RF-Seismograph on Pi

RF-Seismograph
running on Raspberry
Pi and Touch Screen

by
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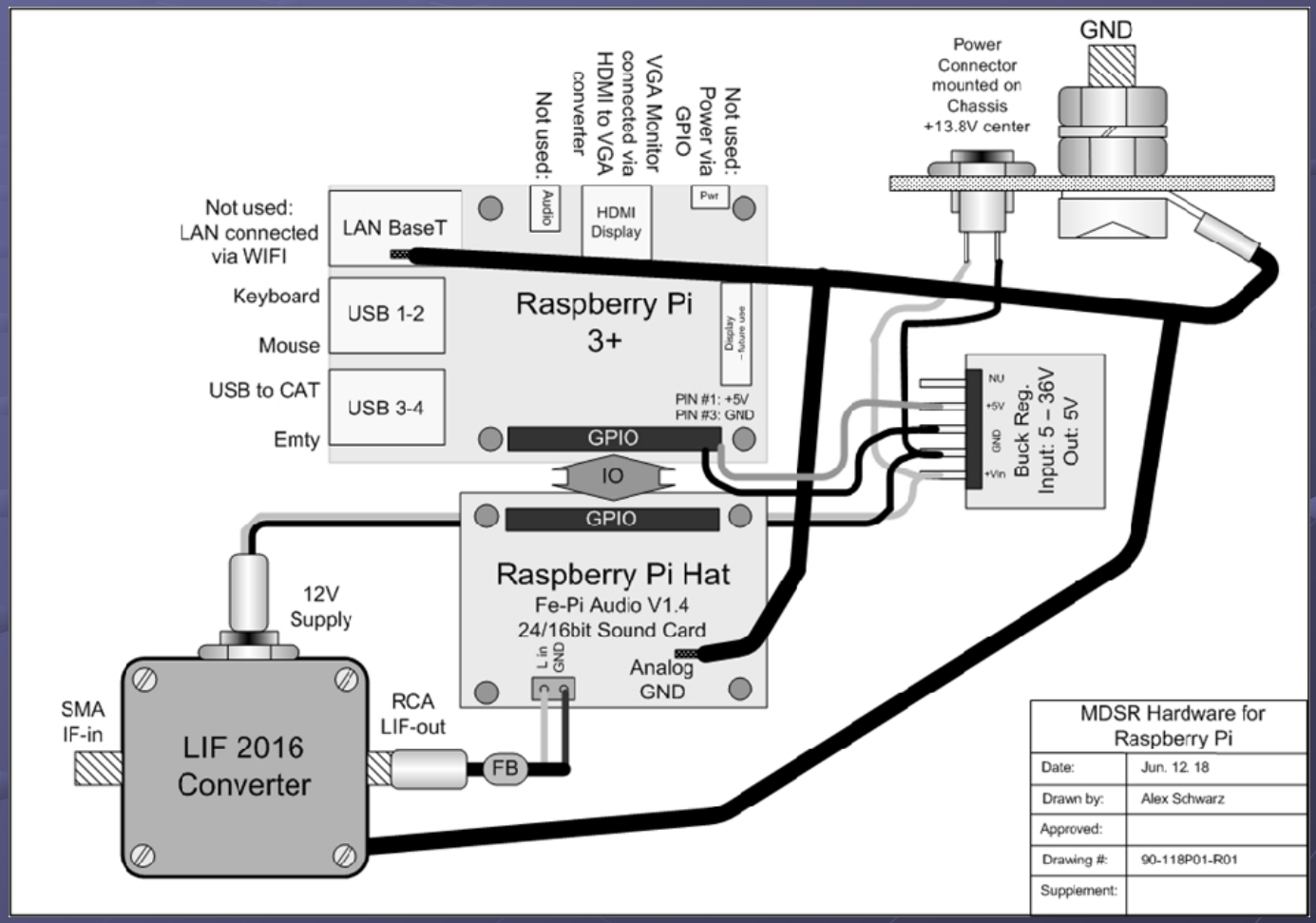
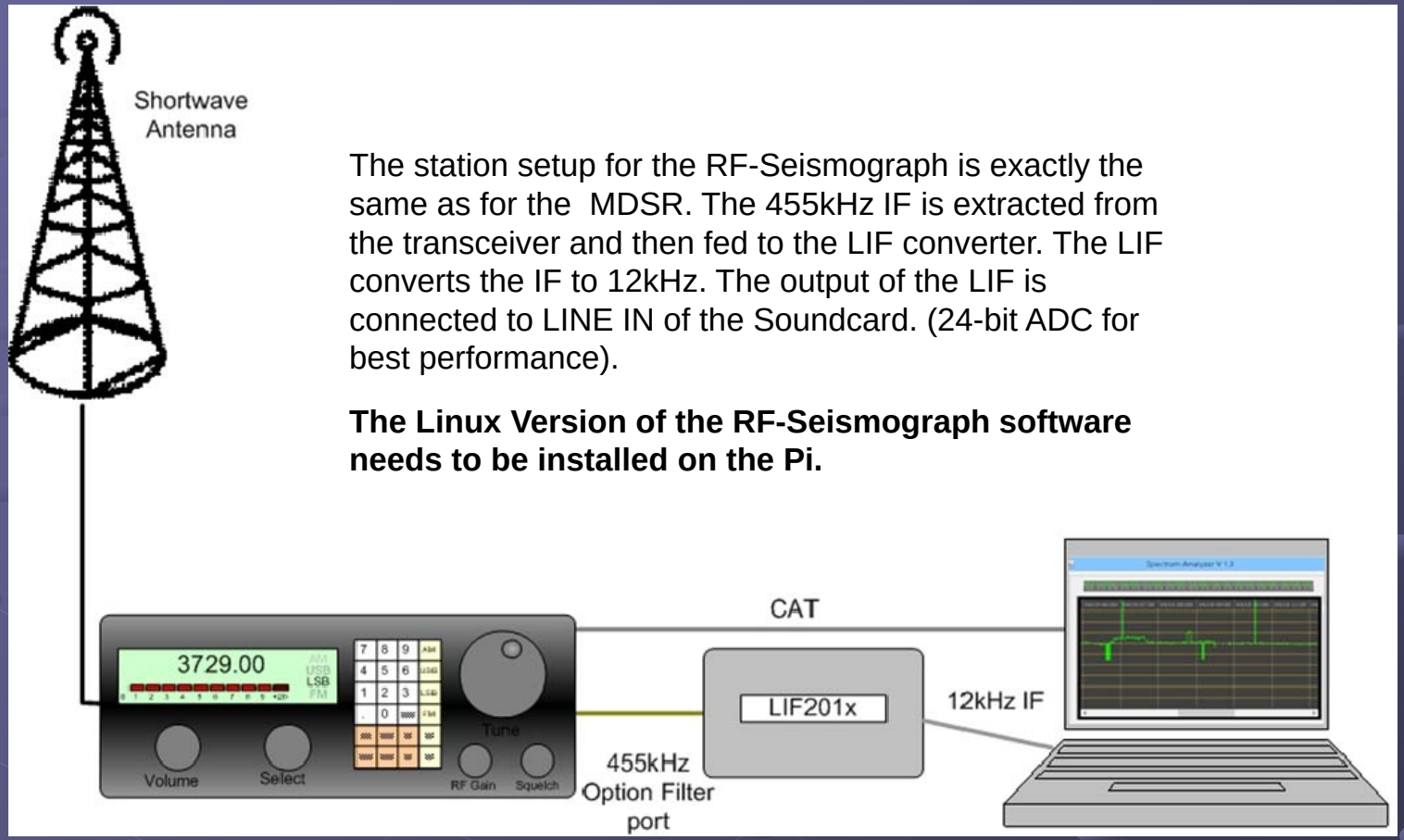
Desktop Version

