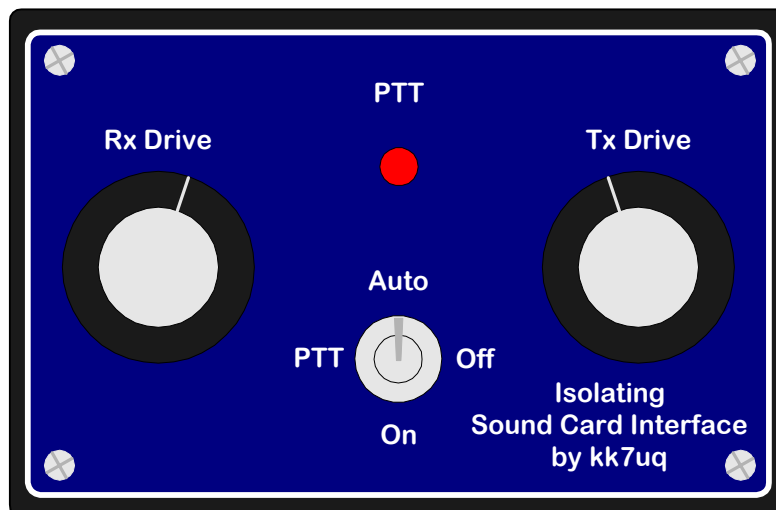


# **Design and Construction Manual**

**for an**

## **Isolating Sound Card Interface for SSB Transceivers**



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# 1 Introduction

**1.1 Scope** - This manual describes the design and assembly of an interface between a PC and a SSB rig. Included in this manual are sections describing the theory of operation of the interface, material list and parts ordering guidelines, assembly procedures, system setup and testing, and web links to find software for operating in PSK31, MFSK16, RTTY, SSTV and CW using the sound card in your PC as the signal processor.

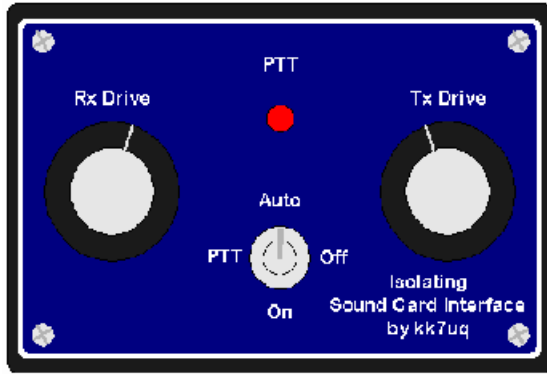
**1.2 Intended Use** - This design has been created for the amateur radio community to encourage more hams to enjoy the pleasures of the new sound card digital modes. This design is ideal for ham club construction projects and for individual hams who likes to build their own equipment. The end result is a solid interface for use with sound card modes such as PSK31, MFSK16, RTTY, Hellschreiber and SSTV.

**1.3 Copyright and Ownership** - all material in this manual is copyright (c) 2001, Discovery Bay Computing. Copies may be made of these materials, for the personal use of licensed radio amateurs. NO commercial use of the designs may be made without express written consent of Discovery Bay Computing.

**1.4 Caveats and Disclaimers**- the designs represented in this manual have been tested in on the air amateur radio operation and are believed to be accurate. Clint Hurd, and Discovery Bay Computing are not responsible for errors, mistakes or omissions made by others when building from these designs. No claims are made to the use or application of the principles in these designs or fitness for any particular purpose. Clint Hurd and Discovery Bay computing are NOT liable for consequential damages resulting from the use of these designs.

