

Modulation – Demodulation Software Radio

12kHz BiLIF Converter V3.0

Please Note: This document supersedes all previously released BiLIF documents and drawings. This is the latest and most up-to-date document at this time. While all previous documents can be used as reference, to obtain the most current technical information please refer to this document only. Dec.12, 2015.

Introduction

The BiLIF2012 is the continuation of the LIF2012 development, which is now also available as a partial kit. It extends the functionality of the RX-only LIF2012 to TX as well. The partial kit contains all the hard-to-find components, such as crystal filters, IF transformers, relays, regulators and ICs. Capacitors and resistors are not supplied but can easily be obtained from the local electronic store. All components are through-hole and the kit is easily assembled.

The BiLIF is the up- and down-converter hardware that works in conjunction with the MDSR software and turn any symmetrical 455 or 450kHz 3rd IF transceiver into an IF SDR. The MDSR has been developed as a stand-alone application and a spectrum analyzer has been added that works in conjunction with the MDSR engine. The transceiver interface software OmniRig has been implemented to control 48 different makes and models of radios. To extend the capability into digital modes, fldigi and Dream for DRM demodulation are included in the download. The MDSR was also tested with WSPR and JT-65-HF with excellent results.

The MDSR software package is available from our [Yahoo user group](#) or from our website (<http://users.skynet.be/myspace/mdsr>) and is free for non-profit amateur radio purposes. This provides a complete transceiver application package for PC desktop computers.

The BiLIF TX functionality has been tested on:

FT-817, FT-857, FT-897, FT-950, IC-7000, IC-756, IC-7200, TS-850.

What is new for BiLIF V3.0

- Updated component value C45 from 100p to 1nF.
 - The BiLIF2012 converter extends the capabilities of the LIF2012 from RX to RX and TX.
 - All measuring equipment needed, except for a wattmeter, is part of the MDSR software.
 - An overdrive monitor prevents DAC overdrive to eliminate close-in band splatter.
 - The BiLIF hardware allows for a wider range of LO frequencies: 450 and 455kHz.
 - Soundcards that have been tested for FCC compliance are M Audio 2496 and Delta 44.
- Note:** other soundcards might work but have not been confirmed, All soundcards work for RX.

1. Technical Specifications

BiLIF Hardware:

Local Oscillator Frequency: 462 – 474kHz
IF Frequency: 455kHz or 450kHz (+/- 10kHz)
IF Input Level: (max) 1mV – 20mVpp
IF Output Level: 20mVpp to 400mVpp
RX Conversion Gain (max): 55dB
TX Conversion Gain (max): -3dB
Output Level for S-9: 0.2Vpp
LIF Bandwidth: +/- 10kHz
LIF Center Frequency: 9 – 18kHz
Supply Voltage Range: 9 – 15V

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2. Creation of 12kHz LIF (Low Intermediate Frequency)

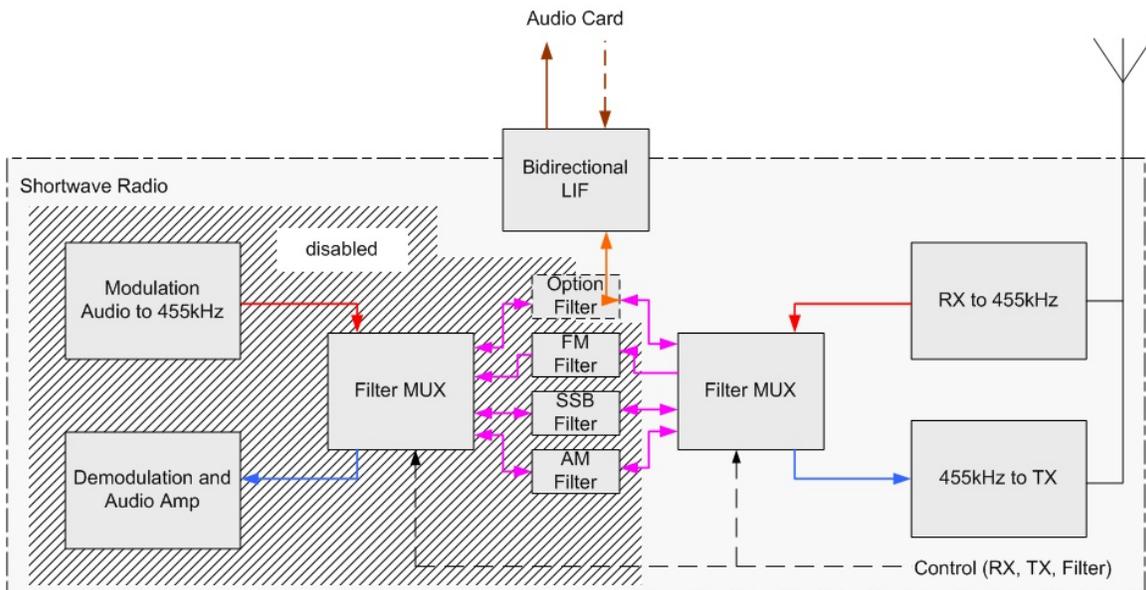
How to extract and inset the 455kHz IF from/to a transceiver