- Hardware fits into a Hammond 1598B enclosure (Dim: 5.25 x 5.25 x 2”) and weighs about 2lb.
- Besides the Pi 3+, there are a Fe-Pi Audio card (16-bit ADC), the Puck Regulator (to make everything work with 12V) and a LIF-2016.
- CAT control USB cable which is “Plug and Play”
- USB mouse, keyboard and HDMI monitor is needed for setup but can be removed once the unit is set-up and running.
- The LIF plugs into the option filter port of the transceiver.

Build the Desktop Version



How does the RF-Seismograph connect to the radio



The station setup for the RF-Seismograph is exactly the same as for the MDSR. The 455kHz IF is extracted from the transceiver and then fed to the LIF converter. The LIF converts the IF to 12kHz. The output of the LIF is connected to LINE IN of the Soundcard. (24-bit ADC for best performance).

The Linux Version of the RF-Seismograph software needs to be installed on the Pi.

How to Set-up and Configure the Pi

- **Note:** Before attempting this, the sound-card has to be configured and working. Depending on what sound hat is used, these instructions vary. Please follow the manufacturer's instructions for the driver installation and confirm that it is working properly before continuing. Any sound-card will work that has a line level input. A good sound-card can make all the difference. The minimum ADC bit count is 16 running at a data rate of 48kHz.
- The sound-card used for the prototype is the **Fe-Pi Audio V 1.4**. It is a very versatile sound-card which has a lot of options such as a 2W PA for the MDSR audio output, headset with mic input plug. For easier installation, the RCA connectors were removed. The 0.1" strip connector was soldered instead, and it provides the input for the LINE IN signal.

Find instructions on the Fe-Pi website:
https://fe-pi.com/p/support-and-setup

Setting up the Audio Volume Controls on Pi

After the audio card has been installed the volume controls have to be enabled manually.
In Raspbian click on the Raspberry Icon at the top left, select Preferences and then Audio Device Settings. Set the Fe-Pi Device that is listed besides the bcm2835 ALSA as the default device. To gain access the volume controls press the "Select Controls" button and then select the controls as shown in the picture left. Set all the "Capture" devices to max for the RF-Seismograph setup.
This only has to be done once, and for the next time it will remember the settings and the selected controls will be visible.
Note: The RF-Seismograph will always use the default audio device.

How to Set-up and Configure the Pi

- ***Set up Raspberry Pi so that it will run Java jar files (Loading RTE)***
  - ***Use a minimum SD size of 8GB without IDE***
    - (if there is not enough space consider deleting some of the bundled software on Raspberian, such as Wolfram, Office and Google Chrome. Check the web on how this is done using the command line interface.)

- **NOTE:** the **sudo** command invokes the super user privileges and is required for most commands.

  - **Install Java RTE the fast way:**
    - **$sudo apt-get install openjdk-8-jre**
    - **$sudo apt-get install openjdk-8-jdk**
    - **$sudo apt-get update**
  - **Verify with the commands with -version option.**
    - $ **java -version**
      $ **javac –version**

  - **If this did not work:**
    - Visit **http://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html**, click the download button of Java Platform (JDK) 8. Click to Accept License Agreement, download **jdk-8-linux-arm32-vfp-hflt.tar.gz** for Linux ARM v6/v7 Hard Float ABI 32bit OS.

      Open command line, enter the command to extract jdk-8-linux-arm-vfp-hflt.tar.gz to /opt directory.
      $ **sudo tar zxvf jdk-8-linux-arm32-vfp-hflt.tar.gz -C /opt**

      Set default java and javac to the new installed jdk8.
      $ **sudo update-alternatives --install /usr/bin/javac javac /opt/jdk1.8.0/bin/javac 1**
      $ **sudo update-alternatives --install /usr/bin/java java /opt/jdk1.8.0/bin/java 1**

      $ **sudo update-alternatives --config javac**
      $ **sudo update-alternatives --config java**

      After all, verify with the commands with -version option.
      $ **java -version**
      $ **javac –version**

How to Set-up and Configure the Pi

- **The next step is only required it you want to edit the Java NetBeans Software. If you want to run the IDE a 16GB SD is needed.**
  - Download Netbeans IDE for Raspberry PI (any OS)
  - Unzip downloaded file; unzip filename.zip
  - Change directory to ~/Downloads/netbeans/bin
  - Run IDE installation for Platform-Independent Package
  - **To run the installation:**
    - After the download of the platform-independent ZIP file completes, extract it to any folder on your system.
    - Run the executable file located in the netbeans/bin directory.
    - **$chmod +x netbeans** //make file executable in directory type: "**./netbeans**" //installer will launch
    - Accept the License Agreement.
    - Click Next. The NetBeans IDE installation starts.
  - **Note**: If a compatible JDK installation cannot be found, you might need to manually add a path to the JDK installation directory by doing the following: (it did not require this step for me)
    - Open the netbeans.conf file located in the netbeans/etc directory in a text editor.
    - Enter the location of a compatible JDK installation for the netbeans_jdkhome option. The default location in Windows is C:\Program Files\Java\jdk1.8.0 or similar.
    - Save the netbeans.conf file and run the executable file in the netbeans/bin directory.
    - Once it has been installed launch the IDE with:
  - in directory type: "**./netbeans**" //application will launch

