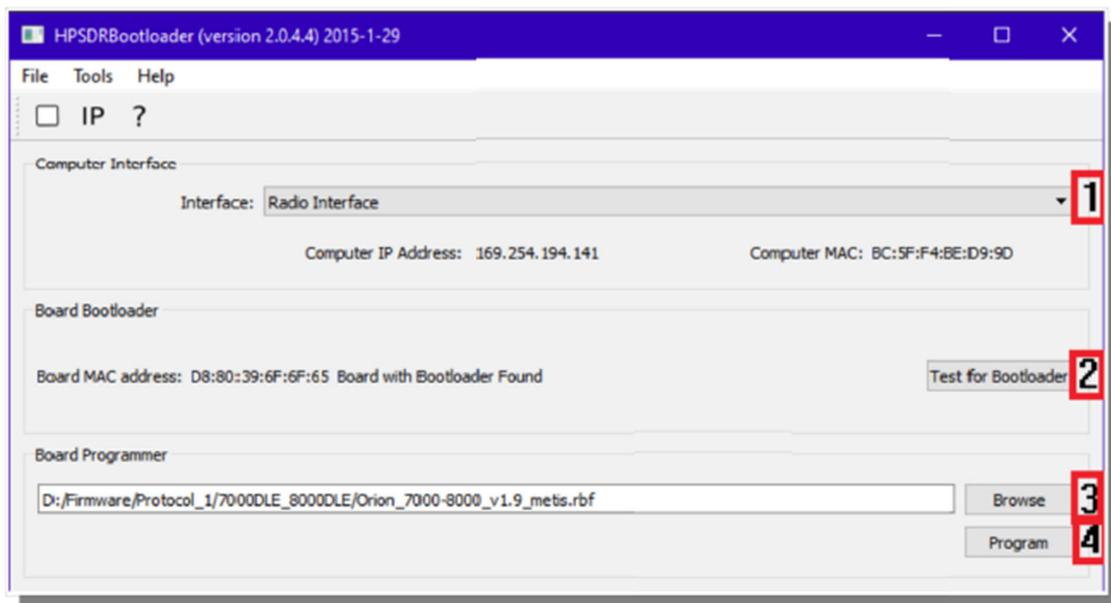
ANDROMEDA uses the same firmware files as the ANAN-7000DLE and ANAN-8000DLE radios. For operation with THETIS, **Protocol 2** firmware is essential.

A definitive guide to the firmware update process can be found here: <https://apache-labs.com/community/viewtopic.php?f=18&t=2333>

### 10.7.1 HPSDRBootloader v2.0

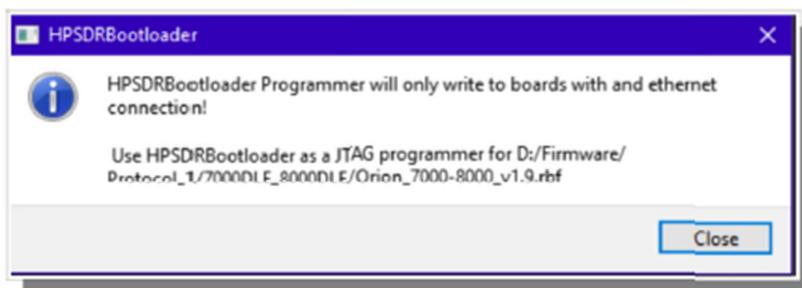
The bootloader is able to operate even in circumstances where the FLASH has lost the “bootloader” FPGA code.

1. Download and install [WinPCAP](#) (Bootloader requires it, you will have to restart after install. Do NOT use "Win10PCAP", Bootloader will not work properly with it).
2. Download the HPSDRBootloader installer for Windows:  
<https://github.com/TAPR/OpenHPSDR-Protocol1-Programmers/releases>.
3. Install the HPSDRBootloader software.
4. Shut down windows and power off the radio. Place the radio into bootloader mode using the slide switch on the back panel. Power the radio ON.
5. Run the HPSDRBootloader software.