During RX the BiLIF2012 hardware takes the 455kHz IF, which is generated inside the radio before the signal is filtered and demodulated, and converts it down to a 12kHz LIF (Low Intermediate Frequency). During TX the 12kHz IF is up-converted and then injected via the LIF port. The transceiver further converts and amplifies the computer generated IF and transmits it on the set TX frequency. All HF transceivers use one ceramic filter to separate the USB spectrum from LSB spectrum and use the same filter for RX as well as TX. This creates one point in the transceiver where a 455kHz unidirectional IF is present. How this IF is routed depends on the state of the transceiver.

Each transceiver is different but all transceiver use same principle for filtering SSB. The models that have already been tested are posted on the website <http://users.skynet.be/myspace/mdsr/>. There is also a lot of information in the files and photo section on the [MDSRadio](#) Yahoo user group.

The LIF port modification does not alter the stand-alone capabilities of the transceiver, but when it is connected to the computer, it creates a powerful IF-SDR transceiver.

The signal flow below shows how the BiLIF is connected and replaces the internal modulation and demodulation hardware.



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Assembling and Testing the BiLIF PCB

The assembly of the BiLIF unit requires the LIF2012 RX-kit and the BiLIF2012 TX-kit. The LIF 2012 comes with all parts needed to built the kit. The BiLIF2012 kit only contains the hard to-get parts. The rest can either be ordered on-line or obtained from your local electronics store. The parts with the orange background are included in the BiLIF kit.