**1.5 Features** - The main features of this design include:

- Ground paths between the PC and the SSB rig that travel through the interconnecting cables are completely eliminated through the use of transformers and an opto-isolator.
- Potentiometers are provided on both Rx and Tx to allow easy level adjustment during operation. Knobs are located on the top of the enclosure for easy adjustment.
- LED provided to show when the PC PTT control line is activated.
- Switch provided to enable/disable automatic PTT, or to force the rig PTT ON for manual operation and test.
- Design implemented on a PCB to reduce wiring lengths and simplify assembly.
- Packaged in a small enclosure consistent with the reduced size of the modern transceiver. The enclosure measures 4.1”w x 2.7”d x 1.6” h.
- Templates provided for hole location on the enclosure and top panel.
- Panel label overlays provided for top and rear panel.
- Can be interfaced to either the rig’s microphone/line out or to a single accessory port on the rig.
- Interface can be configured for solid state drive of PTT or for relay contact closure for use with older tube type transceivers.



**Top view of the control panel of the Sound Card Interface**



**The Sound Card Interface with the top cover removed**

## 2 What You Will Need to Build the Interface

**2.1 Skills** - This design is not a kit, in the normal sense of the term. Rather, it is a homebrew project that requires basic skills in electronic and mechanical assembly. To be successful at building this project, you must be able to:

- Identify basic electronic parts
- Order parts from an electronic distributor via a website (or telephone)
- Solder parts to a printed circuit board
- Operate an electric hand drill
- Drill holes in an aluminum plate and in the plastic enclosure using supplied templates.
- Cut and trim holes in a plastic box using the drill and an exacto knife
- Cut and trim overlays and glue them onto the panel
- Measure some voltages and currents with a multi-meter
- Determine the wiring of the microphone input of your SSB rig and build the adapter cable to connect it to the interface

To simplify the assembly process: templates are provided for drilling the plastic box and the aluminum cover plate; a printed circuit board is used to mount all electronic parts; printed overlays are used for the panel and enclosure; a detailed bill of materials is provided for ordering the parts; and a complete assembly manual is provided.

**2.2 Tools and Materials** - You will need the following tools and materials

- Needle nosed pliers
- Side cutters
- Phillips screw driver
- Small blade screw driver
- Soldering iron and good quality rosin core solder
- 1/4" electric drill, with bits of 1/16, 5/64, 1/8, 7/32, 1/4, 5/16 & 1/2 inch
- 1/2" counter sink drill bit
- Exacto knife with a new, pointed blade
- Spray on contact cement
- Electronic board cleaner
- Hacksaw or fine toothed craft saw
- Multi-meter
- Scissors

## 3 Theory of Operation

**3.1 PSK31 Requirements** - The use of a PC sound card to modulate the audio of a SSB rig has seen explosive growth in the last few years. In particular, the PSK31 (Phase Shift Keyed, 31 Baud) has changed the nature of communications over ham radio and attracted thousands of hams to use this as their main mode of operation. PSK31 is extremely efficient of operating bandwidth use, typically requiring about 60 Hz. Signal separation of 100 Hz without interference is common practice. The nature of the PSK31 modulation system is such that it is effectively a two-tone modulation system. Because of this, good linearity must be provided throughout the audio path to prevent unwanted side bands from being created by the system.

**3.1.1 Bandwidth** - To realize this low bandwidth and close signal separation, some care must be taken in adjustment of the audio drive of the transmitter from the PC, and particular attention must be paid to minimizing stray signal pickup from sources such as the RF field of the transmitter, AC power lines and other sources. It is the job of the interface system to provide clean signals to the transmitter in this potentially hostile environment.

The basic concept is very straight forward. During transmit, audio output from the PC sound card is provided at the microphone (or accessory port) of the SSB rig. The SSB rig is keyed using the PTT input to the rig. Data input from the operator is provided by the keyboard to the sound card software. The sound card software converts it to the modulation format and uses the sound card to create the audio output for the SSB rig.

During receive, the audio from the SSB rig is connected to the audio input of the PC sound card, and the sound card software decodes the audio signal and provides text output on the screen.

