# Soundcard Interface Circuit KIT For HF & Packet Modes

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NOTICE: THIS KIT REQUIRES UNDERSTANDING OF SIMPLE CIRCUITRY AND BASIC SOLDERING AND CONSTRUCTURE ABILITIES. IT MAY NOT BE APPROPRIATE FOR BEGINNERS WHO DO NOT HAVE ADEQUATE MENTORING. THE INSTRUCTIONS ARE SET AT A LEVEL APPROPRIATE FOR A BUILDER WHO HAS BUILT KITS BEFORE. IF YOU HAVE NEVER BUILT A KIT BEFORE, SEEK A COMPETENT MENTOR BEFORE BEGINNING. PLEASE READ THE ENTIRE INSTRUCTIONS BEFORE BEGINNING. THIS KIT AND THE INSTRUCTIONS AND ANY OTHER COMPONENTS ARE PROVIDED WITHOUT ANY WARRANTEE OR GUARANTEE OF PERFORMANCE AND THE BUILDER AGREES TO HOLD THE DEVELOPER OF THIS KIT HARMLESS FOR ANY AND ALL DAMAGES.

## INTRODUCTION

In order to be able to transmit information digitally using a voice transceivers (whether SSB on HF bands, or FM on VHF/UHF bands) some circuity/software is needed to change alphanumeric characters into tones that will go into a microphone jack, and to key the transmitter. Vice versa, to unscrambled the mishmash of audio signals and turn them into readable data, software/hardware is needed also. Hardware-only solutions (which often included a processor running obligatory software, but hidden inside) have long been sold and named Terminal Node Controller, or PACTOR modem, or similar. Recently, the power of the personal computer and capabilities of modern sound cards have taken on much of this work, so that a much simpler hardware system, allowing for adjustment of signal level, isolation of transceiver from computer, and push-to-talk (PTT) activation can be used along with relevant software. Commercial solutions abound for this, with the Tigertronics Signalink being very popular, along with the Rigblaster, a recent MFJ product, and some older systems that relied on a signal from a 9-pin serial port.

**Representative (AND INCOMPLETE) Collections of Software / Hardware**

| Frequency Bands | Digital Mode / Goal | Software | Hardware |
|---|---|---|---|
| HF | Winlink WINMORE for email | RMS EXPRESS[1] | Soundcard and interface capable of electronic control of PTT |
| HF | PSK31, Olivia, etc. Simple QSO | FLDIGI[2] | Soundcard and interface; PTT can be done manually if electronic control not avail. |
| VHF/UHF | Packet / email or "classic packet" | RMS EXPRESS + soundmodem.exe // easyterm.exe + soundmodem.exe[3] | Soundcard, softare and interface capable of electronic control of PTT |

The cost can be reduced somewhat by building one's own interface, and either using a laptop's built in sound card, or an inexpensive USB-connnected sound dongle. For the Raspberry Pi user (including those building a **`linbpq`**-based node, a "classless" (no driver required) USB audio adapter such as the Adafruit 1475 (typically $5) or equivalent is preferred. The classless adapters will function properly with `alsamixer` to allow easy gain adjustment of the sound card system; generally you want to have fairly high signal levels in and out of the soundcard (but not into distortion!) to reduce the damaging effects of hum pickup etc. Then inside the soundcard adapter, gain adjustments are made with a hardware potentiometer.

Figure 1 (below) shows a schematic of a single transistor-based soundcard interface that provide for gain adjustment in both directions, transformer-based ground isolation, and fast automated PTT control derived from the audio on one channel (VOX-type circuit). The basic idea of this circuit is certainly not original with me; countless previous similar designs have been presented. It simply consists of transformer isolation of signals in both directions between the sound card and the radio transceiver, and a simple audio amplifier driving a diode detector to create a VOX-type signal that is then used to switch a relay, as well as an indicator LED to facilitate initial setup.