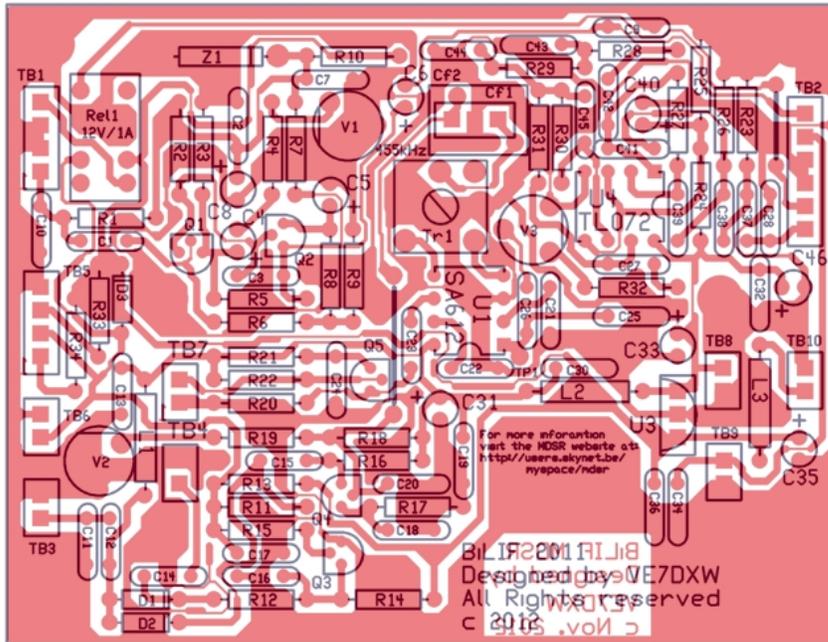
Part List BiLIF2012			
Part Value	Info	Amount	Location
470p	monolithic	7	C9 C11 C20 C25 C28 C30 C34
1n	monolithic	8	C2 C3 C10 C22 C36 C43 C44 C45
2n2	monolithic	1	C41
4n7	monolithic	3	C37 C38 C39
10n	monolithic	2	C23 C32
68n	monolithic	3	C12 C14 C15
100n	monolithic	9	C1 C7 C13 C16 C17 C18 C19 C21 C24
220n	monolithic	3	C26 C27 C42
1uF	25V radial	3	C6 C31* C40
10uF	25V radial	2	C4 C46
22uF	25V radial	1	C5
47uF	25V radial	2	C8 C33*
100uF	25V radial		C35
455kHz	crystal filter	2	Cf1 Cf2 note: only one component
1N914	switching	3	D1 D2 D3
470uH	inductive	3	L1 L2 L3
2N3904	NPN	5	Q1 Q2 Q3 Q4 Q5
22	1/4W	1	R17
100	1/4W	2	R4 R16
270	1/4W	1	R10
330	1/4W	1	R8
470	1/4W	1	R21
820	1/4W	1	R9
1k	1/4W	1	R1
1k2	1/4W	3	R7 R33 R34
1k8	1/4W	1	R32
2k2	1/4W	2	R13 R14
2k7	1/4W	1	R23
3k3	1/4W	2	R3 R26
4k7	1/4W	1	R20
5k6	1/4W	1	R19
8k2	1/4W	1	R5
10k	1/4W	4	R11 R12 R15
22k	1/4W	4	R22 R28 R29 R30
39k	1/4W	1	R18 R27
56k	1/4W	1	R31
82k	1/4W	1	R2
100k	1/4W	3	R6 R24 R25
HK23F	12V/1A	1	Rel1
IF	42IF103	1	Tr1
78L08	8V reg	1	U3
SA612	mixer	1	U1
TL072	dual OPA	1	U2
10k	var	2	V1 V3
5k	var	1	V2
1N4739A	zener 9V1	1	Z1

* radial low profile

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Highlighted orange: included in the partial kit