- ***Download MDSR_SA software from MDSR ftp server***
  - Open a command line, go to the Pi directory
    - //to download the MDSR_SA archive
    - **$ wget http://www3.telus.net/public/bc237/MDSR/MDSR_SA_Archive.tar**
    - **$tar -xvf MDSR_SA_Archive.tar** //to create and extract the files into MDSR_SA
    - To change directory type **cd /MDSR_SA.**
    - **$sudo chmod +x SpectrumAnalyzer.jar** //make file executable
    - To run the SpectrumAnalyzer.jar in the directory it's in**: /home/pi/MDSR_SA/.**
    - Type **"$java –jar SpectrumAnalyzer.jar"**
  - ***Desktop Shortcut to start the RF-Seismograph from the desktop***
    - In the MDSR_SA folder there is a shortcut file called MDSR_SA which has an oscilloscope icon. This file can be copied and placed on the desktop to easily start the RF-Seismograph by double-clicking it.

How to Set-up and Configure the Pi

- ***Installation Instructions for flrig on Raspberry Pi***
  - Before installing flrig the FLTK and X11 Libraries have to be installed.
    - **$sudo apt-get install libx11-dev** //install X11 libraries
  - Download the FLTK tar from: http://www.fltk.org
  - ***fltk-1.3.4-2-source.tar.gz***
    - *place in the Pi directory*
  - *$**tar -xvf fltk-1.3.4-2-source.tar.gz** //unzip*
  - Install FLTK by running the following commands:
    - **$ sed -i -e '/cat./d' documentation/Makefile &&**
    - **> ./configure --prefix=/usr **
    - **> --enable-shared &&**
    - **> sudo make** **//**will take about 20 min
    - **$ sudo make docdir=/usr/share/doc/fltk-1.3.4 install** **//**will take about 5 min
  - ***Installing fl rig***
    - http://www.w1hkj.com/ download FL Rig 1.3.39.tar.gz.(or newer). After download the file will be in the “Download” directory. To unzip, double click the file in the file editor. As destination give the Pi directory.
    - Open a command line:
    - `cd' to the directory containing the package's source (fe: /Pi/ FL Rig 1.3.39/)
    - **$sudo ./configure**
      Might take a while, while running, it prints some messages telling which features it is checking for.
    - Compile the package.
    - **$sudo make** **//**this will take about 30 min
    - Type to install the programs and any data files and documentation.
    - **$ sudo make install** **//**this will take about 2 min

The executable is in the “data” directory and called Flrig. If you are using the file browser double clicking will launch the program. By copying and pasting this file to the desktop you can launch the program by double clicking on the desktop.

Note: All the modified radios on our website have using the OmniRig for doing the CAT setup. FL-rig the new software will work with the same CAT control settings as OmniRig. The only difference is that in Linux there are no COM ports. They are called TTY ports.