1 Download from www.winlink.org
2 Download the version for your operating system from: https://sourceforge.net/projects/fldigi/files/fldigi/
3 Download soundmodemXX.exe and easytermXX.exe from http://uz7.ho.ua/packetradio.htm

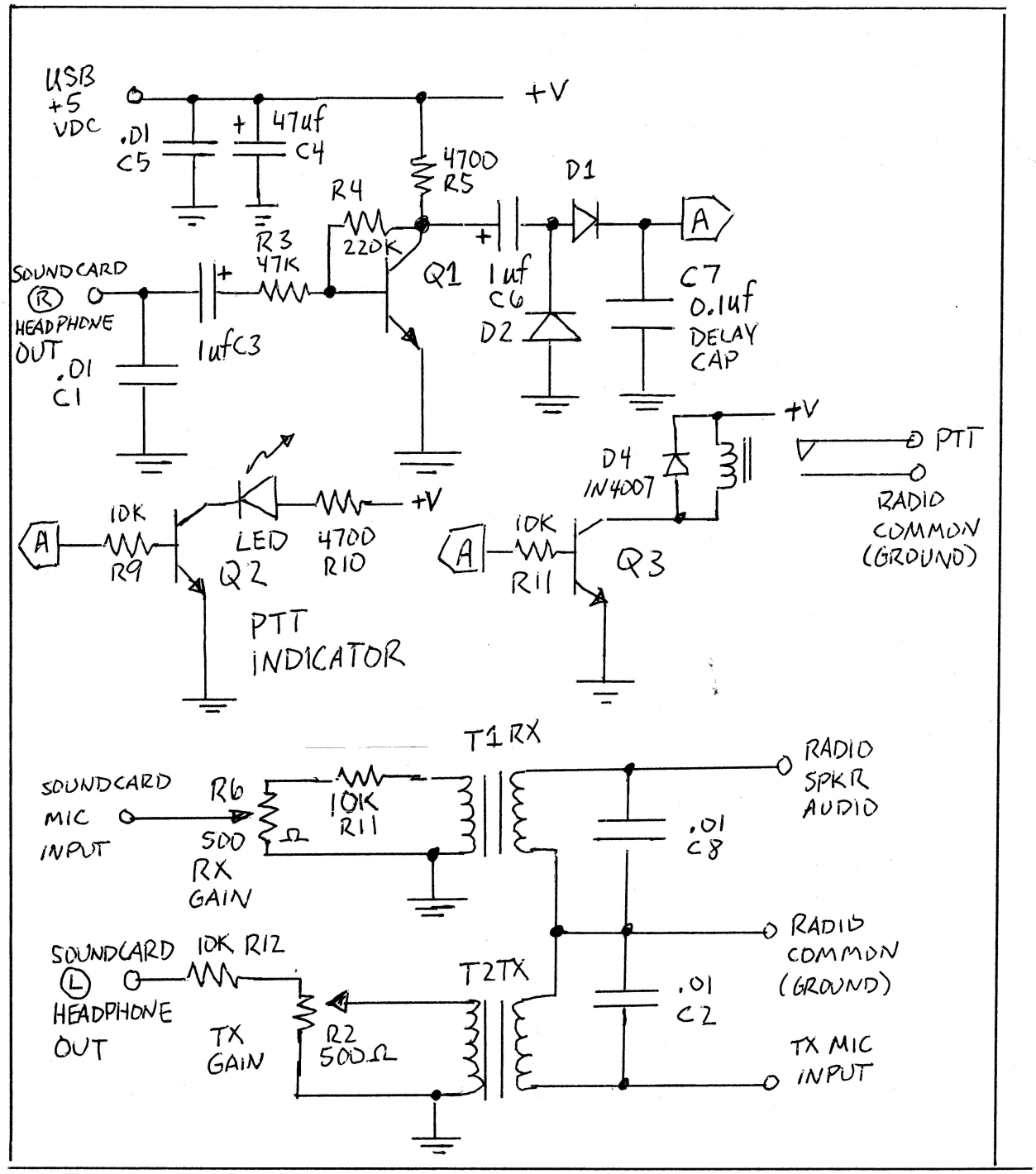


FIGURE 1. *Schematic for sound card interface. The values of R11 and R12 and not crtical but may be changed to better match your radio's signal levels; typical values are either 4700 or 10K. The printed circuit board includes an additional "backward" diode between USB+5 and Ground to protect against accidentally applied reverse power supply voltage.*

