Magnis SDR

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WELCOME (Part 2 of 2)

Welcome to the Magnis SDR. The kit is designed as an advanced project for assembly by hand. It is a precision device and requires precision building. If the guide lines presented here and in the builders notes are followed, the result will be a high quality transceiver that will bring ham radio enjoyment for many years.

All support for the Magnis SDR is located at: https://groups.io/g/TheVeteranSDR . Please join the group.

Also, please read the ECN and Errata documents for important information that may supersede the contents of this assembly document.

This is an advanced kit and requires fine detail work. Two of the ICs have very fine pitched leads. Installing these requires high level of attention to detail. However these ICs have been successfully installed many times IF the instructions presented here and in the builder notes are followed carefully and exactly. If you believe this beyond your skill level, it is suggested that the Semi DIY kit be purchased instead.

DO NOT ATTEMPT TO REMOVE INTEGRATED CIRCUITS EXCEPT WITH A HOT AIR TOOL. YOU WILL DAMAGE BOTH THE IC AND CIRCUIT BOARD.

Magnis SDR

Required Tools

Safety glasses
Illuminated magnification
Soldering iron with 1/32" tip
Flux core solder, 0.020" or 0.015"
Solder flux, pen or syringe
Desoldering wick
ESD-safe work area and parts trays
#1 and #2 Phillips screwdrivers
Pliers for #4 & #6 nuts Electronics
Electronic multimeter
Ruler
SMT tweezers
Wire cutters
X-ACTO knife or Scissors

Optional Tools / Supplies

Oscilloscope
RF signal generator
Hot air rework tool
Thermal Paste Compound Grease

Additional Equipment

CW or SSB receiver
USB cable, standard A-B
13.8V 1A regulated power supply
Power supply wire, 20AWG or better
50 ohm antenna, BNC terminated
50 ohm dummy load
Computer to run DSP software

PLEASE SEE THE BUILDERS GUIDE FOR ADDITIONAL INFORMATION

Most of the time, a simple multimeter is the only diagnostic tool you will need to successfully assemble the Magnis SDR. If there's a difficult problem then you may find it necessary to use a signal generator and oscilloscope. Soldering errors can be found with a 5X or 10X illuminated magnifier. A bad part is extremely rare. Even electronics built by robotics will have problems due to soldering errors. Work slowly and take lots of breaks.
Please use the Yahoo Group to ask for help and help others.

CAUTION: Use only an X-ACTO knife or other very sharp pointed instrument to remove the components. For components that are laying on anti-static foam, cut only around the outside of the foam and then carefully lift the component off the sheet. Otherwise, there is a risk of damaging the semi-conductor leads. There is a good chance the component will stick to the laminated sheet that secures it to the paper sheet. Simply grasp the component with tweezers and gently pull it off the tape.

☐ 14. Windows Device Driver

This manual will cover testing the Magnis SDR under a Windows operating system. The application used for testing is HDSDR. When completed the radio and software will be fully ready for use.

You're welcome to use another operating system or application but for the purposes of getting the Magnis SDR up and running, HDSDR is the only host application that will be used and supported by Magnis SDR.

Windows requires a device driver. Other operating systems do not. Download Zadig from here https://zadig.akeo.ie/driver install driver for **libusb-win32(v1.2.6.0).** In device manager under libusd-win32(v1.2.6.0) you should see Multus SDR Control (Interface 0)

NOTE: If you have ever installed the PE0FKO driver (for support of Softrock rigs and similar) on your computer it will need to be removed *BEFORE* installing the driver for the OSB. The PE0FKO driver will be listed in the Windows (Win 7) device manager window under "libusb-win32 devices". The previous radio must be attached to the computer so that the rig maybe seen in the device manager. If the previous radio is not available attach the OSB. A libusb-win32 device should be displayed in the device manager although with an incorrect name and/or with the yellow (!) exclamation mark. Right click on the device and select "Uninstall". Next, in the pop up window select the check box "Delete the driver software for this device". Now press OK. This will delete the device and remove the associated driver.

Attach the Magnis SDR to the computer via a USB A/B cable.
Launch Device Manager. The Magnis SDR appears as a sound card and appears with the name "Multus IQ Sound" with the current version of the firmware and should have been automatically installed by Windows because it is a standard USB audio device. There should also have a "Multus SDR Control (Interface 0)" device which needs a device driver installed above.

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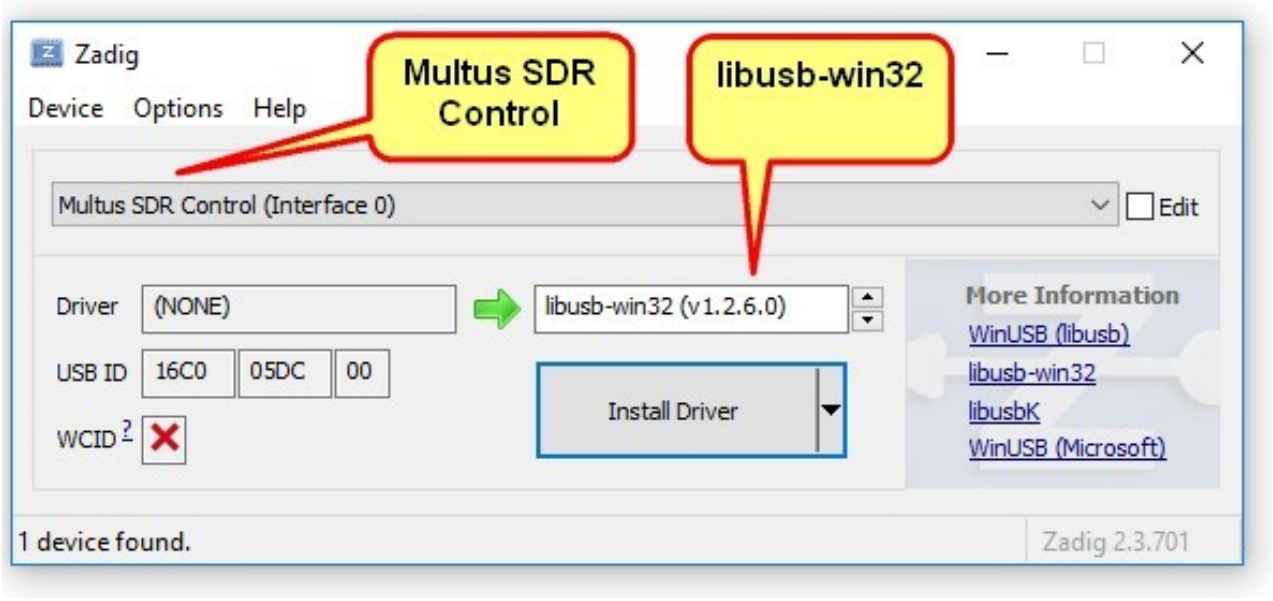
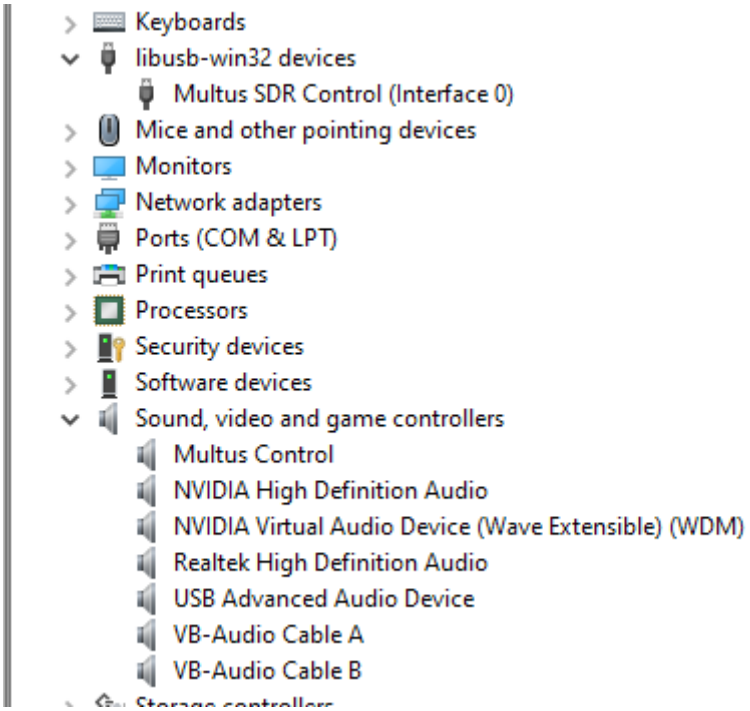
1) If this is a clean install device manager may show a DG8SAQ-I2C device that needs a driver. Zadig, when opened, should automatically show this device. If not used the drop down menu to select it. Then select libusb-win32 (v1.2.6.0).



2) Click “Install Driver”

You should now have Multus SDR Control under libusb-win32 devices and Multus Control under sound devices.



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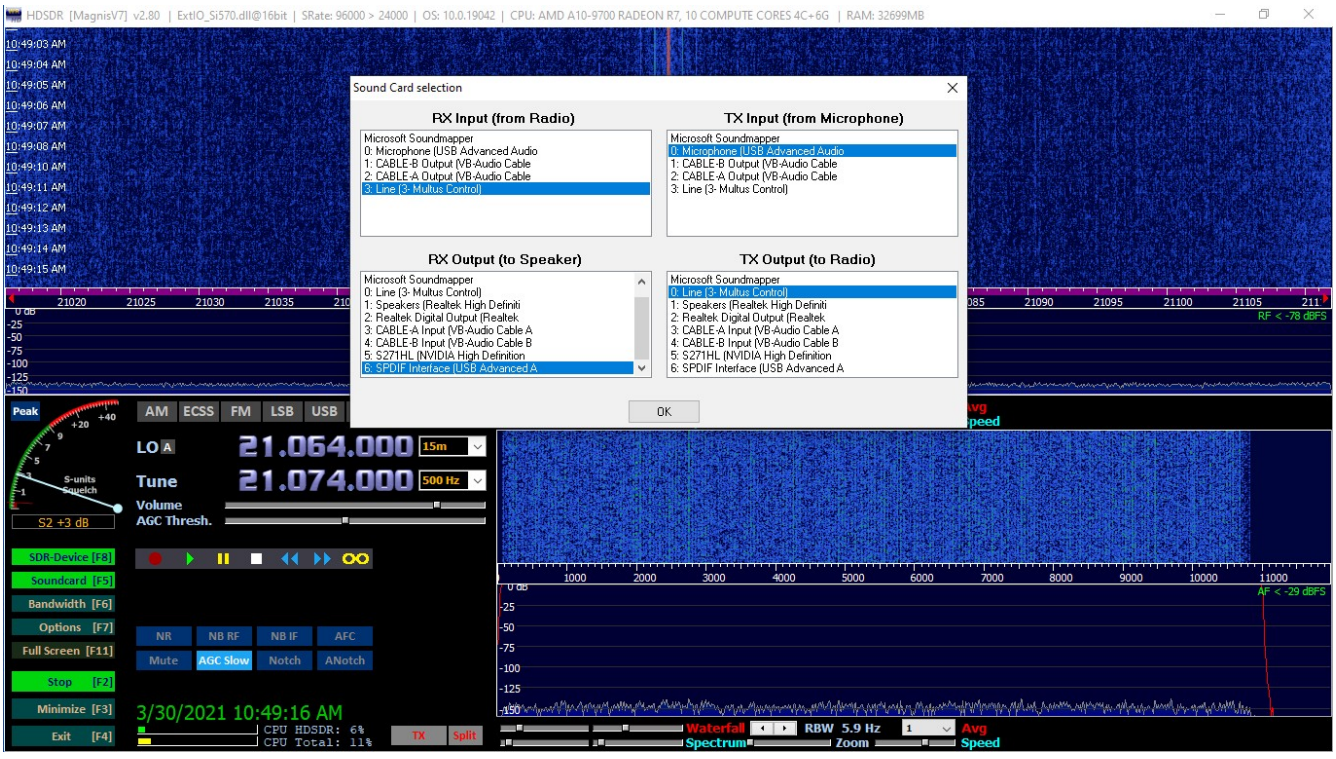
☐ 15. HDSDR Application