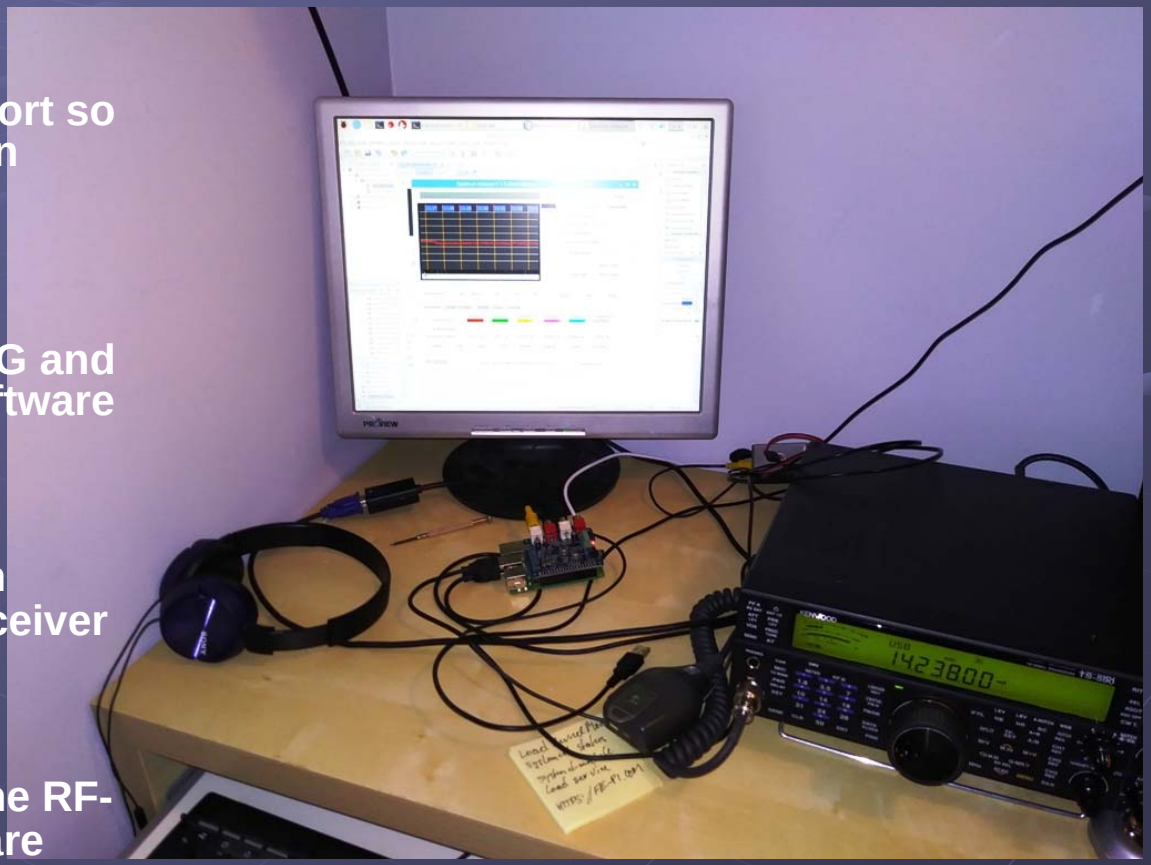
How to Set-up and Configure CAT Control

- ***How to set up the Serial device for the CAT Control interface:***
  - Connect USB to serial converter,
  - Open command line editor and type
    - **$Dmesg | grep tty**
  - Return should state that the ttyUSBx is now attached to the RPB Pi.

Note: Many of the USB to serial and USB to CAT interfaces will work besides Windows also on Linux. The above test is designed to help with discovering which devices are not capable to run on the Pi. Personally, I have tested the USB-RTS-01 and the USB-RS232 Converter (Model SP-880). Both work like a charm. There are a lot of other converters that can work with Linux. When more users use the Pi and Linux, radio manufacturers will be required to provide drivers for their units.

Running the TS-590

- LIF Modification:
  No extension filter port so the LIF taken from an internal test point
- Radio:
  CAT control for fl-RIG and RF-Seismograph software
- LIF-2016 unit
  as interface between computer and transceiver
- Raspberry Pi
  running fl-Rig and the RF-Seismograph software