The author & many friends have built a dozen or more of this circuit and they are in continuous usage inside several packet node stations, as well as in use for WINLINK client email applications, as well as casual radio QSO's. However, construction on standard perfboard takes an experienced builder roughly 2 hours, and novices may take quite a few hours.

To make construction faster and easier, a printed circuit board design was created which resulted in a 2-layer PCB (3.8” x 2.5” ) with silk screen lettering.

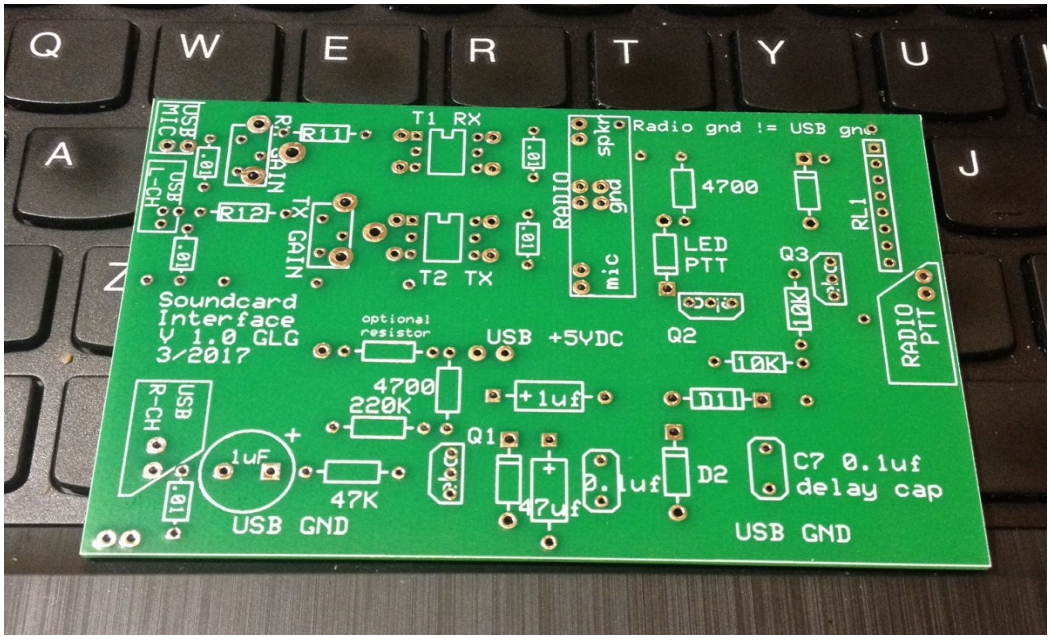


Figure 2. *Bare printed circuit board (prototype board shown) Your board may have slight improvements.*

# CONNECTIONS:

This circuit connects soundcard signals, arranged generally along the left side of the board, to an amateur radio transceivers' mic/speaker/ptt, which are connected generally at the upper middle and right hand side of the board as follows:

**SOUND CARD CONNECTIONS**

| **Connection** | **Location** |
|---|---|
| sound card ground | bottom left corner of board, two larger pads |
| USB +5 volts | Can be connected to either of the two larger pads at center of board labeled “USB +5VDC” or if the optional series 22 ohm resistor (as a current limiter/fuse) is used, can be connected to the single large pad to the left of the 22 ohm resistor (labeled “optional resistor”) |
| Sound card mic | 2 larger pads upper left corner labeled “USB MIC” |
| Left channel headphone output (used to send signal for transmission to the transceiver) | 2 larger pads just below the mic input, labeled “USB L-CH” |
| Right channel headphone output (used to operate the PTT via a “voice-activated VOX” type circuit | 2 larger pads left lower portion of the board, labeled “USB R-CH” |