Install the latest version of HDSDR. It's a standard Windows installer. Take note of the path it installs to. If you already have HDSDR installed then run the "delete_settings.cmd" so you have a clean start. If at any time problems are experienced when following this guide, come back to this beginning and run "delete_settings.cmd" to start anew.
http://www.hdsdr.de/
Install the latest version of CFGSR. The setup.exe generally works better than the msi installer.
https://pe0fko.nl/CFGSR/
You have to figure out where CFGSR was installed. It doesn't always tell you. It's different on the various versions of Windows. When you find it, somewhere within is a ExtIO_Si570.dll file. Copy this file to the HDSDR folder. Here are the paths for a Windows 10 system:
C:\Program Files (x86)\CFGSR\ExtIO_Si570\ExtIO_Si570.dll
C:\Program Files (x86)\HDSDR\ExtIO_Si570.dll

Set the "RX Input (from Radio)" to "Multus Control". Set the "RX Output (to Speaker)" to wherever you want to hear audio. Press OK.



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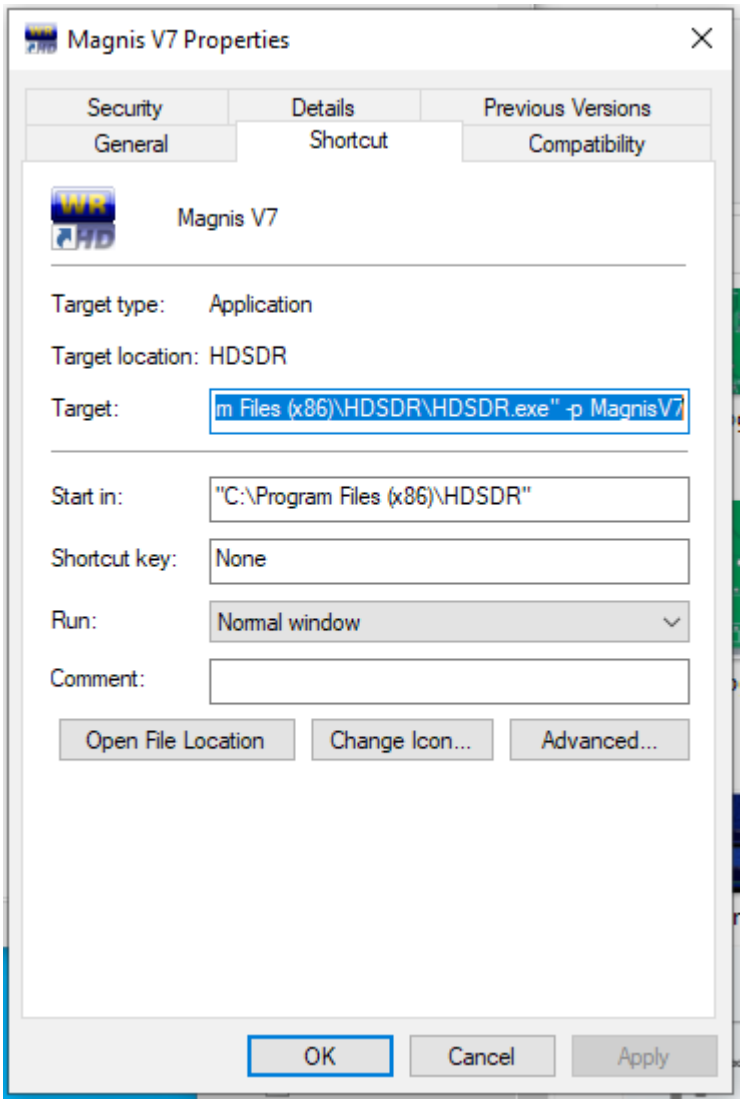
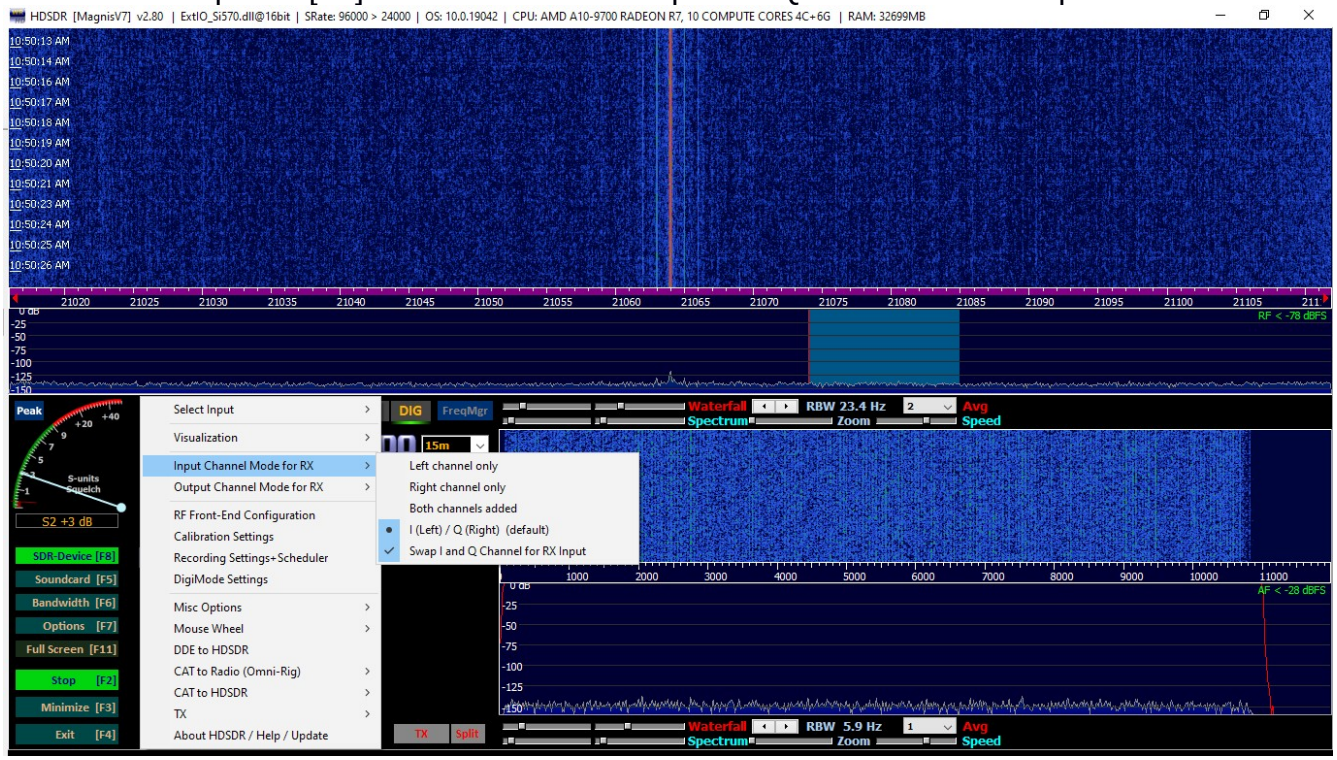
Tip for using HDSDR with multiple SDR radios. All the configurations are stored in the registry so to store different setups per radio you can use the -p command. Simply right click on the desktop HDSDR icon and select properties. On the target address add a space then -p with another space and a name for the radio. Then click apply. Now the setting will be stored for that radio. Don't forget to change the name of desktop icon to reflect that radio.

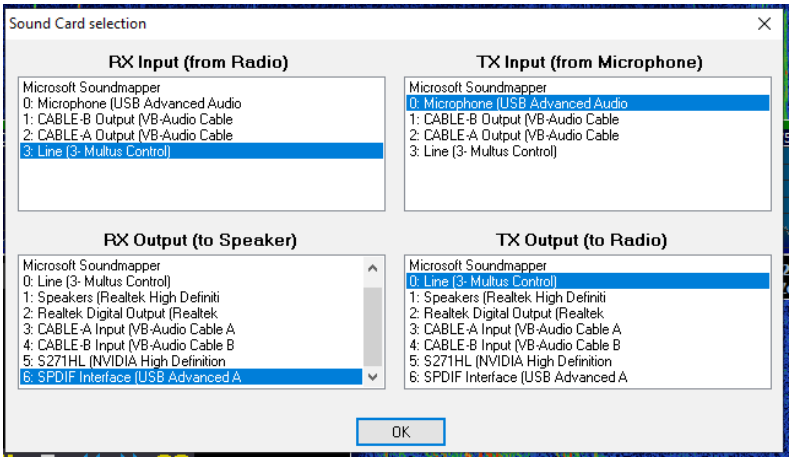


Magnis SDR

Click on the “Options [F7]” button. Enable “Swap I and Q channel for RX Input”.



Click on the “Options [F7]” button again. Select “SDR TX Support”. Choose “Yes” after reading the warning. Set the “TX Input (from Microphone)” to where you have a microphone. Set the “TX Output (to Radio)” to “Multus Control”. Press OK.