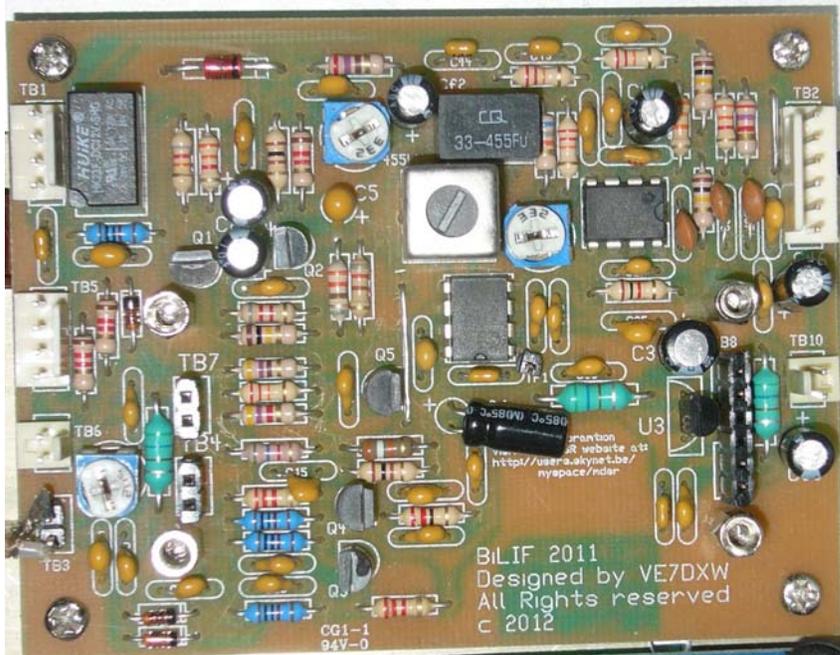
Layout



MDSR_V2.TSS 11/26/12 02:18 pm

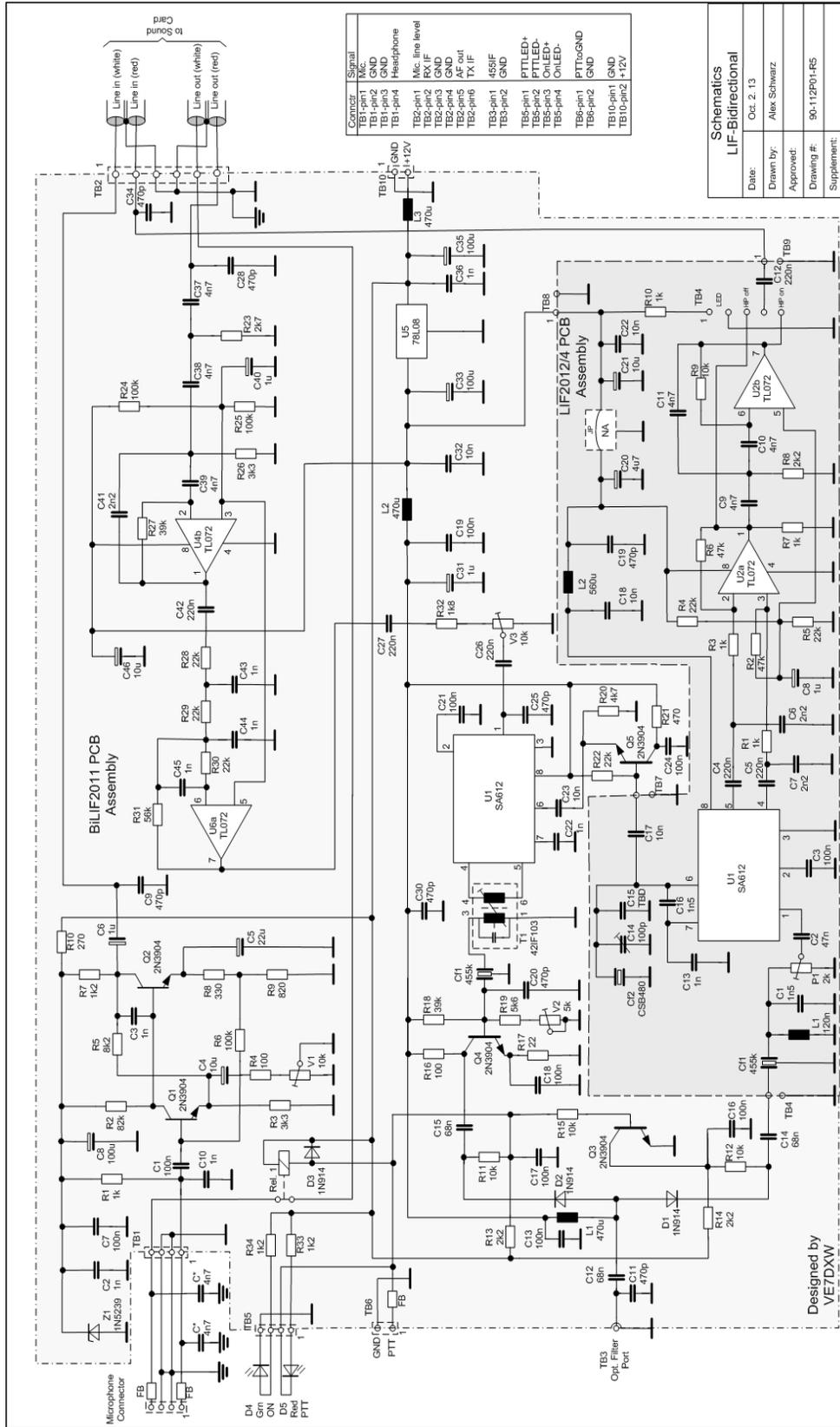
BiLIF PCB

The picture below shows the assembled BiLIF2011 PCB. The black female strip connectors provide the location of the LIF2012 to plug into making the BiLIF2012 assembly.