**RADIO CONNECTIONS**

| **Connection** | **Location** |
|---|---|
| Radio ground (isolated from USB ground) | Center of boxed-in area, center-top of board, labeled “gnd”. Multiple pads provided |
| Radio MIC input | Lower portion of boxed-in radio connection area, labeled “mic”. 2 pads provided |
| Radio SPEAKER OUT | Upper portion of boxed-in radio connection area, labeled “spkr”. 2 pads provided |
| Radio PTT connection (relay output, limit current to 25 mA). During intended transmission, this connect is shorted to Radio ground. | Right hand edge of the board, labeled “RADIO PTT”. 2 pads provided. |

NOTE: if your radio has separate PTT and MIC grounds, this circuit does not provide separated grounds for those purposes, so connect both of them to “Radio Ground.”

Extra pads were provided for connections simply for redundancy.

# COMPONENTS

The components in the table that follows will be required. All resistors can be 1/4 watt. (The board is drilled for 1/4 watt resistors.) All electrolytic capacitors can be 10V or greater. Transistors are specified for 2N3904 but many general purpose small NPN transistors would work. The relay is a somewhat delicate but fast reed relay; most radios have a tiny push-to-talk current, but limit this to 25 mA. The specified relay has 4 pins on 0.2” centers , while the circuit has 6 pads on 0.1” centers. Thus not all the pads will be used! The pads are wired so that the relay may be installed starting either from the bottom pad or the top pad (there will be one left over at the opposite end) and it works either way. This was due to the limited number of standard “components” offered in the design package and my lack of knowledge to create a customized relay pad structure.

Either of two sizes of trimmer potentiometer may be used. The tiniest size requires a thumbnail or small plus head screwdriver; the larger size can be operated with the fingers. Alternatively,, wires can be soldered and go to a panel mounted potentiometer.

The transformers have one coil to the left, and the other to the right. The center pin is not used on each side (not connected). I'm unable to tell primary from secondary on general purpose 600 ohm 1:1 transformers, so mount either way as long as one side is LEFTand the other side if RIGHT, not up and down.

The printed circuit board has positions for optional 0.01 uf capacitors across soundcard mic and left headphone channels. I haven't needed these, but they may benefit some.

u = “micro”

**NOTE:** *Most of these components are literally only PENNIES. The cost of shipping is one of the larger costs, and frequently if you buy 10 of an item you get a price break. As an amateur radio operator going to the trouble to order parts, you might want to buy some “extras” and keep them in your “spare parts” drawer.*

| **Component** | **Qty required** | **Digikey Part No.** |
|---|---|---|
| 0.01 uf ceramic capacitor (used to filter out RF) | 4-6 | 490-11884-ND https://www.digikey.com/product-detail/en/murata-electronics-north-america/RCER71H103K0K1H03B/490-11884-ND/4277785 |