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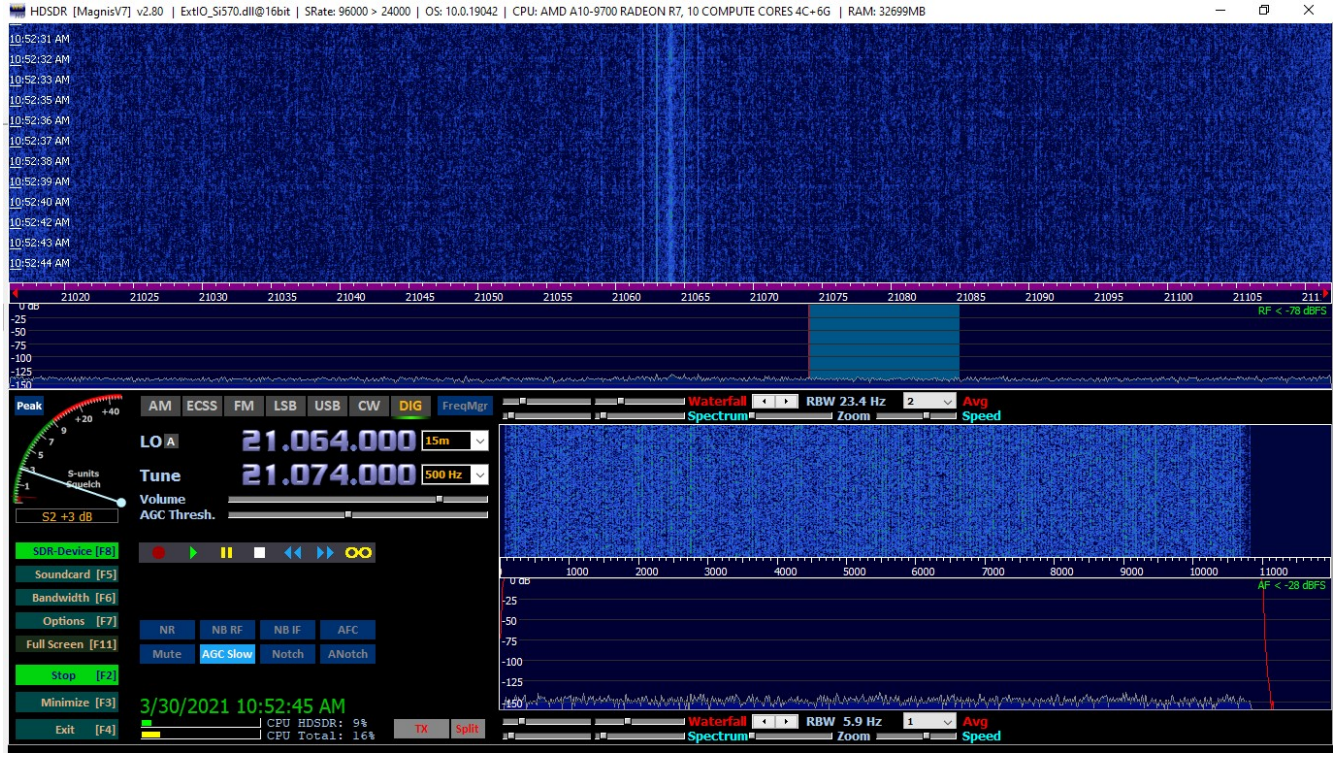
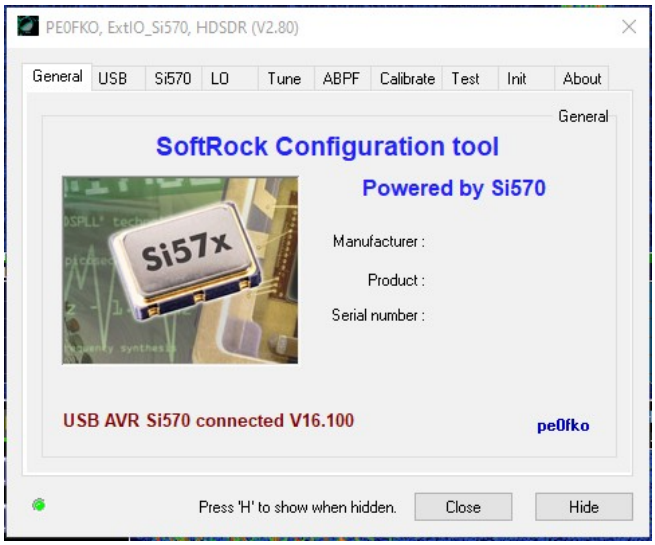
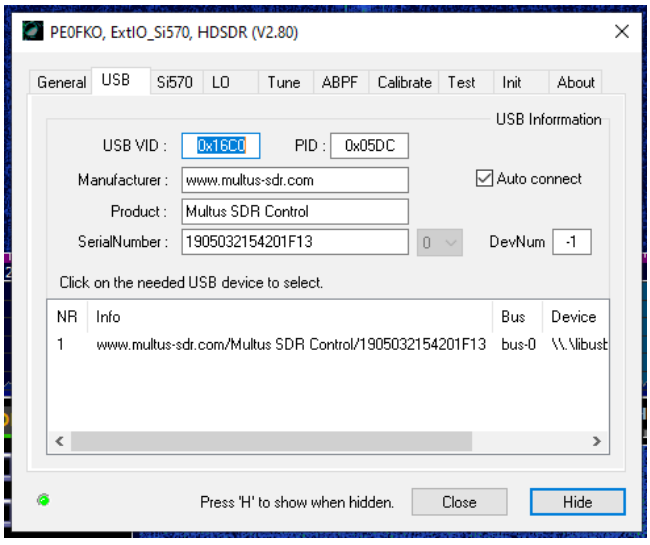
Click on the “Bandwidth [F6]” button. Select 96000 for the sampling rate for both input and output. Close the dialog with the “X” button. Click on the “Start [F2]” button. The radio will begin working and you’ll hear static from the speaker.



Click on the "SDR-Device or [F8]" button. You should see a message about the Si570 being connected. If not, you can try and figure out what's going on from the USB tab.

NOTE: The reported firmware version may be different from that displayed below.





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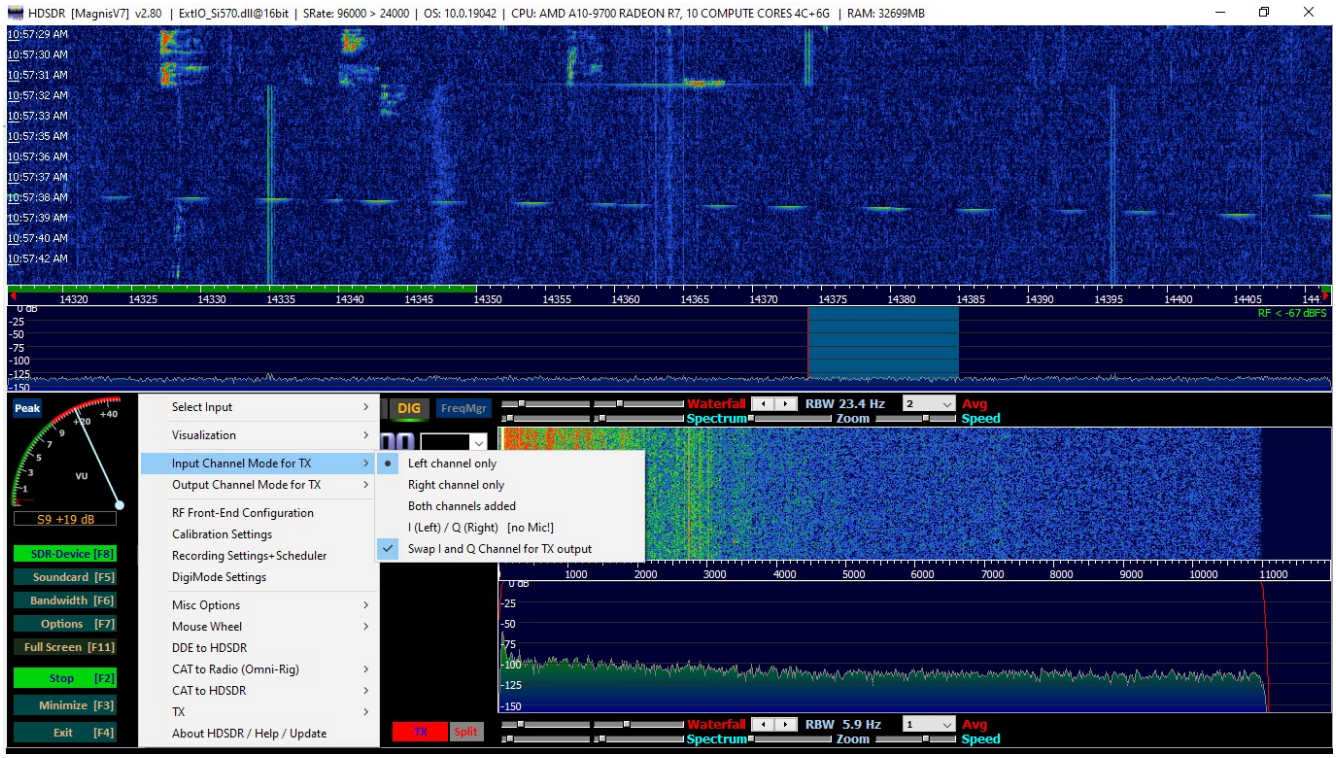
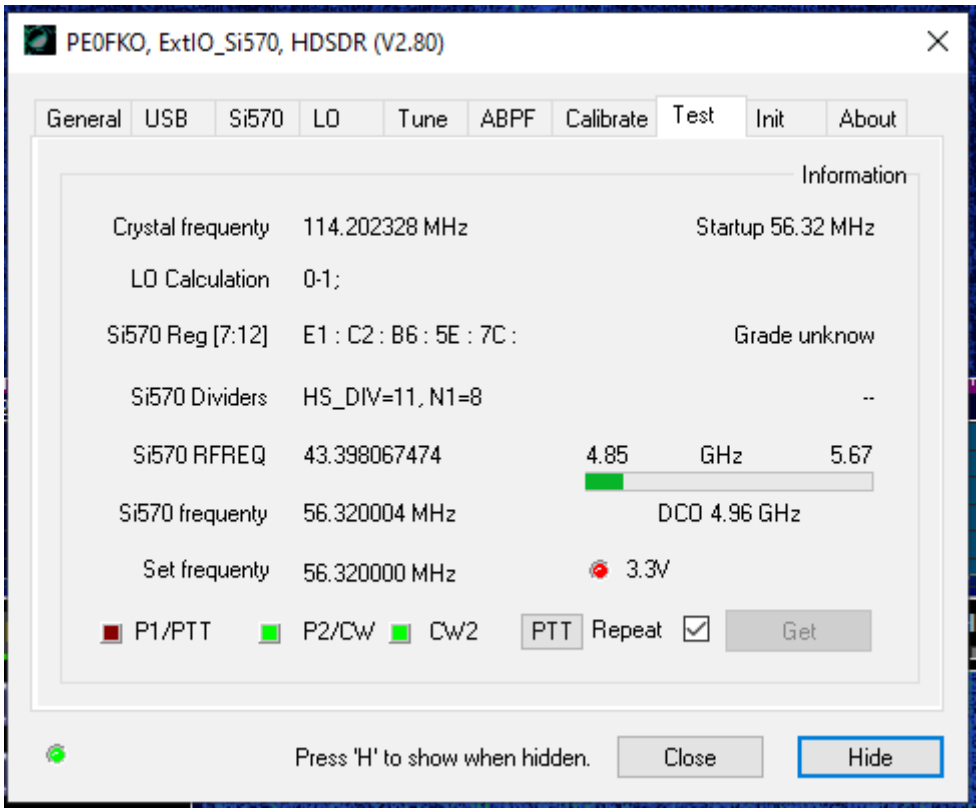
Click on the “TX” button. The LED on the radio will blink rapidly while HDSDR is transmitting. The transmitter has not been built yet so nothing is really being transmitted.
Click on the “Options [F7]” button. Enable “Swap I and Q channel for TX Output”. HDSDR must be in transmit mode to accomplish this.
Press “TX” to turn off the transmitter. All the critical setting are done. Take few moments to experience tuning and setting the different modes (AM, USB, etc.).



☐ 16. Testing the KEY jack

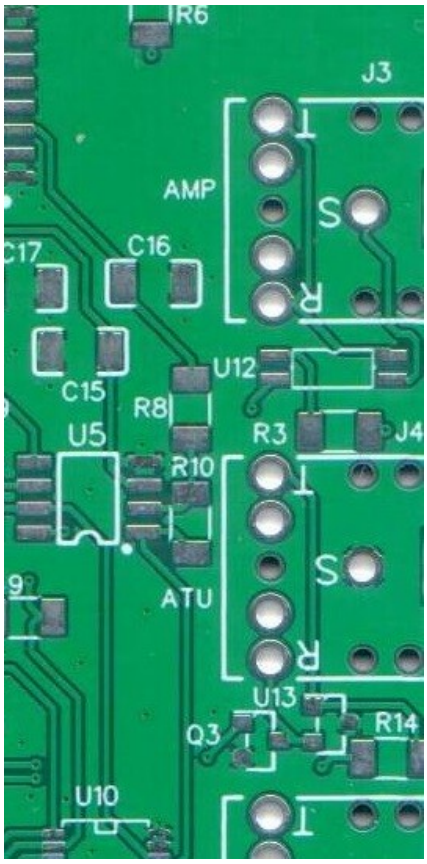
Currently, HDSDR does not support sending CW with the key jack. Only the application authors can add keyer support because source code is not published. Other applications such as Quisk, Rocky and PowerSDR-IQ do support the key jack. The key jack may be tested using the ExtIO_Si570.DLL.