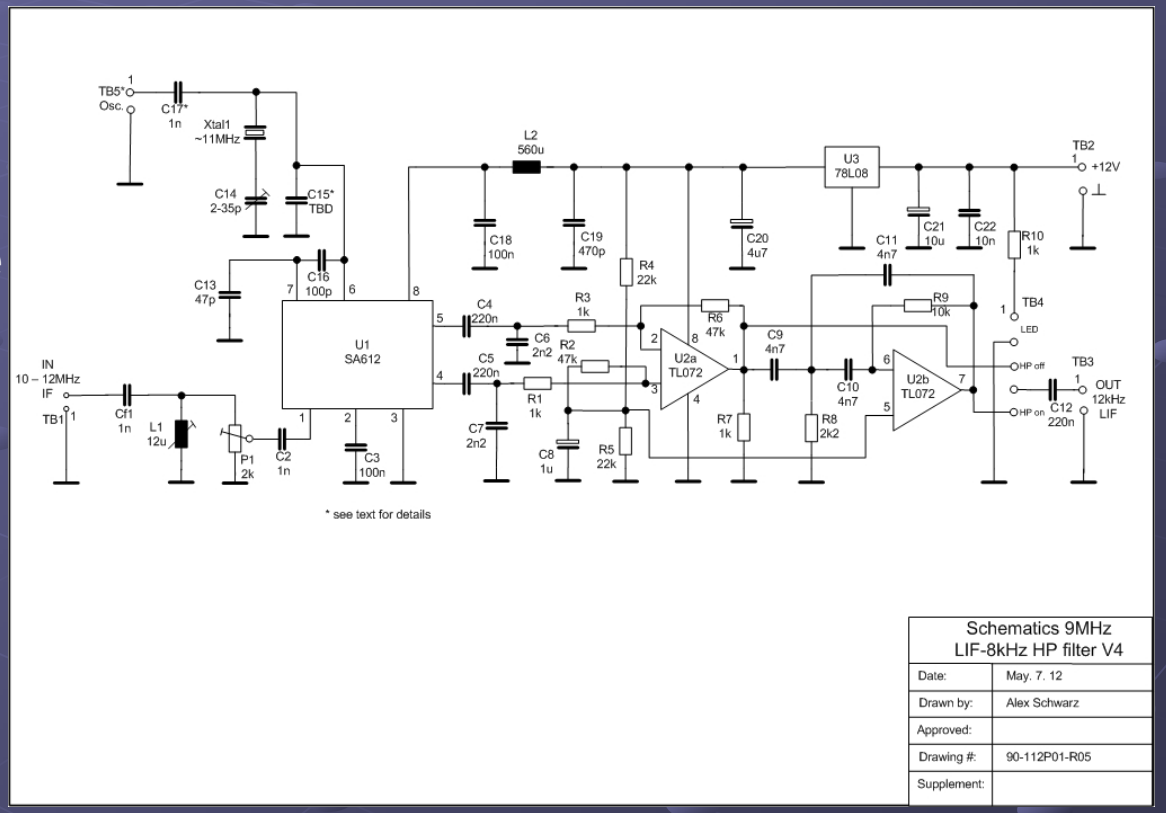


LIF Mod for TS-590

The 10.695MHz LIF port connects to the output of the 2nd Mixer and is routed to the back panel and terminated with an SMA connector. Ground is provided by the screw just above the cable.

LIF Mod – 10.695MHz IF

- The schematics for the LIF-2016 for 10,695MHz is mostly the same as for all different IF inputs. The only part that changes is the value of the input filters and the parts involved with the Oscillator circuit.
- The Crystal is in series resonant configuration and tuning the C14 will move the LO frequency about +/- 500Hz.



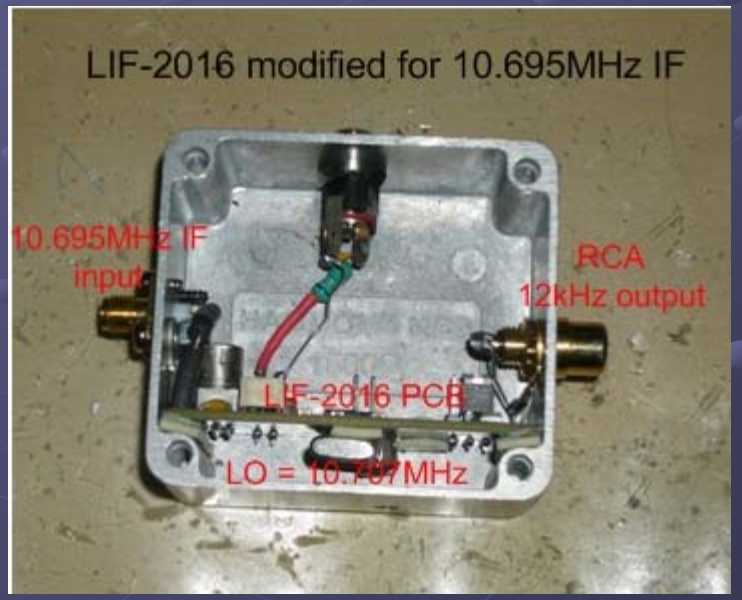
LIF Mod – 10.695MHz IF

- This is the shielded box containing the modified LIF-2016 converter. It transforms and amplifies the incoming IF to Line Level and a frequency of 12kHz.