| | | |
|---|---|---|
| 0.1 uf capacitor to act as short delay capacitor | 1 | 445-2637-ND<br>https://www.digikey.com/product-detail/en/tdk-corporation/FK26X7R2E104K/445-2637-ND/970587 |
| 1 uf electrolytic capacitor | 2 | 493-10230-1-ND<br>https://www.digikey.com/product-detail/en/nichicon/UMF1V010MDD1TP/493-10230-1-ND/4312489 |
| 47uf electrolytic capacitor to filter out any hum on +5 line | 1 | P5539-ND<br>https://www.digikey.com/product-detail/en/panasonic-electronic-components/ECA-1EHG470/P5539-ND/245138 |
| 22 ohm 1/4W resistor, optional, used as current limit/fuse in the +5 line | 1 | CF14JT22R0CT-ND<br>https://www.digikey.com/product-detail/en/stackpole-electronics-inc/CF14JT22R0/CF14JT22R0CT-ND/1830311 |
| 47K 1/4W resistor | 1 | CF14JT47K0CT-ND<br>https://www.digikey.com/product-detail/en/stackpole-electronics-inc/CF14JT47K0/CF14JT47K0CT-ND/1830391 |
| 4700 1/4W resistor | 2-4 | CF14JT4K70CT-ND<br>https://www.digikey.com/product-detail/en/stackpole-electronics-inc/CF14JT4K70/CF14JT4K70CT-ND/1830366 |
| 10K 1/4 W resistor | 4 | CF14JT10K0CT-ND<br>https://www.digikey.com/product-detail/en/stackpole-electronics-inc/CF14JT10K0/CF14JT10K0CT-ND/1830374 |
| 220K 1/4W resistor used to bias Q1 into quasi linear range | 1 | CF14JT220KCT-ND<br><br>https://www.digikey.com/product-detail/en/stackpole-electronics-inc/CF14JT220K/CF14JT220KCT-ND/1830407 |
| 2N3904 transistor epoxy package TO-92 case<br><br>**Pay attention to the mfgr. drawing of EBC leads.** | 3 | 2N3904FS-ND<br>https://www.digikey.com/product-detail/en/fairchild-on-semiconductor/2N3904BU/2N3904FS-ND/1413 |
| Diode, 1N4007 or almost any | 4 | 1N4007-TPMSCT-ND<br>https://www.digikey.com/product-detail/en/micro-commercial-co/1N4007-TP/1N4007-TPMSCT-ND/773694 |

| | | |
|---|---|---|
| 500 ohm trimmer | 2 | Choice of miniature or thumb-adjustable size<br>Miniature:<br>3306K-501-ND<br>https://www.digikey.com/product-detail/en/bourns-inc/3306K-1-501/3306K-501-ND/84791<br><br>Thumb adjustable:<br>201XR501B-ND<br>https://www.digikey.com/product-detail/en/cts-electrocomponents/201XR501B/201XR501B-ND/98331 |
| LED | 1 | C503B-RCN-CW0Z0AA1-ND<br>https://www.digikey.com/product-detail/en/cree-inc/C503B-RCN-CW0Z0AA1/C503B-RCN-CW0Z0AA1-ND/1922930 |
| Reed Relay | 1 | 306-1062-ND<br>https://www.digikey.com/product-detail/en/coto-technology/9007-05-00/306-1062-ND/301696 |
| 600 ohm 1:1 audio transformers | 2 | These can be obtained much more inexpensively over ebay. The impedance can be anything near 600 ohms.<br><br>Here is an example of TEN transformers for less than $4, shipped from Europe:<br>http://www.ebay.com/itm/10X-Audio-Transformers-600-600-Ohm-Europe-1-1-EI14-Isolation-Transformer-TSUS/112271494516?_trksid=p2045573.c100506.m3226&_trkparms=aid%3D555014%26algo%3DPL.DEFAULT%26ao%3D1%26asc%3D41376%26meid%3Dd49cdfe8fb154623a304652fcb7f689c%26pid%3D100506%26rk%3D1%26rkt%3D1%26<br><br>Digikey has an expensive model at $5.60 each:<br><br>MT4135-ND<br>https://www.digikey.com/product-detail/en/tamura/TTC-105-1/MT4135-ND/285702 |
| Snap on ferrite core for cables | 2 | 240-2599-ND<br>https://www.digikey.com/product-detail/en/laird-signal-integrity-products/28A1507-0A2/240-2599-ND/2242762 |