Press the “ExtIO” button in HDSDR. Select the “Test” tab from the dialog. Check the “Repeat” box.



The P2/CW and CW2 lamps will go out when the key contacts are closed.

☐ 17. AMP and ATU JACKS



☐U12 – EL3H7 Optocoupler
☐U13 – PESD12VL2BT ESD
☐Q3 – MMBT3904
☐J3, J4 – Stereo jacks
☐R3 – 1k
☐R14,-4.99k

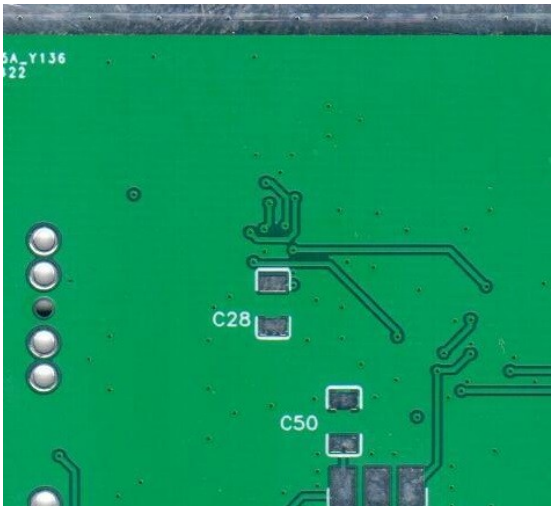
The AMP jack will trigger an external RF amplifier. Many amps include an RF detector and timer but if it has a manual trigger then you don't have to worry about SSB missing a first syllable or cutting out during a long pause. The AMP jack is designed for CMOS/TTL triggered amps. It will not allow enough current to directly trigger a relay. The ATU jack supports the Elecraft T1 automatic antenna tuner and ATU Expander. The Magnis SDR will signal the tuner when you change bands. There is no configuration or setup needed. Simply connect the tuner with a stereo patch cable.

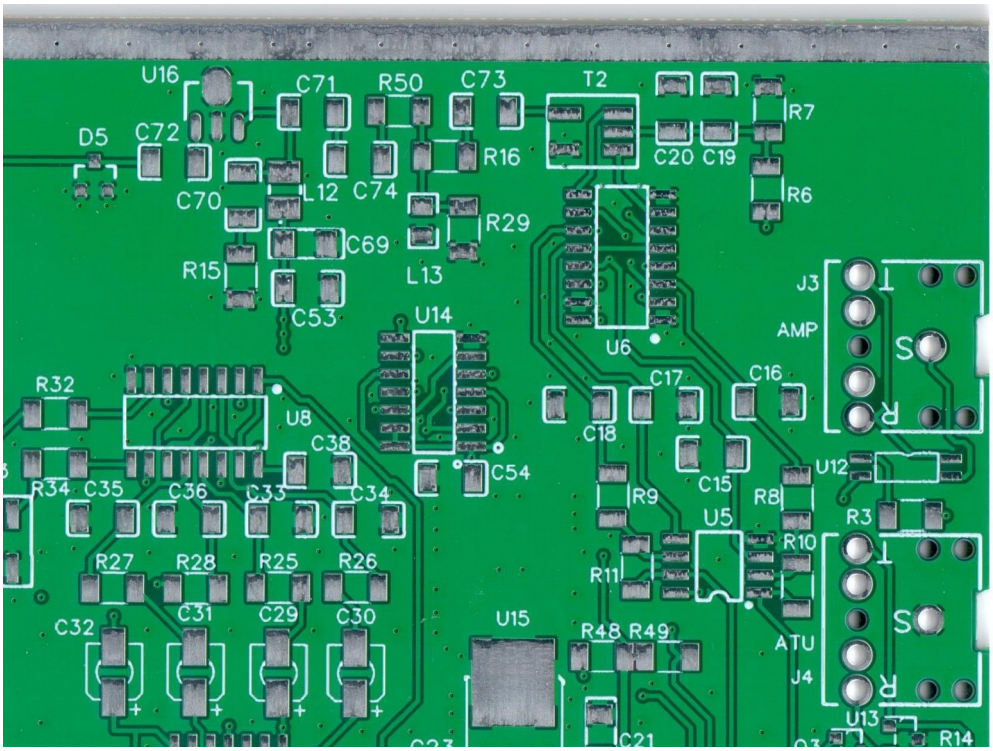
NOTE: Install the semi-conductor components first so that the connectors do not obstruct the soldering of the components.

☐ 18. Receiver

U5 is installed with the beveled edge facing J4. The bevel may only be seen with magnification. Install the SMD components first then install T2 before L11.

☐R10, R11 – 1k
☐R8, R9 – 49.9Ω
☐C15-C18, C20 – 0.01µF
☐C28, C49, C53, C54, C70, C71 – 0.1µF
☐C19 – 4.7µF
☐R6, R7 – 2.21k
☐C72 – 4700pF
☐C73, C74 – 5.6nF
☐C69 – 10uF
☐R15 – 220Ω
☐R16, R50 – 27Ω
☐R29 – 270Ω
☐U5 – LT6231CS8
☐U14 – SN74ACT74
☐U16 – MMG3
☐L12 – 15uH
☐L13 – 390nH
☐T2 – 1:1
☐D5 – SMP1330-005LF





Magnis SDR

Testing

Power Jack J2 – 190-210mA

U14 divides the Si570 clock by 4 to generate two square waves 90 degrees out of phase. You can observe this on an oscilloscope. Changing the LO frequency in HDSDR will change the frequency seen here.

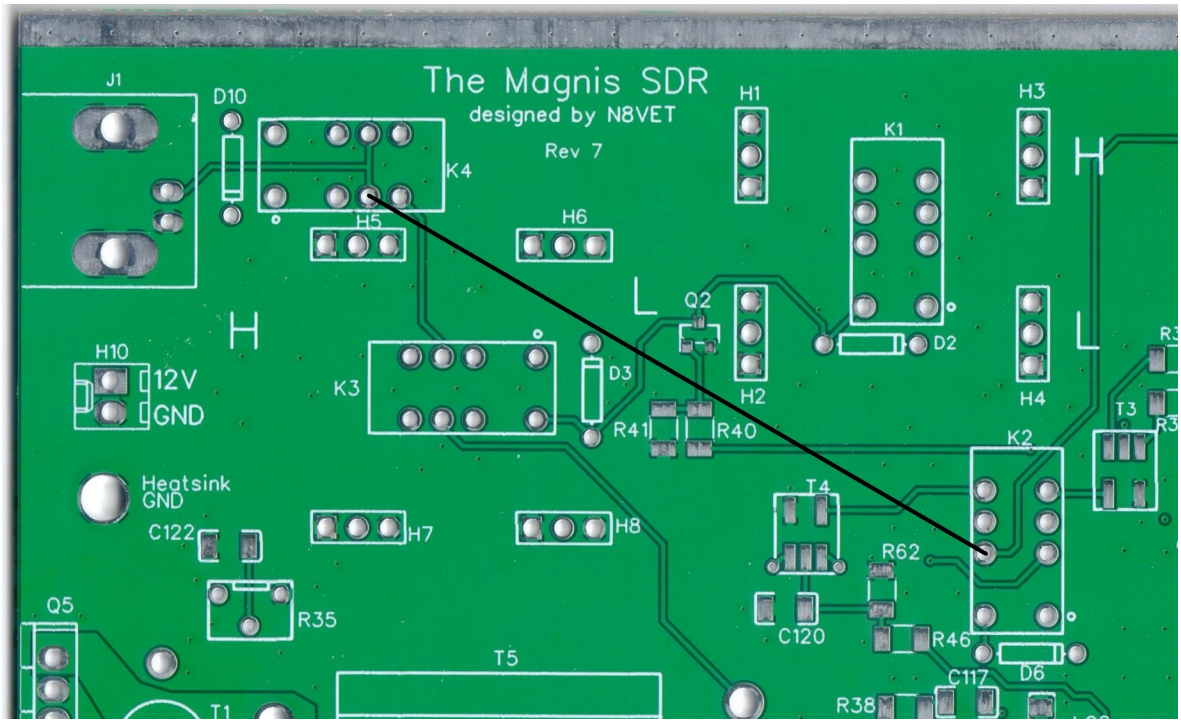
☐U6 pins 2 and 14 – LO Hz 5V square wave
☐J1-BNC Jack
☐Install temporary jumper as in below image

Power Jack J2 – 255mA

If you have a signal generator then inject an RF signal between -40dBm and -100dBm into BNC Jack or connect to antenna.

☐HDSDR RX SSB or CW – Injected signal
☐U5 pins 2,3,5,6 - ⎪Injected signal frequency – LO frequency⎪
☐U5 pins 1,7 – Mixed signal amplified by OpAmp gain (R10÷R8)

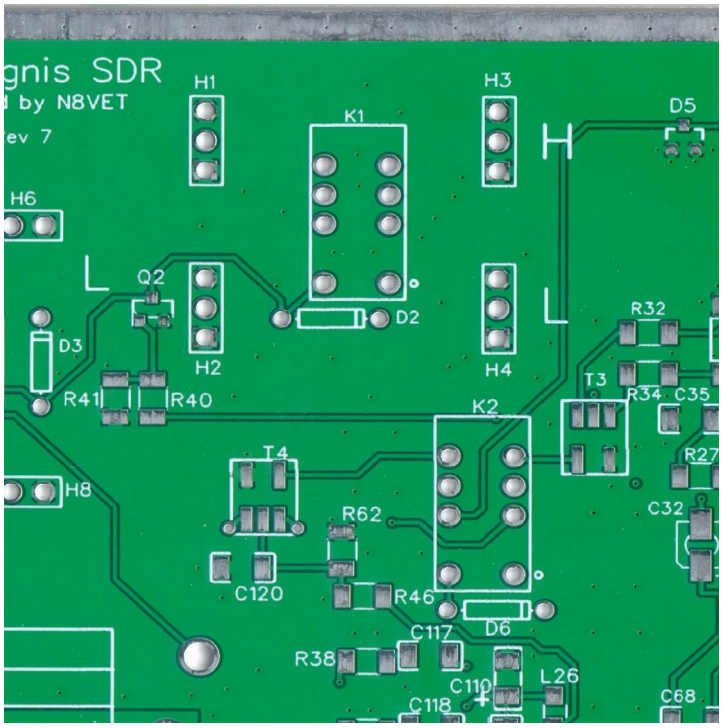
If the equipment is not available, then there's nothing practical to test here. Voltage measurements from a multi-meter are not useful for tracing an RF signal path.