  •A tuning hole allows for calibration of the LO frequency

  •The power plug has an additional choke and cap to keep the LO inside and line noise outside.

  • To prevent RF to enter through the SMA connector 4 ferrite beads block the passage of unwanted signals.



Why use a simple crystal-controlled Down-converter?

The frequency stability and the phase noise of a crystal cannot be duplicated without some major expenses in DDS and time base circuitry. A lot of the cost-effective and commercially available oscillators have severe phase noise and stability issues. Crystal oscillators allow us to keep the budget low and the quality of the LIF high. The flexibility of the variable IF that DDS allows for, has now been programmed into the software running on the Pi.

- The measurement to the top shows the 10.707MHz crystal LO of the SA-612 mixer. With a span of 2MHz, the very flat noise floor is down by -68dB. The peak of the carrier is very steep and at the -68dB mark it is only 20Hz wide! Custom crystals can still be made by www.quartslab.com in England.

The main Station for monitoring

- Antenna: Hy-Gain HT18jr
  mounted on the roof of 3287 Mountain Hwy
- Radio: FT-950 CAT control for MDSR and RF-Seismograph software
- BiLIF unit as interface between computer and transceiver
- ASUS Win8.1, i5 Proc.

  running the MDSR and the RF-Seismograph software during the eclipse and automatic upload of the latest image of the graph

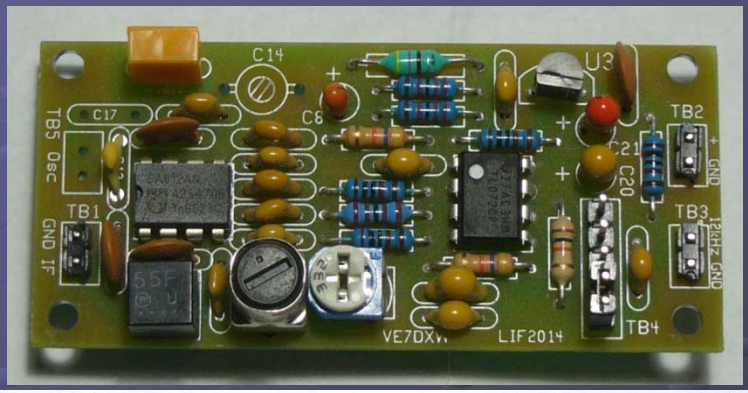
LIF and BiLIF Hardware

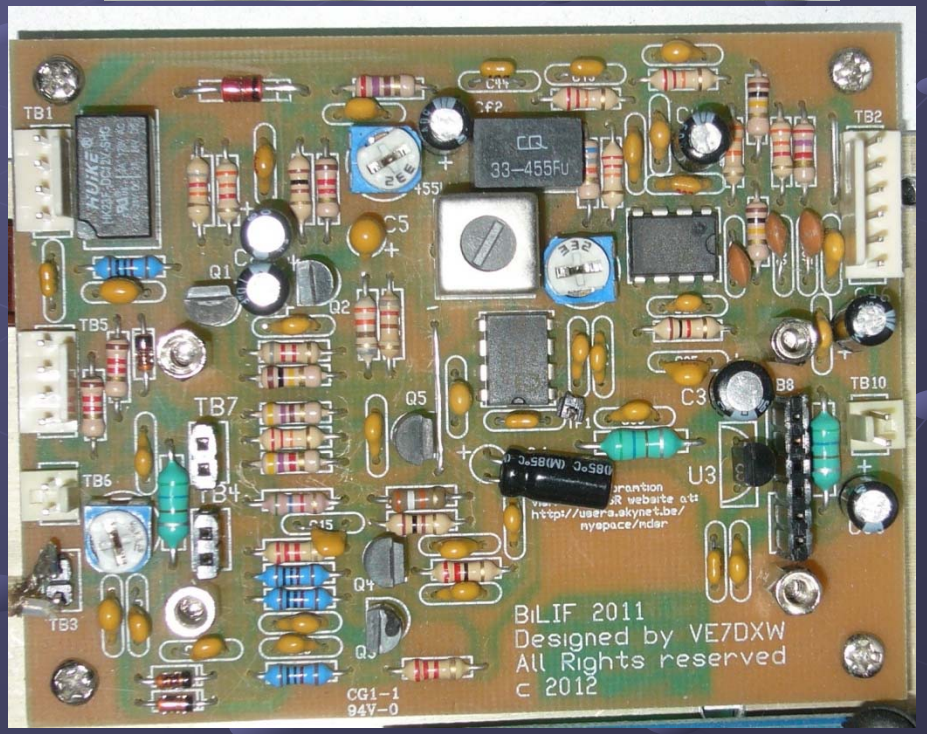
- LIF2014 PCB
  Down-converter for 450/455kHz & 9MHz to 12kHz LIF