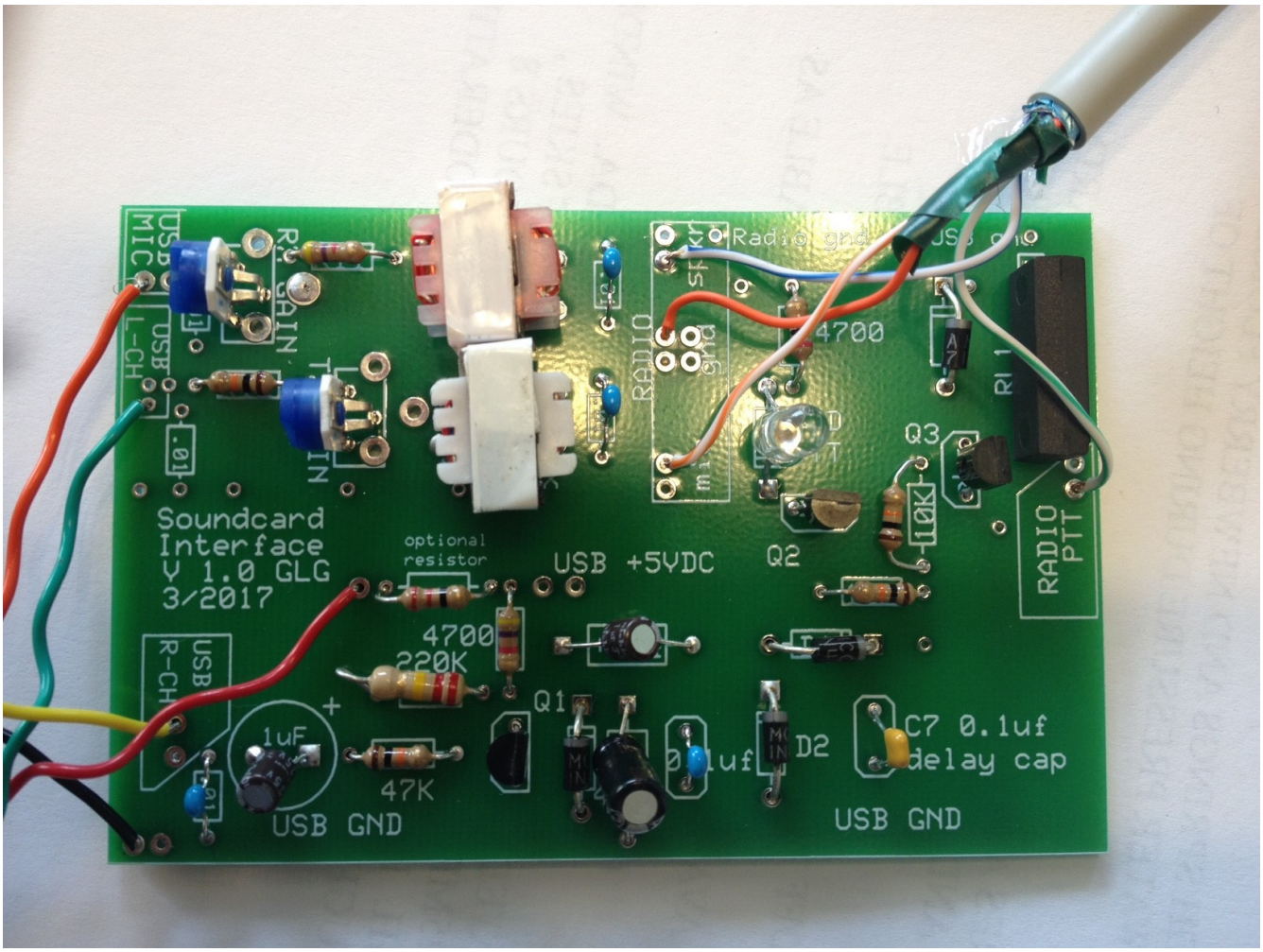


Figure 3. *Completed circuit board, using "tiny" potentiometers. The spacing for the transformers has been since increased.*