**3.1.2 Software Functions** - The software running on the PC provides the functions of:

- Operator Interface - Keyboard and Screen
- Scanning a portion of the audio band (200 to 4000 Hz) and presenting a view of this spectrum on a waterfall or spectrum display
- Selection of a particular signal, filtering it to separate from other signals and decoding it.
- Presenting the output to the screen.
- When ready to transmit, accepting the data via keyboard and converting the keyboard data to a modulated audio output to be sent to the SSB rig.

**3.1.3 SSB Rig Audio Levels** - are consistent with driving speakers or headsets. These signals have an extremely wide dynamic range: from millivolts to around 5 V p-p. The PC Sound Card accepts levels up to about 5v p-p. In general, the audio levels from the rig to the sound card are compatible. If signals approach the maximum range of the sound card input, a warning message from the software will be given for the operator to reduce the audio level. The receive audio level can be controlled by RF gain of the receiver, input gain of the sound card, or the RX level control potentiometer in the interface. In practice, all of these controls are used during setup and operation of the system.

**3.1.4 PC Sound Card Audio Levels** - The audio levels created from the sound card are in the range of 0.1 to 5 v p-p. Typical signal level is around 1V p-p. The SSB rig, however, expects signals that are compatible with microphones, i.e. in the tens of millivolts range. The interface must provide some level reduction to bring the signals to the right scale. The actual level required is a function of the microphone gain setting of the rig, the audio level of the PC soundcard and the TX level control potentiometer in the interface. All of these controls are set during the system setup, covered in chapter 6.

**3.1.5 Noise & Feedback** - One problem with lower level input is that any signal picked up on the transmit audio wiring can approach the expected signal level, degrading S/N and putting unwanted signals on the transmitted audio. If the noise source is the RF created by the transmitter, feedback will occur with broad band noise resulting on the transmitted audio. There are several lines of defense that can be taken to ensure clean, quiet operation.

- Shield the cables, and provide good ground connections for all components of the system, including the PC.
- Provide a filter in the interface to remove unwanted RF signals that have been picked up. This combined with short lead lengths in the cables from the interface to the rig can be very effective.
- Eliminate any ground loop between the components placed along the signal path which may inject common mode noise into the audio. This is done in the interface by using audio transformers on

both the input and output audio paths. The PTT control is also isolated using opto-isolator components.

- Select the audio levels along the path to enhance S/N ratio when ever possible. This is covered in the chapter on system setup.
- Ensure that the audio created by the PC is in fact the ONLY audio created by the sound card software. Other inputs to the sound card exist, and can be active unless positive steps are taken to ensure that they are turned off. This is also covered in the chapter on system setup.

**3.2 Description of the Interface** - The schematic diagram for the PCB is shown in figure 3.1 below. Sound card or PC functions are shown on the left side of the drawing. SSB rig functions are shown on the right side of the drawing. Signal flow is indicated by arrows to show the flow from the source to the destination.