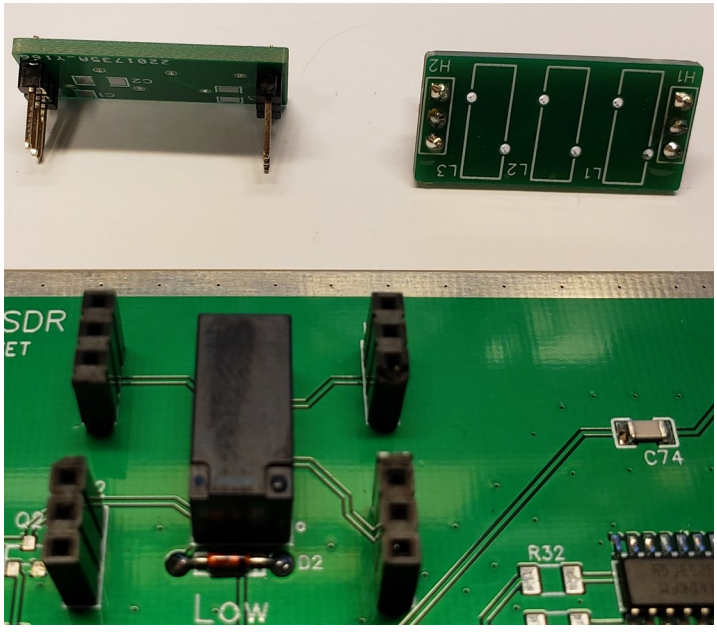
☐ 19. Band-pass filters

If the band chart calls for something like “630pF (300+330)” it is asking for two capacitors in parallel. Simply attach one to the board as usual then solder the other one right on top of it. It is much easier to install all the capacitors before the inductors.

☐K1, K2 – Relay
☐D2, D6 – 1N4148
☐H1-H4 – Header Extensions
☐H1, H2 – Headers on BPF PCB
☐Q2 – 2N7002
☐R40 – 1K
☐R41 – 100K



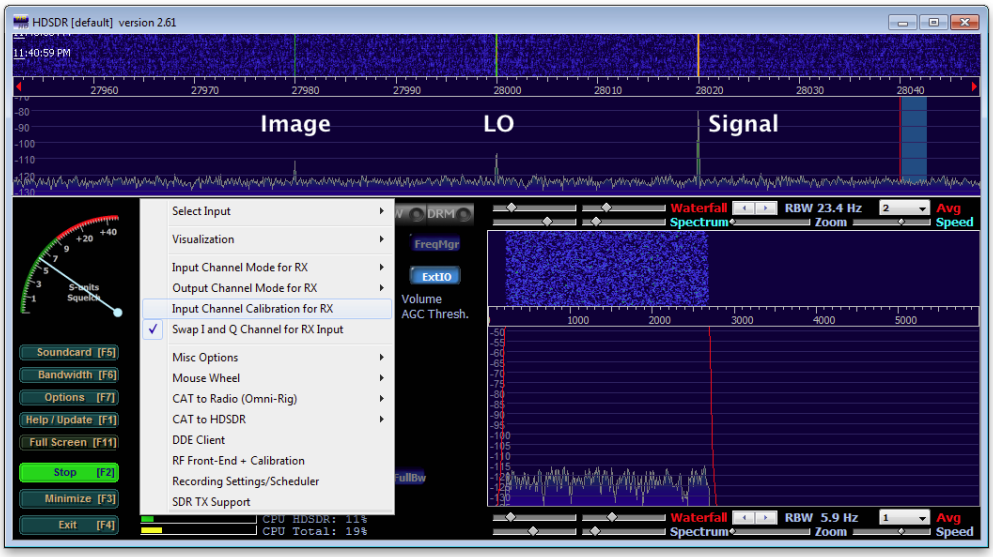
Testing
The receiver should be fully working in HDSDR. The relay click as bands are changed. Either use a signal generator to test or have fun with your antenna. The Magnis SDR is a transceiver so it expects an antenna that can transmit well. For example, a vertical with ground radials, a dipole, a yagi, etc. If a random wire is connected to the center of the BNC then receiver performance will be poor.



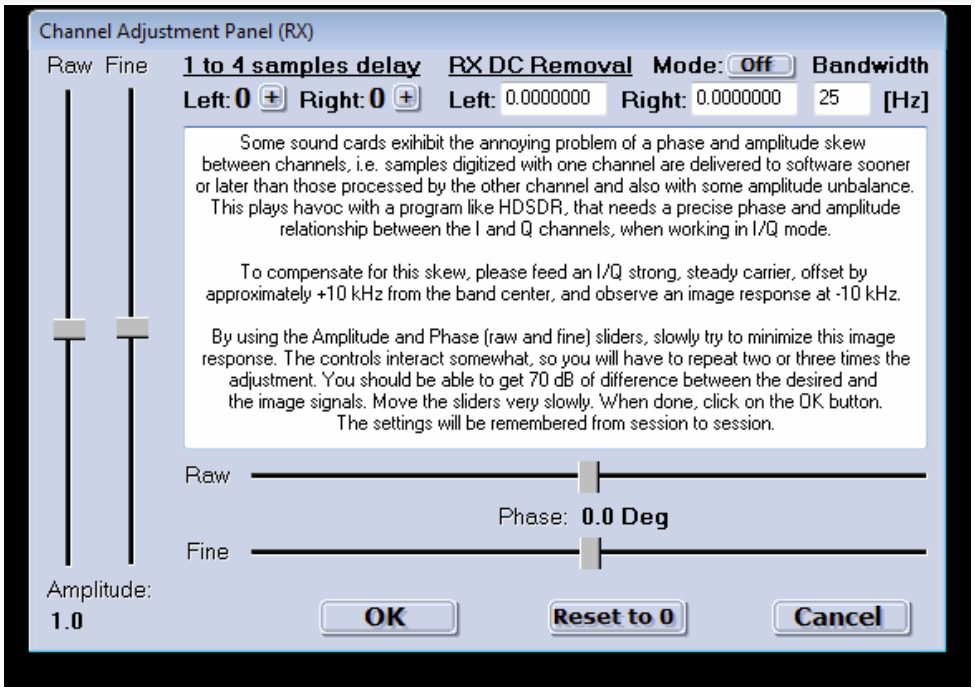
☐ 20. RX Adjustment

Zero-IF radios like the Magnis SDR must have the I/Q data adjusted to compensate for hardware variances.

In HDSDR, click “Options [F7]” then select “Input Channel Calibration for RX”. A dialog with sliders and some help text will appear. Ignore the settings about sample delays.



Set MODE to AUTO. HDSDR will remove the DC component of the I/Q audio signal.



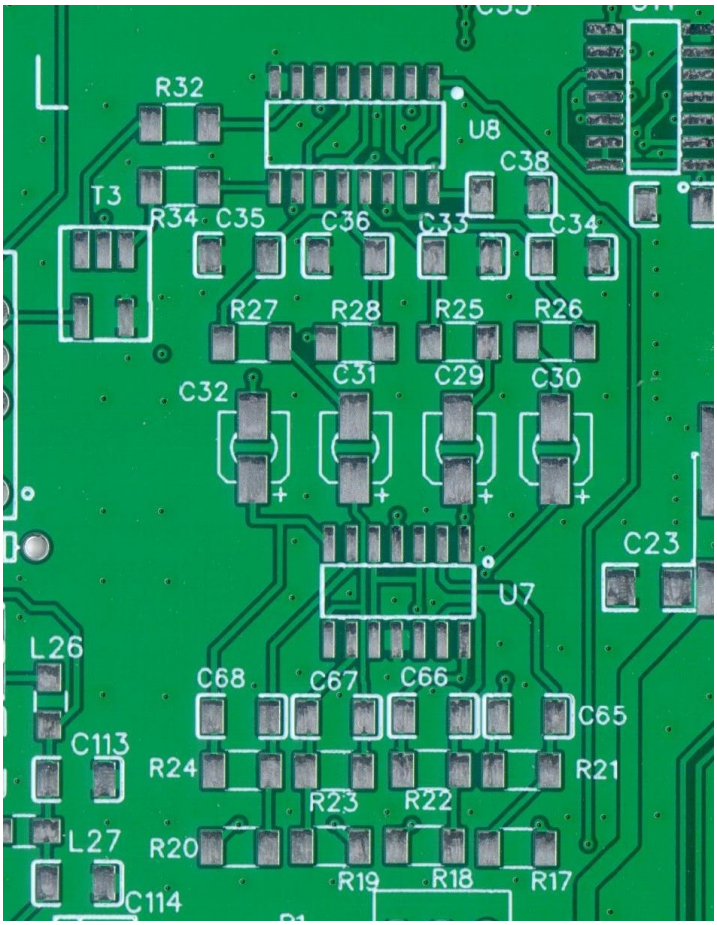
☐ 21. TX Circuit and Mixer

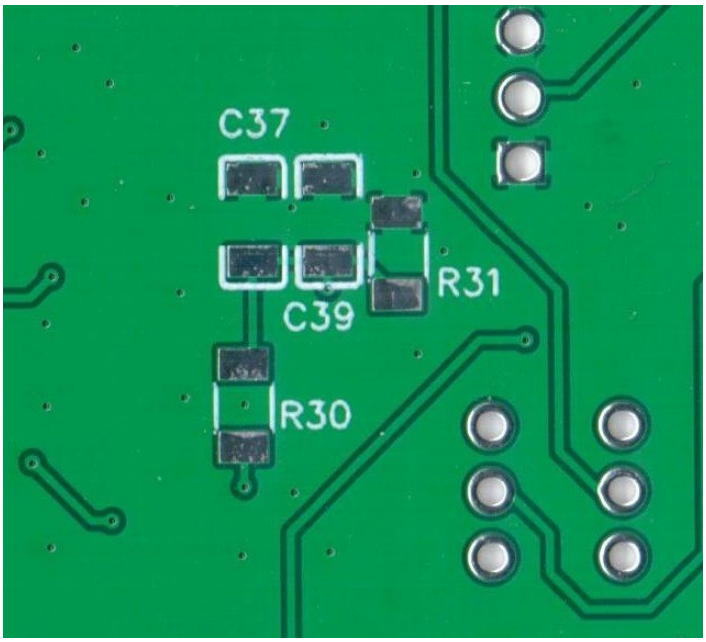
☐C65-C68 – 100pF
☐U7 – TLV2464C
☐C22,C24,C38 – 0.1uF
☐C29-C32 – 10µF
☐C33-C36 – 0.022µF
☐C37 – 0.01µF
☐C39 – 4.7µF
☐R32, R33 – 49R9
☐R30,R31 – 2.21kΩ
☐R25-R28 – 49.9Ω
☐R17-R24 – 10kΩ
☐T3 – 1:1 Transformer

Testing
Launch HDSDR and set it to FM mode. Tune to a frequency on a band of the build. Activate the transmitter so there is a FM carrier. Set the output power slider to MAXIMUM and turn on mute.