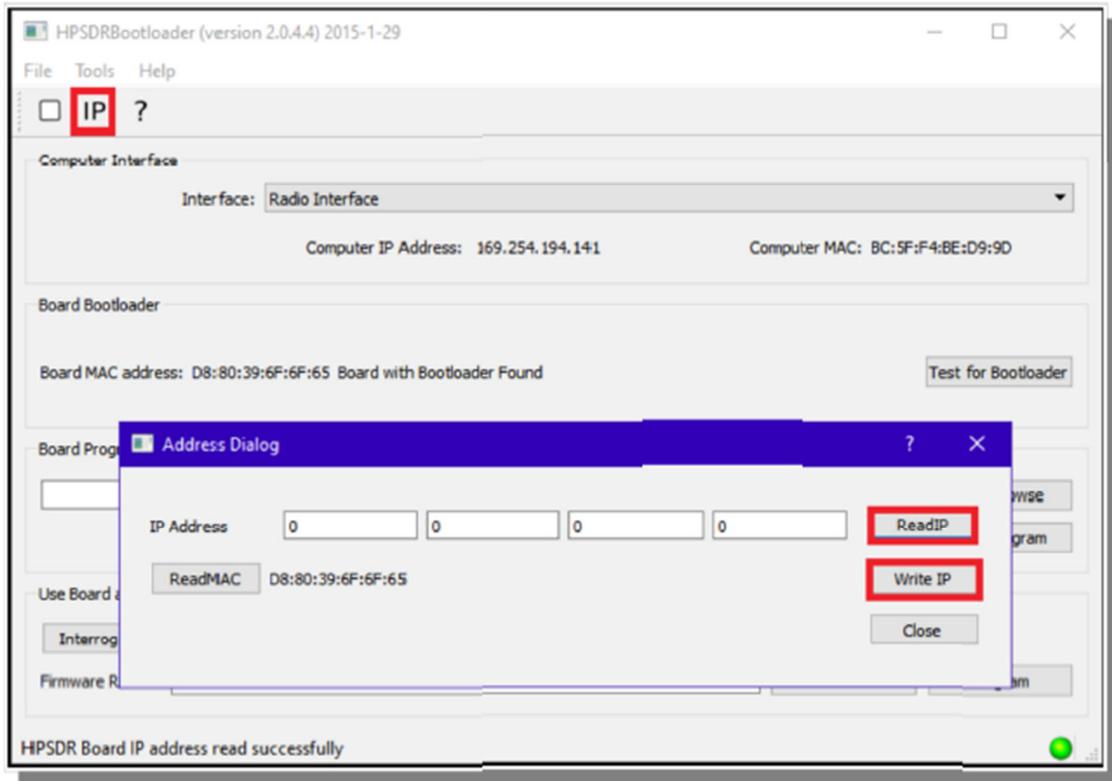
1. Choose the **Computer Interface** that the radio is connected to using the pull-down menu.
2. Click on **Test for Bootloader**. Wait until the information is updated in the **Board Bootloader** field.
3. **Browse** to the location of the firmware file you will be using to update the radio.
4. Click on **Program** to flash the firmware.

Firmware files are available for download from <https://github.com/TAPR/OpenHPSDR-Firmware>. Firmware Update files will have the “.rbf” suffix.



If you receive this error message, rename the rbf file adding the word **metis** to the file name. In my example I added it to the end.

### 10.7.2 Assign Static IP Address using HPSDRBootloader



1. Choose the correct Computer Interface and then Test for Bootloader.
2. Click on IP from the menu.
3. Click on ReadIP to read the current IP address of the radio.
4. Enter the new IP address in the IP Address fields.
5. Click on Write IP to update the IP address in the radio.

To revert back to using DHCP or APIPA enter 0.0.0.0 in the IP Address fields and click on Write IP.