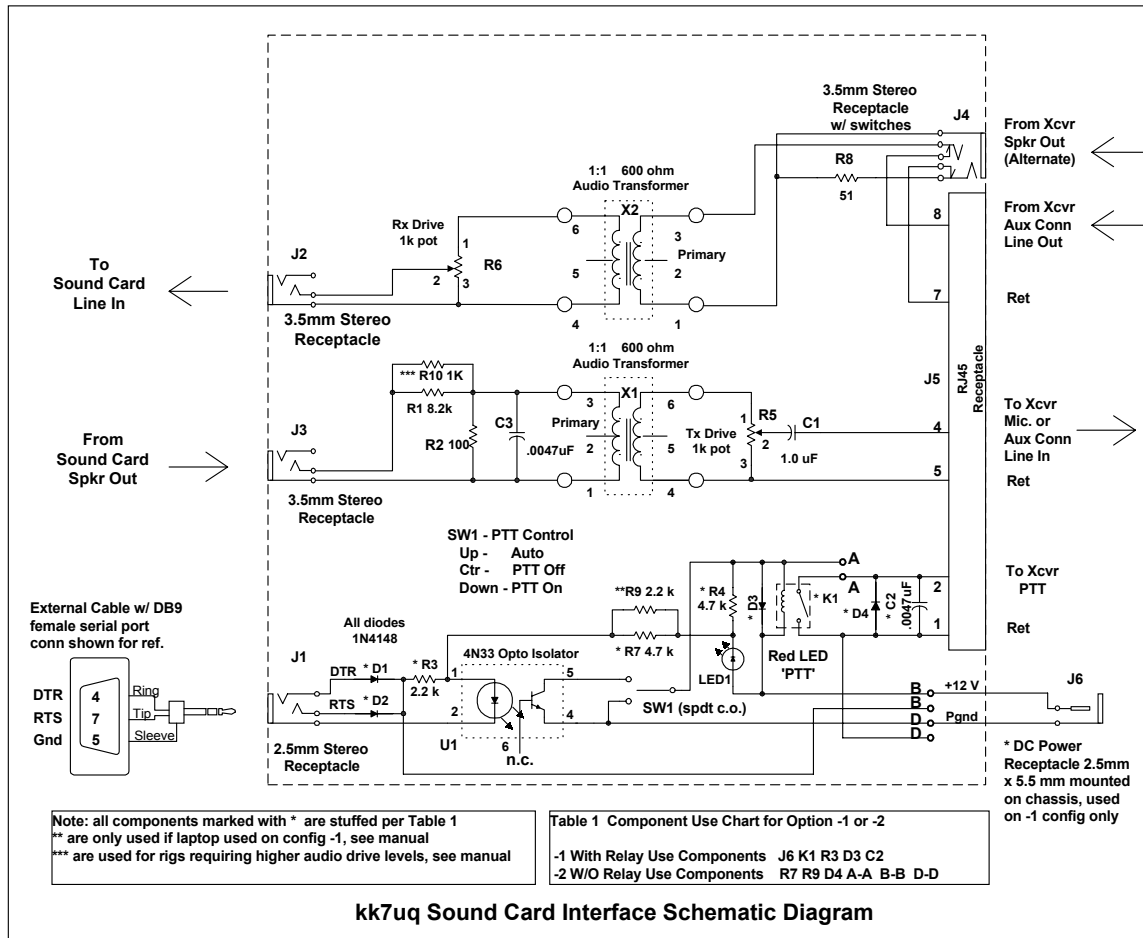


Figure 3.1 Sound Card Interface Schematic Diagram

**3.2.1 Receive Audio Path** - At the top of the page the flow of audio from the rig to the sound card is shown. There are two possible sources for this audio: a source terminated in an audio connector such as a 3.5mm monoaural source (speaker out, headset out or line out). The other possible source is from an accessory connector which contains both output audio, input audio, and PTT functions. The interface is designed to operate with either method of connection. If the 3.5mm audio connector in J4 is used, switches internal to the connector are used to disconnect the audio from the RJ45 connector (J5). This prevents two sources from the rig being connected together. During the time that the plug is inserted in the jack, J4, the

cable can be momentarily shorted, hence resistor R8 is used to provide a load during this short time interval.

The audio from one of these two sources is sent to the primary of transformer X2. The output of the transformer feeds potentiometer R6 which is used to control the signal output level sent on to the PC sound card. The output connector is a 3.5mm stereo jack since the sound card expects stereo input. Only the TIP (left channel) connection is used. The connection to the sound card should be a shielded stereo cable.

**3.2.2 Transmit Audio Path** - In the center of the page, the audio path from the sound card to the rig is shown. The sound card output is provided in the form of a shielded stereo audio cable. The TIP (right hand channel) connection of 3.5mm audio jack J3 carries this signal. The other channel is not connected. As will be seen in chapter on system setup, there is an advantage to only using one of the two channels.