R17-R20 – FM carrier at │Tune – LO│ frequency
C29-C32 – FM carrier at │Tune – LO│ frequency

Power Jack J7 – 290mA Idle

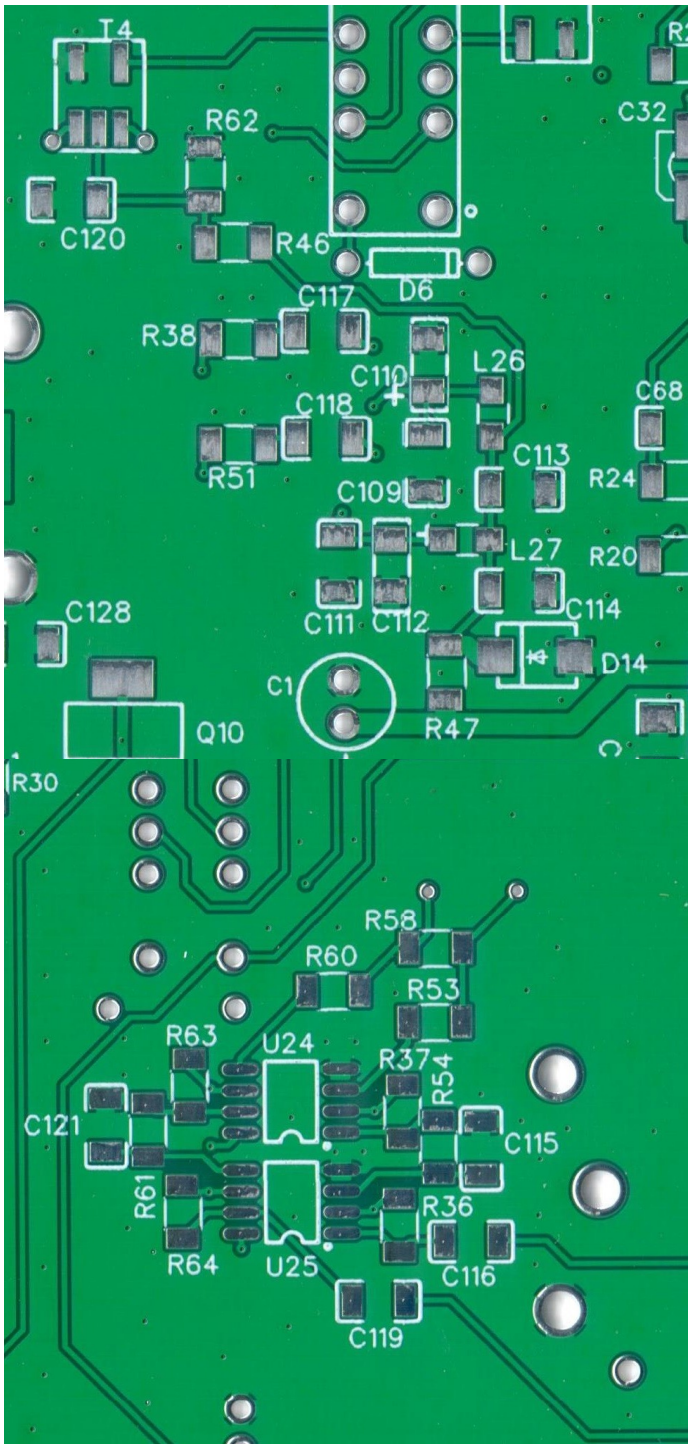




☐ 22. TX Pre-Amp

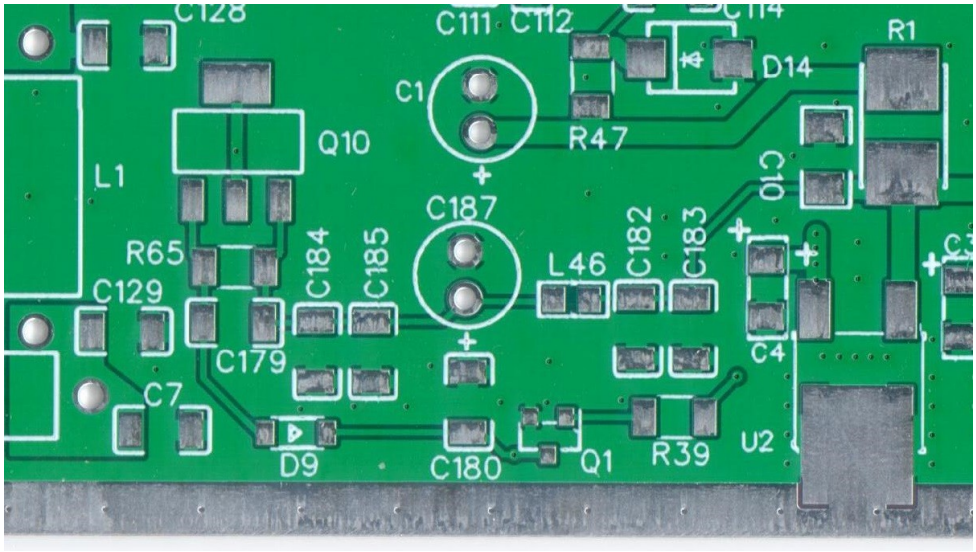
☐T4 – 4:1
☐C109,C111,C113,C114,C117,C118,C120 – 0.1uF
☐C110,C112 – 10uF
☐R46,R62 – 1K
☐R38 – 220Ω
☐R51 – 470Ω
☐L26,L27 – Ferrite Bead
☐D14 – 12V Zener
☐R46 – 56.2Ω
☐R47 – see band chart
☐C46 – see band chart
☐U24,U25 – OPA2467
☐C116,C199 – 0.1uF
☐C115,C121 – 33pF
☐R58 – 200R
☐R53,R54,R60,R61 – 22R
☐R37,R63 – 330R
☐R36,R64 – 470Ω

Testing
Power Jack J2 – 325mA



☐ 23. TX Bias Circuit

☐Q10 – ZVP2106GCT
☐Q1 – 2N7002
☐C179,C180,C182,C184 – 0.1uF
☐C182,C185 – 0.01uF
☐C187 - 100uF
☐R39 – 1K
☐R65 – 4K7
☐D9 – 1N4148W

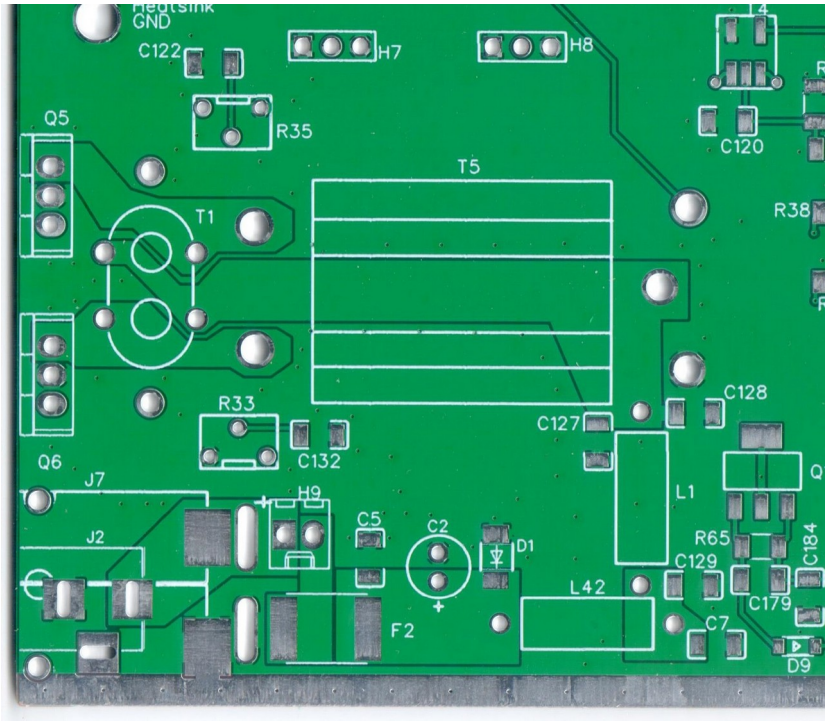


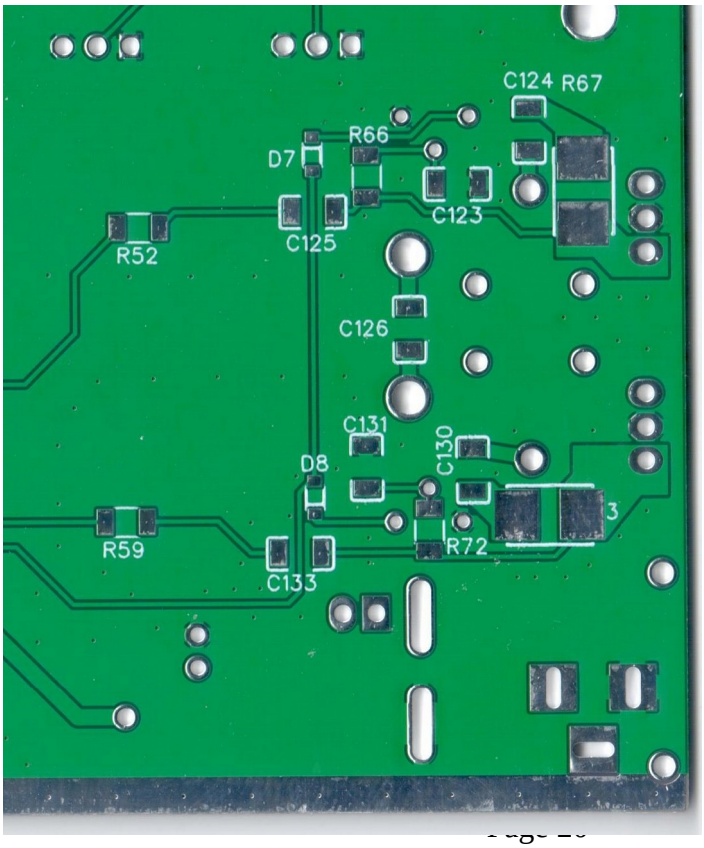
Testing
Using CFGSR on test tab press PTT test for BIAS voltage of ~10 on large tap or center pin.

Power Jack J2 – 325mA

☐ 24. TX Finals

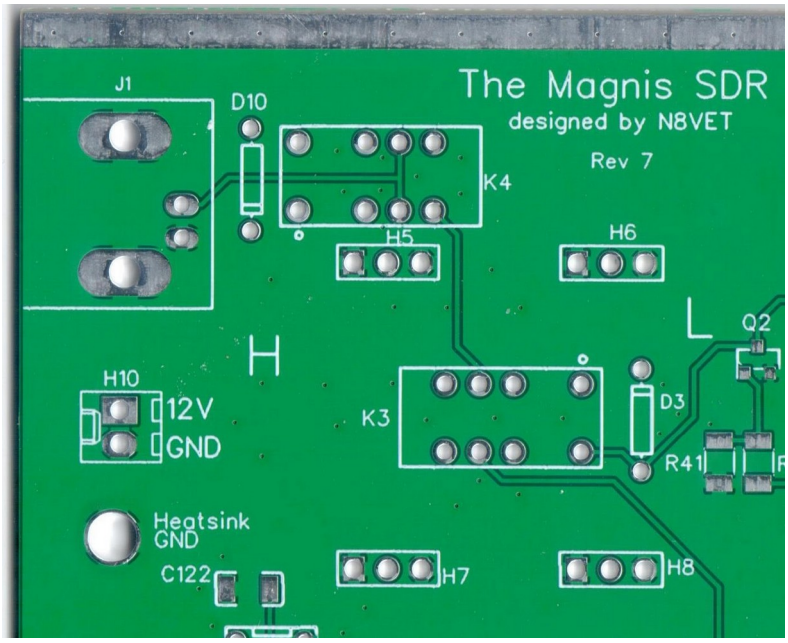
☐C5,C123,C125,C127,C132,C133 – 0.1uF
☐C7,C122,C128,C131 – 0.01uF
☐C124,C130 – 0.1uF 100V
☐C126 – 270pF
☐D7,D8 – BAS16J
☐L1,L42 – Inductors
☐R33,R35 – 5K Trimmers
☐R52,R59 – 4R7
☐R66,R72 – 24R9
☐R73,R73 – 220R
☐Q5,Q6 – MOSFET of choice
☐T1 – Balancing Transformer
☐T5 – Output Transformer





☐ 25. LPF and T/R Relay

☐K3,K4 – Relays
☐H5-H8 – Standoff Headers
☐H10 – Molex Jack
☐RD3,D10 – 1N4148



Testing
First we need to see the BIAS Current. Install some filter modules into the appropriate standoff headers. Then connect a dummy load.