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Schematic



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Modifying the LIF2012/4 PCB

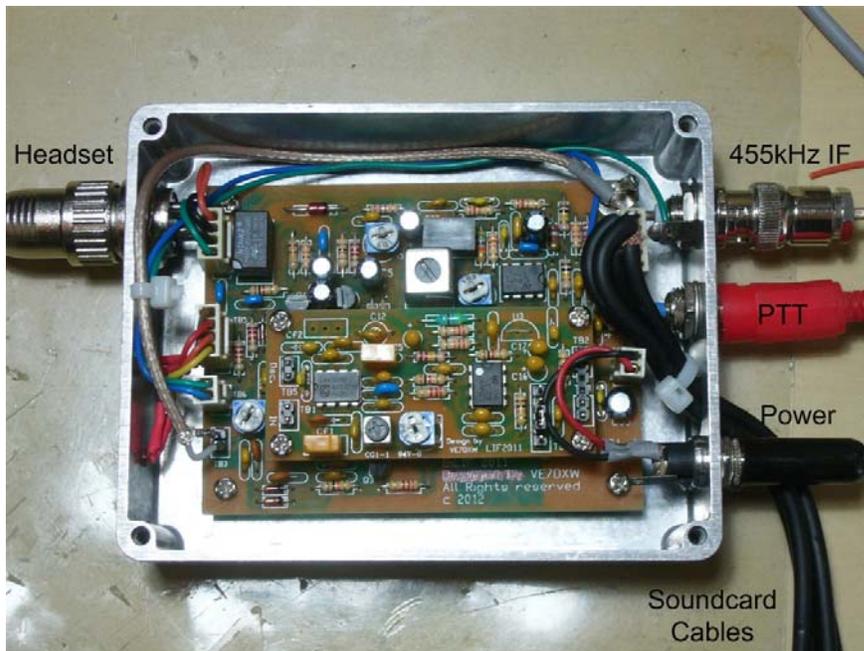
If the LIF2012 was assembled as a stand-alone unit with the connectors facing up, follow this procedure to make it ready for the up-converter PCB.

- Remove the connectors TB1, TB2 and TB3.
- Push the pins all the way to one side. Mount and solder the connectors 180 deg so that the pin sticks out from the solder side of the PCB.
- Remove LM78L08 and bridge pin #1 and #3 with a wire. The 8V supply is on the BiLIF2011 PCB.
- Add a 10nF capacitor C17. This extends the LO signal to the LIF2011 PCB.
- Push the pins all the way to one side. Add the TB5 connector facing down towards the BiLIF2011 PCB.



Assembled in an Enclosure

The BiLIF PCB assembly easily fits into a pre-made shielded aluminum enclosure. This is a quick and easy way to get a professional looking unit with a minimum amount of work. All that is required is drilling the holes. The size of the enclosure is 4.7"(l) x 3.7"(w) x 1.3"(d) (120 x 95 x 35mm³). The up-converter PCB is mounted with 5mm M3 standoffs to the bottom of the enclosure.