The audio goes to voltage divider R1/R2. This provides a signal level reduction of about 82:1. Signal levels of around 1 volts become around 10 millivolt after this divider. There are some rigs whose accessory ports require substantially higher drive, in the range of 100 millivolt. For these rigs, an extra set of pads in position R10 is provided to place a 1k ohm resistor in parallel with R1. This changes the signal level reduction to about 10:1.

Capacitor C3 is provided across the primary side of transformer X1. This acts as a filter for any RF present on the audio input line. The output of the X1 feeds a potentiometer (R5) to allow for final adjustment of signal level going to the SSB rig. The wiper of the potentiometer is fed through capacitor C1 to provide DC blocking of the signal sent to the SSB rig.

An RJ-45 jack is provided as the method of connecting to the SSB rig. This connector is set up to allow feeding the microphone jack of the rig, or an accessory connector, if available. Signals on this connector include the audio received from the SSB rig, the audio sent to the SSB rig and the PTT control of the rig. Notice that the return lines (normally chassis ground of the rig) are not tied together in the interface. They are only tied together at the connector to the rig itself. Pinouts used on the connector are chosen to be compatible with the twisted pair sets on a standard CAT 5 patch cable.

**3.2.3 PTT** - The Push To Talk (PTT) rig function is used to turn on the transmitter when sending audio to the rig through the interface. The PTT Control circuit is described below.

**3.2.3.1 PTT Control** - The PTT (Push to Talk) control circuit is shown at the bottom of the diagram. The interface is set up to activate PTT under the control of a serial port of the PC. Historically, two different signals have been used to perform this function for ham radio sound card applications: RTS (request to send) and DTR (data terminal ready). One or both of these signals have been used by different software written for these applications. Today, most software has been rewritten to activate BOTH of these lines to maintain compatibility. Hence there are two diodes D1 and D2 which perform a logical OR of these two signals so that either one will activate the rig. The output of the diodes is used to feed an opto-isolator (U1) which in turn is used to activate the PTT line. The connection to the interface is via a 2.5mm three conductor jack, J1. An external cable which connects the DB9 type connector of the PC to the 2.5mm plug must be provided. The construction of this cable is described in section 5.2.1.

**3.2.3.2 PTT Configuration -1 With Relay** - Two configurations of PTT drive are provided with the interface. The first configuration, designated -1 drives a reed relay in the interface whose output contacts drive the PTT line. A capacitor, C2, is provided across these contacts in case they feed an inductive source such as a relay coil. The -1 configuration is used for older, tube type rigs which have relay coils connected to the PTT line. This configuration requires a power source from 12V to 13.8 volt DC to power the reed relay coil. This is connected to the board via DC power connector J6, mounted external to the board on the back of the enclosure. There is a short "captive cable" between J6 and the PCB. In this configuration, components R7 and D4 are NOT stuffed on the board, nor are jumpers A-A, B-B or D-D used.

**3.2.3.3 PTT Configuration -2 Without Relay** - The -2 configuration is in fact the “normal” configuration for most modern transceivers. It expects the PTT to be connected to solid state, low current requirement, non-inductive loads. It is driven directly by the output of the opto-isolator. It does not require an external power source for the interface. The wiring of the LED which indicates PTT activation is moved to be in series with the serial port control signals arriving via D1 or D2. The output of U1 is moved to connect to the PTT lines of the SSB rig. “Just in case” there is a diode placed across the output of U1 to protect it if an inductive load is ever connected to it. In the -2 configuration, several components are NOT stuffed. The components NOT used are J6, K1, R3 D3 and C2. Jumpers A-A, B-B and D-D ARE installed for this configuration.

Some laptop computers have lower than standard RS 232 voltage levels on the RTS and DTR lines. The current derived from these signals may not be high enough to properly light the LED or activate the opto-isolator circuit. A set of pads has been provided at location R9 to allow a 2.2k ohm resistor to be inserted to parallel R7. This reduces the series resistance and increases the current drive. See the discussion on PTT test in section 7.4.2.6 to determine if you need to add this component.