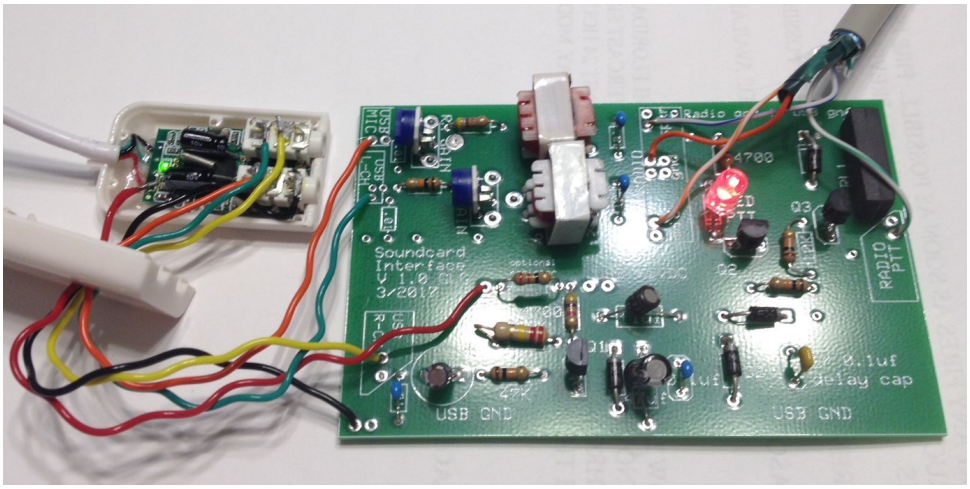

Figure 4. Completed circuit board wired (by direct soldered connections) to an Adafruit 1475 sound

adapter. (The connections to the sound adapter can also be made by stereo 3.5 mm (1/8") cables/plugs[4], and USB +5 and ground obtained using a cut-off USB cable (RED generally +5V and BLACK = ground, but verify with a voltmeter before wiring to be safe.)

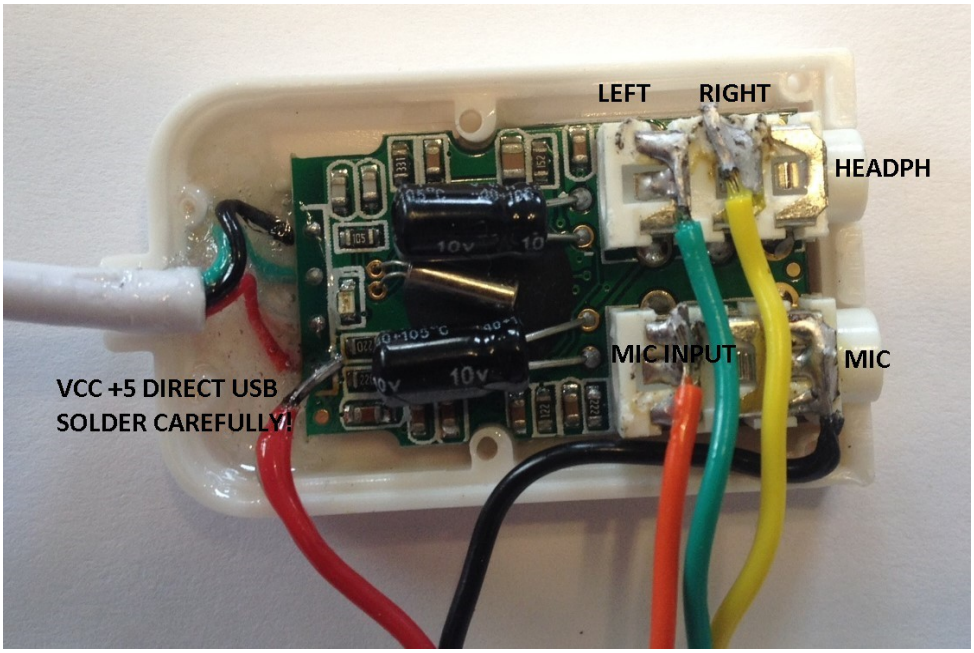


Figure 5. *Close-up of direct soldered connections to Adafruit 1475 sound adapter, after gently prying case open. The +5V red wire connection requires special finesse to avoid the delicate red USB wire on the underside coming loose. The right-most top connection of both headphone output (top) and mic input (bottom) are connected together in the 1475 sound adapter.*

## MOUNTING

To protect the soldered connections on the bottom of the circuitboard, affix a piece of cardboard either with a bit of epoxy glue or (better) some double-stick mounting tape such as used to hold posters to walls. This will avoid short circuits from metallic surfaces touching the bottom of the circuit board.