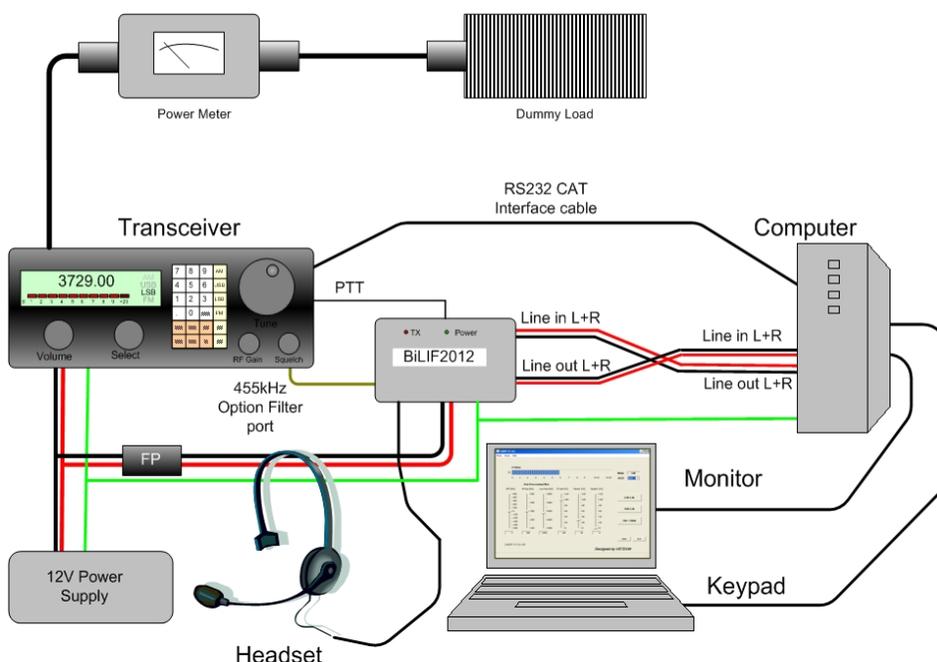


Note: Hidden below the power connector is the grounding pin – a 10-24 screw which connects to station ground. On the side where the headset plug is located there are also the power and the PTT LED located.

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Setting up the BiLiF hardware

Test setup with BiLiF and MDSR



Setting up the maximum power level

Turn the transceiver to 1/5 output power and connect a power meter and dummy load. This will prevent the PA from overheating during setup. This power output setting is now considered “Max power”. The MDSR is running and RX is configured and working properly.

- Open the TX panel window (F3) – select “Voice Parameters”.
- Set V2 (near TB3) to (12 o clock) and the V3 near Tr1 to off (5 o clock), set Tr1 into about center position
- In the “Voice Parameters” turn Compression slider to 100%, the RF Gain to 20%, press the “Save” button
- In the “Mod Source” selection select “Carrier” - a carrier becomes visible near the red center line in the SA (if no carrier is visible press the “RST” button and try again)
- Click on the “TX Setup” tab and adjust the RX - TX Frequency Compensation slider until the carrier is exactly behind the red dotted line – 0 BFO setup
- Press the TX button in the TX parameters window – the rig goes into TX mode.
- Adjust the RF Gain slider upwards until the PO meter reads 70% on the main panel – press the save button.
- Adjust V3 slightly upward until the output power reaches max. power (1/5 of total output).
- Use the offset selector and select -700Hz – now the peak moves into the blue frequency window and a tone will be heard in the speaker.
- Adjust Tr1 to equalize the power output between 0Hz and -700Hz
- Use the offset selector and select +700Hz – now the peak moves +700Hz up from the center line. No tone will be heard.
- Adjust Tr1 to equalize the level power output between 0Hz and +700Hz
- Adjust Tr1 for best power equalization of the 3 settings.

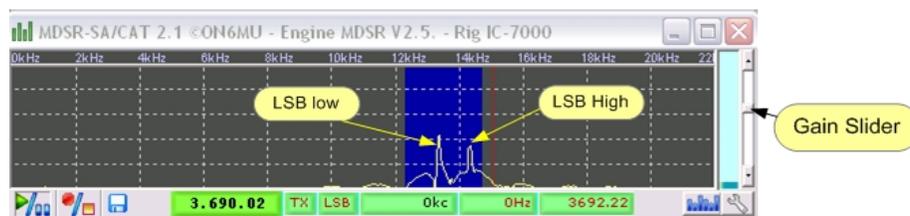
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Setting up the mic audio level V1

- Same hardware setup as above.
- Open the Audio Setup panel by pressing F5.
- Talk into the mic with a normal voice and adjust V1 for -10dB maximum input (left input channel).

Setting up the TX filter pass

- Same hardware setup as above.
- Select LSB mode on main panel.
- Open the “TX Setup” by pressing the tab; select Voice Parameters.
- Set LSB-Gain to 50% and the upper and lower “Filter Form Factors” for LSB to 500.
- Set USB – LSB Gain Balance to 200 and High- and Low Boost slider to 100%, HiPass at 300Hz and LowPass at 2400, set Mic Gain to 20.
- Select TX Setup; in “Mod Source” choose “IMD” - two carriers becomes visible in the filter box of the SA (if no carriers are visible press the “RST” button and try again)
- Now the TX IF level meter is indicating a signal level (bottom left).
- Watch the ALC slider/indicator at the bottom left of the MDSR window. It has to stay at 100%.
- In “TX Setup”; on the bottom of the TX panel adjust the upper and lower filter slope to get both peaks equal in amplitude.
- **Note:** higher values increase the level. (values from 300 to 600 are optimal)
- adjust the LSB-Gain to a TXIF output meter readout of -6dB. Repeat previous step until best results are obtained. (if the filter values are out of range adjust the Gain accordingly)
- Press the “RX” button and then the “Save” button.