**3.2.3.4 PTT Indicator** - LED1 is a low current, red LED used to indicate that PTT has been activated. In the -1 configuration, it means that the output PTT control lines have been activated. In the -2 configuration, the LED means that either RTS or DTR on the serial port has been activated.

**3.2.3.5 PTT Mode Control Switch** - Switch SW1 provides control over the PTT lines of the rig. If the switch is in the UP position, automatic PTT has been enabled. Any time either RTS or DTR on the serial port is active, the PTT output will be activated (low impedance). If the switch is in the CENTER position, the PTT lines can not be activated. If the switch is in the DOWN position, the PTT lines are forced to the active state, and the rig is keyed. This latter mode is useful for testing, and for those installations which do not have a serial port, or VOX available to key the rig. It can be keyed manually by activating the switch.

### **3.3 Deciding Which Configuration is Right for Your Rig**

Check the manual for your rig. Often, it will tell you what the current will be drawn when the PTT input is activate. If not, you can measure it using the following procedure.

Find the pin out configuration of the microphone connector on your rig from the rig manual. There will be a PTT pin, and a return pin for the PTT. Sometimes the PTT return and the microphone audio return are on the same pin. Using the VOLTAGE scale on a multi-meter set at 50v or higher, measure the voltage from the return pin to the PTT pin. Note the voltage and polarity. Typical measurements would show something on the order of + 5 to + 14 volts on the PTT pin as referenced to the return pin.

Next measure the current between these same two pins using the CURRENT scale of the multi-meter. Set the range for around 1 amp. When you do this, you will be keying the rig, so before making the measurement, set the rig control to USB and connect it to a dummy load. Momentarily connect the meter across the PTT and return pins. You should see activation of the rig, and see some current on the meter. You may see current in the range of a few ma. to a few hundred ma. If the current is really low, you may have to reduce the scale on the multi-meter to get a good reading.

If the current measures around 30 ma. or less, then it is most likely a solid state connection, or else a low current reed relay. If the measurement is more than 30 ma., you probably have a larger relay coil being activated. Use the -1 option if you have a current above 30 ma., or voltage measurements above 15 volts. Use the -2 option if the current is less than 30 ma. and the voltage is less than 15 volts.

During construction, follow the procedures for the appropriate configuration.

## 4 Ordering Parts

**4.1 Sources** - The parts list for the interface is provided in the table 4.1 below.

The Printed Circuit Board, Legend Overlays and this Manual are available from::

Discovery Bay Computing  
253 Snagstead Way  
Port Townsend, WA 98368

Phone (360) 379-4042  
Email: [discobay@waypoint.com](mailto:discobay@waypoint.com)  
Web: [www.waypoint.com/users/~discobay/](http://www.waypoint.com/users/~discobay/)

Most of the other parts are available from:

Mouser Electronics

Phone 1-800-346-6873

[www.mouser.com](http://www.mouser.com)

In this case, the page number from the 2003 catalog is shown, as well as the Mouser part number. Pricing from the 2003 catalog is also shown for reference. Some of these parts, such as resistors, capacitors, and diodes could be ordered from other sources if you choose. Other parts are selected for their physical size and configuration to match the PCB design. These parts are marked with an asterisk (\*) . Parts so marked should be ordered from Mouser unless you are sure you have a compatible part. Every effort has been made to ensure that these parts selected are in supply and that the part numbers are correct.

**4.2 Alternate Sources** - There are some parts that are available from other sources, possibly at better pricing. These parts are shown with a double asterisk (\*\*) and in particular include the ready made shielded stereo audio cables. Radio Shack has these at better prices than Mouser. If you have a local Radio Shack store check out their pricing on these components Radio Shack part numbers and catalog references are also provided for these parts.