  available as kit
- Up-converter LIF2011
  Up-converter, both kits make up the BiLIF unit for full RX/TX MDSR operation

  available as partial kit

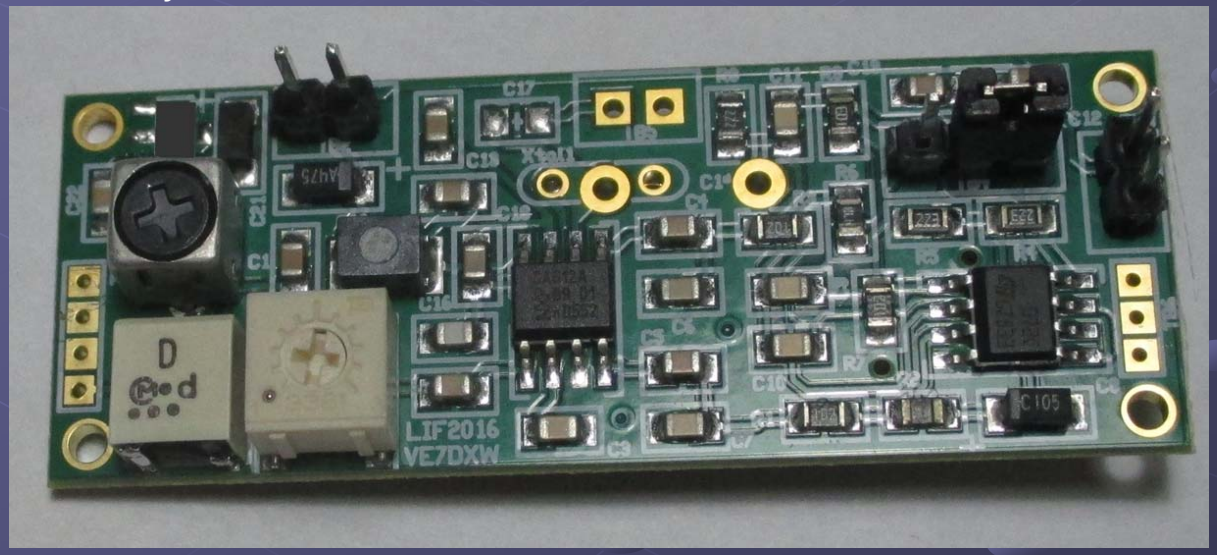
- easy to build
- easy to follow manuals
- no fancy tools are required
- only for 450 or 455 kHz IF
- online tech support





LIF 2016

- Fits into the option filter slot of many Yaesu and other radios
  - PCB size: 56 x 22mm (2.2 x 0.850”) same pin-out as option filter
- Only requires +12V to be wired from inside the radio
- 12kHz output ready for the Sound Card on TB3
  - RX only



References

Eleven Years of Sporadic E (must read!)
http://www.qsl.net/w/wa5iyx/Mar1992QST.htm

NASA Solar Eclipse Experiment 1999
http://science.nasa.gov/science-news/science-at-nasa/1999/ast04aug99_1/

Guy Roels (ON6MU) Experiment together with ON5OO Software (1999)
http://users.belgacom.net/hamradio/experiment.htm

National Research Council Canada (DRAO)
http://www.nrc-cnrc.gc.ca/eng/

NOAA Radio Communication Dashboard
http://www.swpc.noaa.gov/communities/radio-communications

Spaceweather.com
http://www.spaceweather.com/

Download MDSR software from:
http://users.skynet.be/myspace/mdsr/

Questions?

Contact information:

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Yahoo user group:
http://groups.yahoo.com/group/mdsradio/

Thank you for your interest and participation in this presentation.
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