### 10.7.3 HPSDRProgrammer for Protocol 2

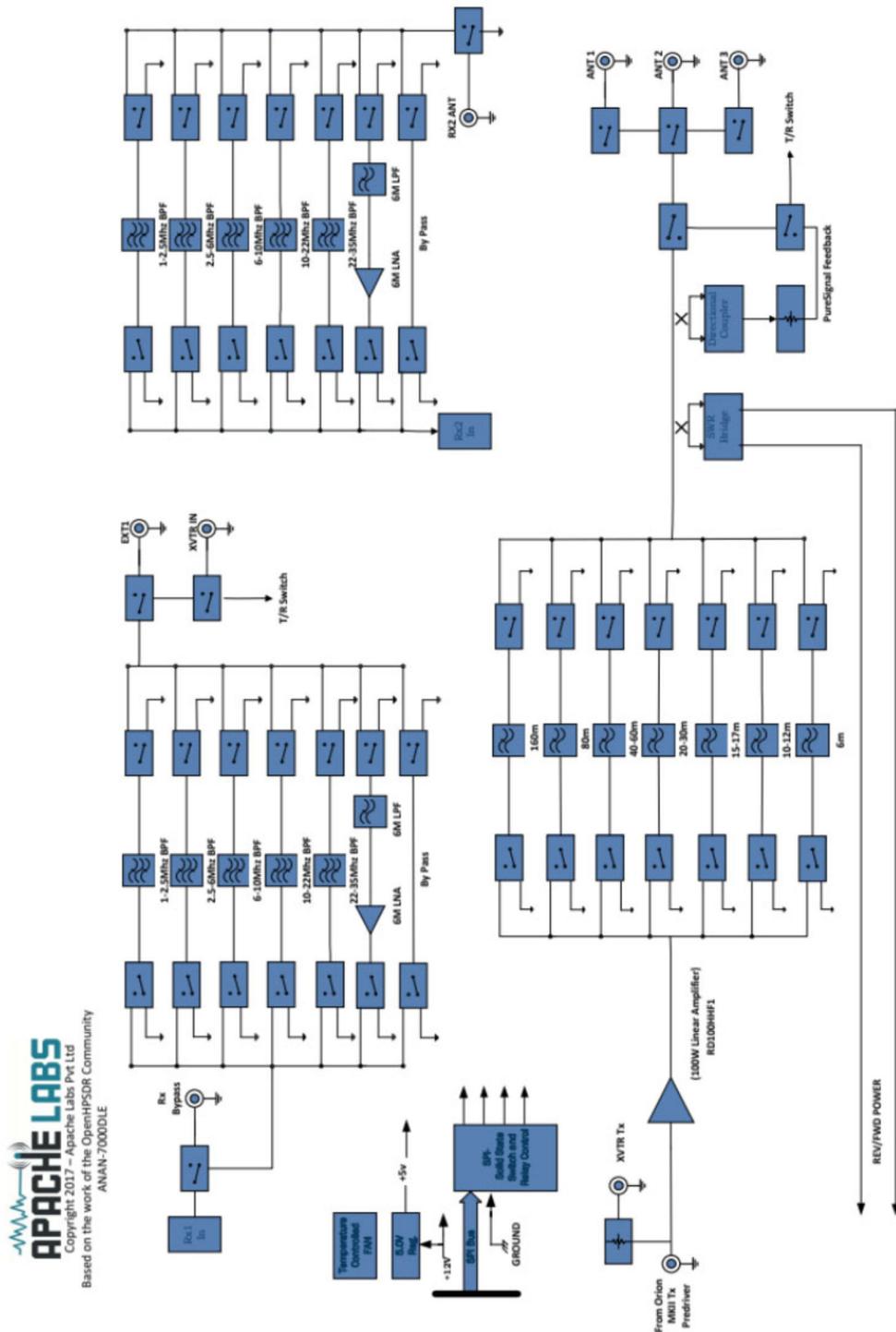
It is also possible to use the HPSDRProgrammer utility to reprogram the flash memory.