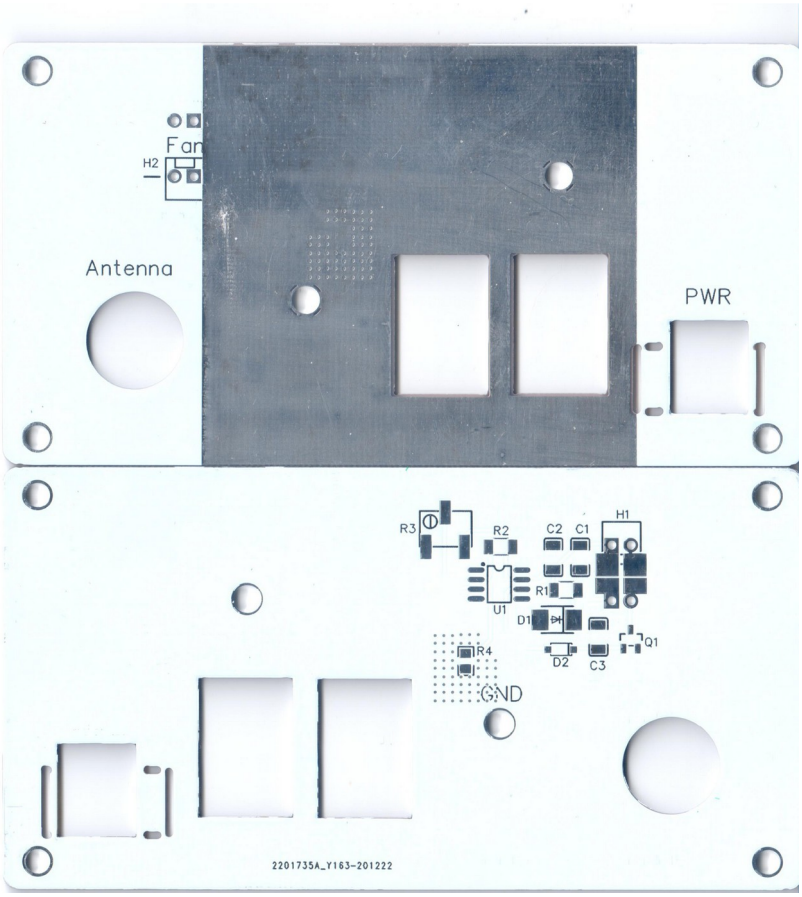
Turn trimmers fully counter clockwise. Using CFGSR test tab press PTT and note current reading then adjust each trimmer for 500mA for each MOSFET.

Power Jack J2 – under 1.5A.

Once this is set use your SDR programs for a TX test into a dummy load. You should be able to get well over 10W on each band. Adjust for 10W max output.
J1 – 0.5-2.0W

☐ 26. PA Cooling circuit on back panel

☐U1 – MC33171DT
☐Q1 – BSS138-7-F
☐C1 – 0.01uF
☐C2 – 0.1uF
☐C3 – 0.22uF
☐D1 – 1SMB5920BT3G
☐D2 – 1n4148W-TP
☐R1 – 150Ω
☐R2 – 4K7Ω
☐R3 – 10K Trimmer
☐R4 – 10KΩ
☐H1,H2 – 2 Pin Molex



Back panel assembly has several options. The continuous run option only requires installing the 2 Molex connectors and jumping the 2 pads under H1 on the inside. The pads are close enough to jumper with solder blobs. I normally jump pins 2 and use a resistor to jump pin 1 in the 100 -200R range depending on fan used and how fast you want the fan to run.

The second option is using the temperature controlled fan on/off circuit. Again there are options depending on the fan your using.
C3 is an off delay capacitor. 0.22uF gives about 1 minute delay with 0.1uF about half that. The Off delay is meant to prevent fan cycling on and off when it it close to the threshold temperature.

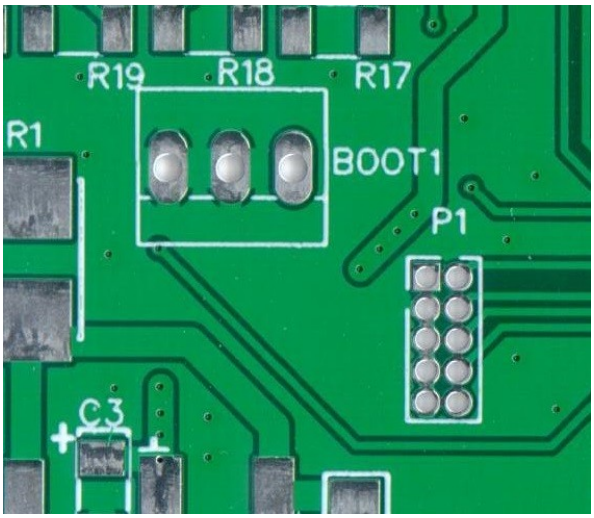
D1 is a Zener Diode to drop the voltage and run the fan at a slower speed to reduce noise. It is also used to prevent the fan speed from varying when supply voltage changes during RX and TX cycles. The part number in the BOM is a 6.3V Zener and if your using the recommended heat sink/fan the fan runs very quiet and provides plenty of cooling for continuous key down.

R1 is the dropping resistor. If you run fan slow enough you really don't need D1 with the proper selection of R1 depending on the fan size and current draw.

Testing
Adjust R3 trimmer for desired fan on temperature.

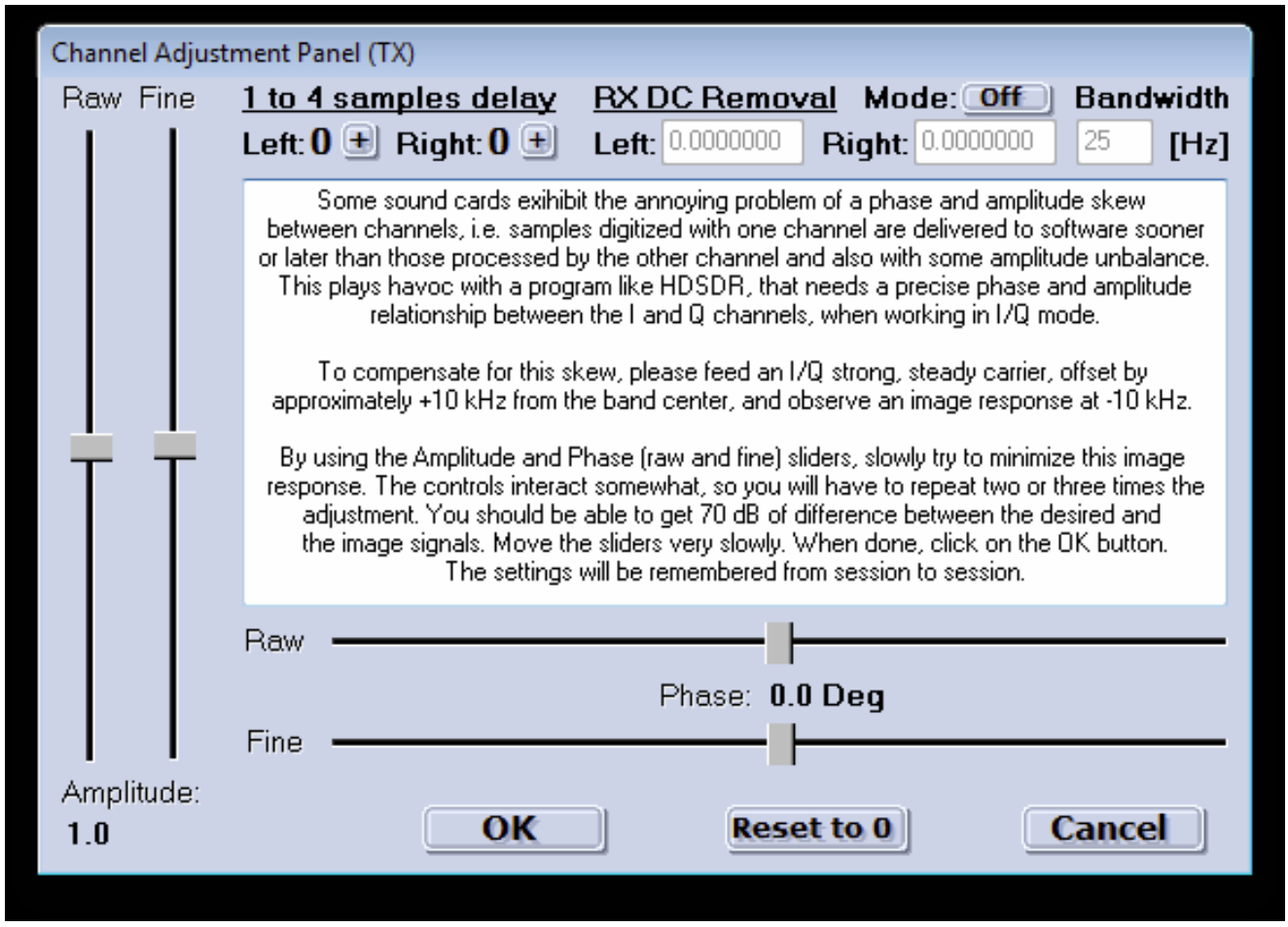
☐ 27. BOOT and DEBUG

Install the three pin jumper block as BOOT and the ten pin connector as DEBUG. The shorter side of both parts goes through the PCB. For normal operation, the BOOT jumper is on the side furthest from BOOT1. The 10 pin connector is installed with the key notch opposite PSoC.
The appendix has information about using these to upgrade the firmware.