It is advantageous to mount this circuit inside a metal box of some sort to provide RF shielding. Computer and transistor circuitry can be very sensitive to radio frequency energy picked up by wires and leads. Such a shielding box can be constructed in several ways, from the extremely cheap to the very expensive

1. Enclose in a cardboard box, bring out the required leads, cover the box with simple aluminum

4 Stereo cabled terminated with 3.5mm stereo plugs at both ends, suitable for cutting in two to provide a way to solder to the board and plug into the sound card signal, can be found for less than $1 such as: https://www.monoprice.com/product?p_id=644

foil like a Christmas present, and tape.

2. Enclose in an appropriately sized metal tin such as for fine teas, or wallets or other small commercial items. Be careful of sharp edges if you drill holes for the leads to come out.
3. (My preferred) use a 2-gang electrical junction box with lid and 3/8" ("non-metallic") clamp connector to protect the leads from sharp edges. Such a box already includes knockouts, which can allow you easy access to the trimmers by removing the appropriate knock-out. The board JUST fits into a 2-gang junction box. (A tiny bit of sanding on the edge of the board might make it fit better.) These are available inexpensively from any home improvement store in the $1 range. Use double-stick mounting foam tape to secure the board into the junction box. Sand or file any rough edges on the flat cover that matches the box.
4. Purchase an aluminum hobby box. The production board includes 3 drilled holes with solder flats. If you use metallic standoffs, and wish to connect the box electrically to the USB ground, there is a jumper position that can be used to do that at the lower right hand side of the board.


Figure 6. *Mounted (actually wedged) into a 2-gang electrical box. One knockout has been removed to allow access to the potentiometers, The USB dongle is also inserted, and another knockout has been removed and a "3/8 non-metallic clamp" used to secure the wires' exit point. There is a standard solid metal plate that fits on top as a cover.*

## ADJUSTMENT

This assumes that you are familiar with the software you will be using. Select the proper choice to pick the sound card that is connected to the interface. With the squelch on your receiver wide open, adjust the receiver volume and the RX GAIN trimmmer for the best results on character detection while listening to an active packet channel if possible. Some radios provide a direct connection to the demodulator that will have a constant 100 mV (or similar) signal level, independent of the transceiver's front panel speaker volume level adjustment; this is ideal.

The goal in adjusting the transmitted level is to get just below the maximum correct deviation of your transmitter -- which for FM corresponds to an audio perceived signal in an FM receiver that is slightly softer than maximum loudness. Cause your transmitter to transmit repetitively (e.g., calling a non-existent station) and adjust for just below the maximum deviation while listening on a 2nd transceiver.

For HF SSB, adjust so that you are near the top of the linear range of output power but NOT so as to "flat top" or cause significant Automatic Level Control (ALC) to be developed by your transmitter. You can observe your transmitted signal level in any of several ways, possibly including an display of your transmitted power, an analog forward SWR meter, or a power meter in the transmission line.

MORSE CODE

At modest speeds you can even use the PTT to key a CW transmitter if desired. Be certain that the current carried is not more than about 25 mA and that the open circuit voltage isn't above approximately 15 volts. The reed relay was not meant to switch significant power. FLDIGI will happily send and receive CW for you. Alternatively, you can use the audio output (L channel) to send modulated tone CW, which is very similar to A0 if there is little hum or distortion on your output sine wave.