The update files are available from <https://github.com/TAPR/OpenHPSDR-Firmware>. Operation with THETIS will require **Protocol 2** firmware. Firmware Update files will have the ".rbf" suffix. The HPSDRProgrammer utility is specifically designed so you cannot inadvertently overwrite or damage the lower bootloader addresses

1. Download the HPSDRProgrammer for Windows: <https://github.com/TAPR/OpenHPSDR-Protocol2-Programmers/releases>
2. Exit from the THETIS program, if it was open.
3. Unzip the folder. There is no formal installer.
3. Open a Windows command prompt ("DOS") window.

4. Navigate to the folder you unzipped and run HPSDRProgrammer\_web.exe (it is recommended you do this from a command prompt window so that you can watch for any error messages and because it gives you certain instructions).
5. Open a web browser and browse to "http://localhost:8228/intro/".
6. Click "Select Interface", then select the interface you think the radio is on. If you guess wrong it is quite possible the programmer will crash. If so, start over at step 5.
7. If there is a radio to be found it will be on the "Select HPSDR" list. Select it and click "Select".
8. Click "Program" then click "Choose File", then choose the firmware file you want to load.
9. Click "Upload", then click "Program". The erasure phase will take a little over 30 seconds. No feedback will be seen in the command window. The programming phase will take about 7 seconds, you should see feedback in the command window.
10. Click "Quit", then click "Quit" again.
11. Re-start THETIS to use the new firmware.

## 10.8 Block Diagrams



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 ANAN-7000DL

## 11 Support

### 11.1 Warranty

We warrant that our products are free of defects in material and workmanship and extend this warranty under intended use and normal service conditions to the original owner for a period of 12 months from the date of purchase. This warranty does not apply to any product that has been repaired [Unauthorized] or altered in any manner and is void if damaged by accident, neglect, unreasonable use, improper installation, lack of proper impedance matching [High SWR], improper tuning, over driving power limits, damage due to use of any third party accessories, or any other cause not arising specifically out of defects in material or workmanship.

Our obligations are limited to repairing or replacing, at our sole discretion, any product or part that is returned to the mailing address, all shipping or transportation charges must be pre-paid, accompanied by proof of purchase and which examination reveals to have been defective within the warranty period stated above.

Our Warranty does not imply any obligation other than herein stated. Any implied warranties, including but not limited to fitness for a particular purpose, are limited in duration for the above one year period.

We shall not be liable under this warranty, or any implied warranty, for loss of use of the product or for any other consequential loss or damage incurred by the purchaser.

Warranty -- Apache Labs website has a link to explain their warranty and other pertinent information:

<http://www.apache-labs.com/terms-of-use.html> under "Terms of Use".

#### IMPORTANT

The FPGA and other components on the ANDROMEDA PCBs can be damaged by Electrostatic Discharge [ESD]. When handling the PCB, you should take ESD precautions [e.g. use a work bench with an antistatic mat on it and wear a grounded wrist strap].

When powered on do not touch the top of any IC in order to determine its temperature. In particular, do not touch the Switch Mode Regulator IC. Touching its leads can change the switching frequency and alter the output voltage.

### 11.2 References

- [1] Apache Labs community forum: <https://apache-labs.com/community/index.php>
- [2] Open HPSDR Project Website: <http://openhpsdr.org/>
- [3] Thetis releases - <https://github.com/TAPR/OpenHPSDR-Thetis/releases>
- [4] Thetis source code repository: <https://github.com/w5wc/Thetis>
- [5] Thetis And PowerSDR™ 3.x CAT Command Reference Guide: <https://github.com/TAPR/OpenHPSDR-PowerSDR/blob/master/Documentation/Radio/PowerSDR-CAT-Command-Reference-Guide-V3.docx>