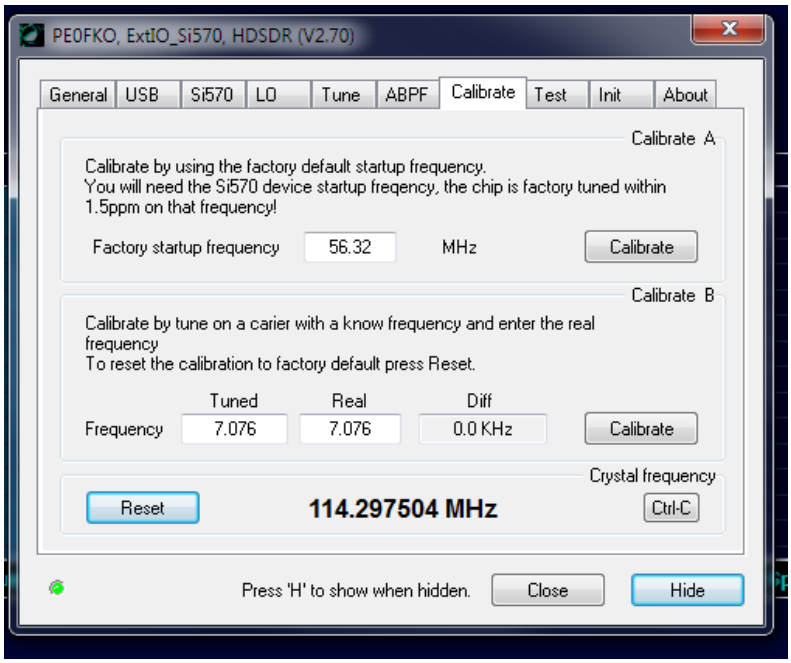
☐ 28. TX Adjustment

The transmitter must have the I/Q data adjusted just like the receiver. If you fail to do so then your image will not be suppressed enough. In HDSDR, while transmitting, click “Options [F7]” then select “Output Channel Calibration for TX”. A dialog with sliders and some help text will appear. Ignore the settings about sample delays and DC removal. The help text here is for the receiver and not very helpful. For example on 10m: Set mode to AM, LO to 28.400, tune to 28.380, and begin transmitting into a 50Ω dummy load. Use another SSB or CW receiver to monitor the AM carrier on 28.420. Adjust the sliders to minimize the strength of the received signal.



☐ 29. Si570 Calibration

A manual calibration may improve frequency accuracy of the Si570. Use the “Calibrate” tab in the ExtIO utility. “Calibrate B” is used to make a manual adjustment. “Calibrate A” will restore the factory calibration.



☐ 30. Get on the air!

Your Magnis SDR is complete. Get on the air and enjoy it. HDSDR is only one of many applications that can be used. You may prefer a different one. Digital modes are typically accommodated with “virtual” audio cables connecting a SSB application like HDSDR with a digital mode application like fldigi. Digital mode configurations are beyond the scope of this documentation

Appendix A: LED Status

A power-on self-test function is included in the Magnis SDR. The status LED sends error messages in Morse code at 5 WPM.

STATUS	INFORMATION
OFF	PSoC NOT INITIALIZED (OR LED FAILURE)
STEADY ON	NORMAL OPERATION
RAPID BLINKING	TRANSMIT MODE (TRANSMITTER ACTIVE)
LOAD (or BOOT) (depending on firmware version)	READY TO RECEIVE FIRMWARE
I2C	NO COMMUNICATIONS WITH PSOC OR PCM3060
SI570	SI570 U9 NOT RESPONDING
PCM3060	PCM3060 U10 NOT RESPONDING

By default, the included LED D4 is driven at 5mA with current limiting by R2. You may prefer to install the LED on your enclosure and increase the power. Pretty much any LED can be used so long as you don’t exceed 16mA. Be careful if you select a complete assembly as some will include a resistor which you do not need.

Appendix B: Channel Reversal and CW Functions

The Magnis SDR will appear as a sound card that shows up the host computer. It carries the I/Q radio signal. (NOTE: With the current firmware revision, the sound device will have the name “Multus SDR”). This will appear as regular stereo device with, for example, the left channel containing the I data and the right channel containing the Q data. There is no standard for which channel carries which data. HDSDR allows for I/Q reversal. However other applications do not.

Tune the LO to one of these magic frequencies and the channel reversal will immediately take effect and be saved to EEPROM. The frequencies of 33.444447 up to and including 34.99999 are reserved for CW management functions. See CW Operations for further information.

LO FREQUENCY	EFFECT
33.333333	NORMAL. THE HDSDR CONFIGURATION IN THIS ASSEMBLY MANUAL ASSUMES THIS SETTING
33.444444	RECEIVE IS REVERSED
33.555555	TRANSMIT IS REVERSED
33.666666	BOTH ARE REVERSED
33.444447-34.999999	CW CONTROL FUNCTIONS
33.888888	CW MODE OFF

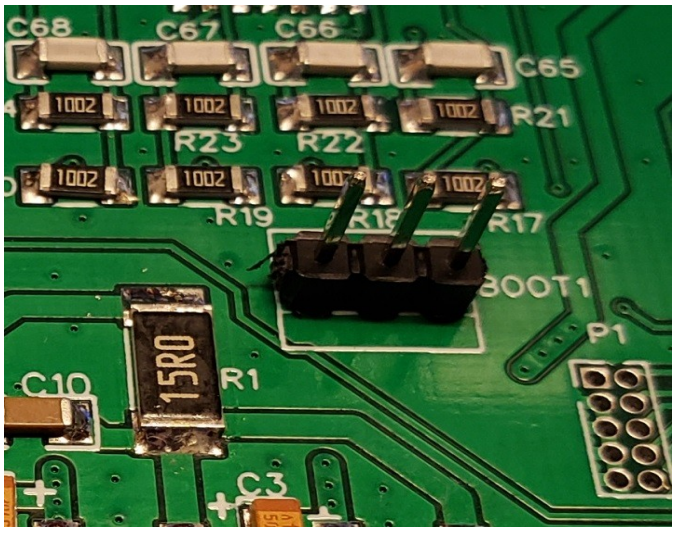
Appendix C: Firmware Updates

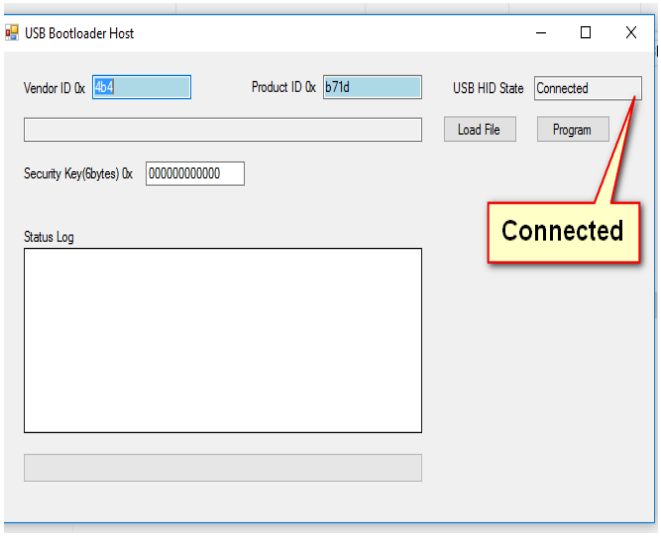
NOTE: If the current firmware version is prior to 117.111 consult Appendix D before proceeding with this section.

There are two methods available for updating the firmware, USB Bootloader and using a miniProg3 programmer.

USB Bootloader
When the BOOT jumper is in the BOOT position (jumper across pins 1 and 2) the LED will blink BOOT in Morse code.
NOTE: Newer versions of the firmware will blink "LOADER".
In this mode the radio is ready to accept firmware.
Note: The most current version of the firmware will be in the firmware directory previously installed.

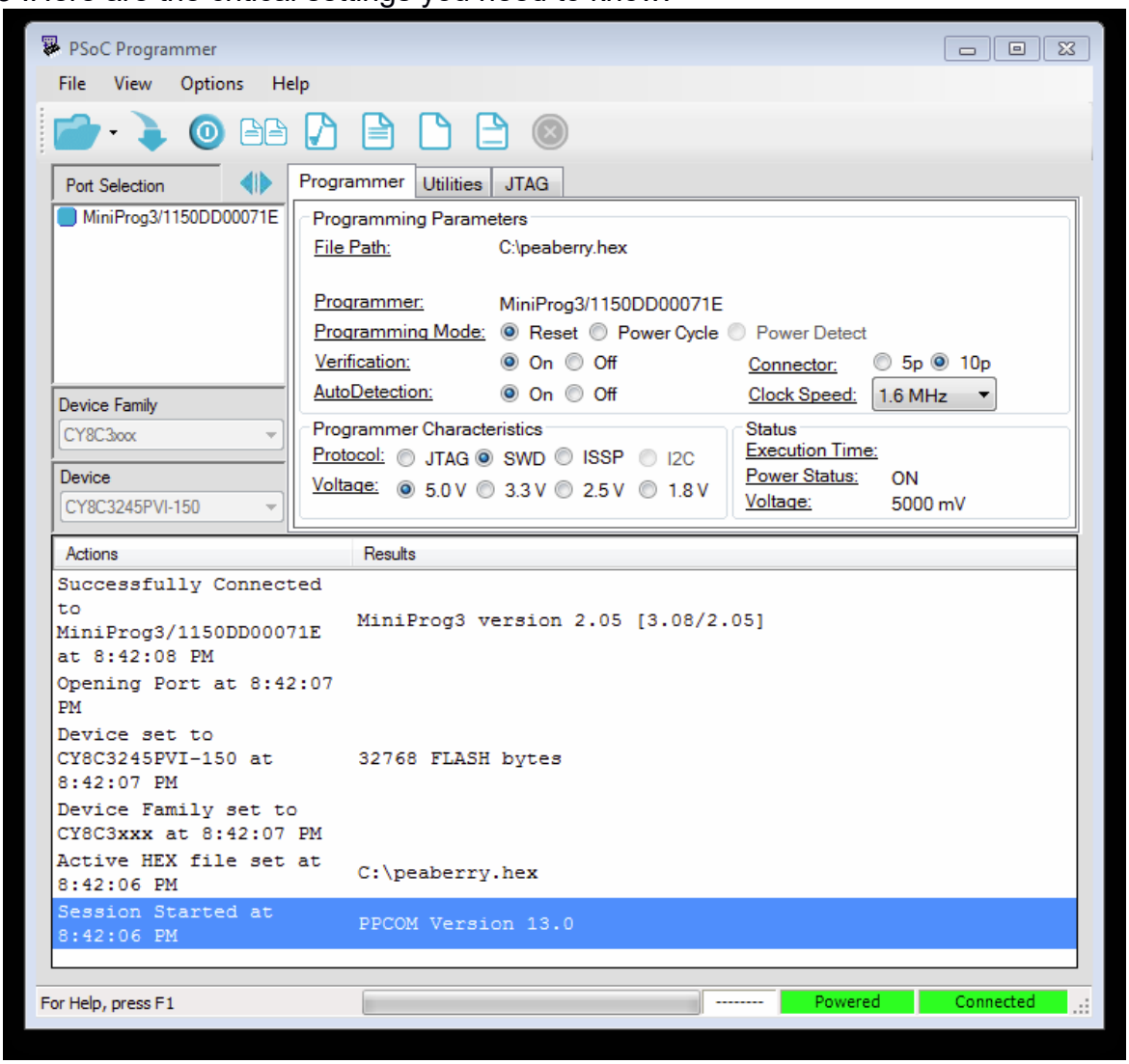
Make sure the BOOT jumper is on the header (2 pins closest to boot1 silkscreen) and the radio is powered and connected. The LED will blink “BOOT” or “LOADER”. Now start the bootloader host application by clicking on the USBBootloaderHost icon on the desktop. The bootloader host application will indicate it is connected to the transceiver.





SWD Programming

A 10-pin SWD connector is included with every radio for connecting a Cypress MiniProg3 or other programmer. This method is for advanced users who should be familiar with the process. The Cypress PSoC Programmer application must be used when using the MiniProg3 .Here are the critical settings you need to know:



File Path: Choose the .HEX file
Programming Mode: Reset
Connector: 10p
Protocol: SWD
Voltage: 5.0V

NOTES

1) The firmware is located at: https://groups.io/g/TheVeteranSDR/files/Magnis/Firmware . Click on the downloads tab and then click on the proper file for the type up firmware update to be performed (bootloader host or SWD).