- Open the “TX Setup” by pressing the tab; select Voice Parameters.
- Set USB-Gain to 50% and the upper and lower “Filter Form Factors” for USB to 500.
- Set USB – LSB Gain Balance to 200 and High- and Low Boost slider to 100%, HiPass at 300Hz and LowPass at 2400, set Mic Gain to 20.
- Select TX Setup; in “Mod Source” choose “IMD” - two carriers become visible in the filter box of the SA (if no carriers are visible press the “RST” button and try again)
- Now the TX IF level meter is indicating a signal level (bottom left).
- Watch the ALC slider/indicator at the bottom left of the MDSR window. It has to stay at 100%.
- In “TX Setup”; on the bottom of the TX panel adjust the upper and lower filter slope to get both peaks equal in amplitude. **Note:** higher values increase the level. (values from 300 to 600 are optimal)
- adjust the LSB-Gain to a TXIF output meter readout of -6dB. Repeat previous step until best results are obtained. (if the filter values are out of range adjust the Gain accordingly)
- Press the “RX” button and then the “Save” button.
- Turn the Mod Source control back to “mic”.

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IMD Spectrum for USB mode



Setting up the TX for best audio

Every time the TX panel (F3) is opened the MDSR goes into monitor mode and the mic audio is fed back to the headset. This is delayed by about 180mS because an input latency of 100mS created by the ADC and an 80mS delay for the DAC. By Pressing and releasing the RX button this feedback is turned off and the MDSR is in normal mode again. This is indicated by the status field going from “Adj” to “RX”

- Adjust mic gain in TX Panel until “clipping” flashes when talking in a normal voice – back off on the control slightly.
- Set the “Hi Pass” and the “Low Pass” to your preference.
- Set the High Boost control for best voice transparency.
- Set the Low Boost control for best low response.
- Press the PTT in TX panel and talk in a normal voice and look at the output power of the radio.
- When you hum or whistle into the mic. and bring the output power to max. power the clipping indicator will start to light up (clipping indicates the activation of the ALC control)
- If there is not enough level – slightly move the V3 pot up or if it is overdriving the PA bring it down.
- Press “Save” to save the adjustments to the hard drive.
- Switch your transceiver back to full power.

Note: While using digital modes turn both boost control sliders to 100%.

Backup your configuration in the profile manager: Go to SA window, select the “Disk” icon (bottom- left) and open the profile manager. In the text field on top enter the name of your radio and press “Save current configuration”. In case there is an accidental deletion of your profile you can recall the profile and you do not have to go to the setup again.

Setting up TX modulation and PTT for 3rd. party programs

The MDSR setup program comes with fldigi to provide digital modes. For the receive side setup of these programs the MDSR output can be shared. This cannot be done for the TX side. For the TX side a second audio card of lesser quality, like an onboard device, can be used. This requires the setup of the output channel of the third party software to point to this device. A jumper between the audio line output of the second sound device and the MDSR modulation input needs to be set up. The PTT can be simulated by using the VOX control of the MDSR.

Modulation – Demodulation Software Radio

Conclusion

This completes the assembly and the test of the BiLIF V2. We hope this unit will provide a new enjoyable experience while operating your radio through the BiLIF – MDSR computer interface.

It is advisable to build the PCB assembly into an aluminum box as shown in this manual.

This is an “off the shelf” box made by Hammond/Eddystone. It is necessary to isolate the BiLIF circuit from TX radiation created by the transceiver.

Any issues and/or questions should be directed to the [MDSRadio Yahoo group](#).

To obtain the partial up-converter kit please contact: Alex Schwarz (VE7DXW) through his e-mail. alexschwarz@telus.net

Thank you,

The MDSR and BiLIF development team

<http://users.skynet.be/myspace/mdsr>