**4.3 Parts List** - The parts list is broken down into the following categories:

- Design and PCB Package
- Circuit Board Assembly, Chassis & Serial Port Cable components
- Additional Components Needed for -1 Option
- Audio cables
- Rig control cable
- Rig microphone or accessory port mating connector

The only component that you will have to track down yourself, is the matching rig microphone or accessory connector. Radio Shack is a good source for these connectors.

**4.3.1 Design and PCB Package - Source Discovery Bay Computing**

Qty	Flag	Item	Cat Pg	Part Number	Ea.	Ext.
1	*	Interface design package		100113	14.50	14.50

**4.3.2 Circuit Board Assembly, Chassis & Serial Port Cable components - Source Mouser Electronics**

Qty	Flag	Item	Cat Pg	Part Number	Ea.	Ext.
1	*	Plastic Project Box 4.19 x 2.74 x 1.57	710	400-5053	3.17	3.17
1	*	Cover, Project Box, Aluminum	710	400-7053	2.24	2.24
2	*	3 cond 1/8" mini jack rec. pcb	447	161-3507	0.71	1.42
1	*	3 cond 1/8" mini jack rec. pcb w/ switch	447	161-3508	0.74	0.74
1	*	3 cond 2.5mm jack rec. pcb	447	161-2502	1.08	1.08
1	*	3 cond 2.5mm plug	447	171-3405	1.24	1.24
1	*	RJ45 jack, pcb mounting	492	571-5577851	1.08	1.08
1		DB9 Female connector, solder pot	536	156-1309	0.66	0.66
1		DB9 Cover	540	156-2009	0.65	0.65
2	*	Transformer, 1:1 audio 600 ohm	385	42TM016	1.73	3.46
1		Resistor, ¼ watt 10% 51 ohm	250	30BJ250-51	0.22	0.22
1		Resistor, ¼ watt 10% 100 ohm	250	30BJ250-100	0.22	0.22
1		Resistor, ¼ watt 10% 1.0k ohm	250	30BJ250-1.0k	0.22	0.22
1		Resistor, ¼ watt 10% 2.2k ohm	250	30BJ250-2.2k	0.22	0.22
2		Resistor, ¼ watt 10% 4.7k ohm	250	30BJ250-4.7k	0.22	0.44
1		Resistor, ¼ watt 10% 8.2k ohm	250	30BJ250-8.2k	0.22	0.22
2	*	Potentiometer, 1k linear taper	892	531-PC16SC-1K	2.35	4.70
2		Capacitor, .0047 uFd 50v	334	140-50P5-472K	0.08	0.08
1	*	Capacitor, 1.0 uFd 50v	345	5989-100V1.0	0.52	0.52
4	*	Diode, 1N4148	5	583-1N4148	0.05	0.20
1	*	Switch, mini-toggle SPDT on-off-on pcb	330	612-100-C1121	3.51	3.51
1		Opto-isolator, 4N33 DIP	186	512-4N33	0.50	0.50
1	*	Diode, LED T 1 ¾	211	512-MV8190	0.29	0.29
2		Knob, ¼" shaft, 1" dia.	723	45KN017	0.81	1.62
<b>Total</b>						<b>28.68</b>

**4.3.3 Additional Components Needed for -1 Option - Source Mouser Electronics**

Qty	Flag	Item	Cat Pg	Part Number	Ea.	Ext.
1	*	Relay, reed, SPST 12V NO Contact	597	677-OMR-112H	1.54	1.54
1	*	Connector, jack, DC pwr round chassis mtg 2.55 mm x 5.5 mm	444	163-4305	1.61	1.61
1	*	Connector, plug DC pwr cable	444	1710-2521	0.65	0.65
Note: if commercial "wall wart" type supply is used, this connector is not needed						
<b>Total</b>						<b>3.80</b>

**4.3.4 Audio Cables - Source Mouser Electronics (M) or Radio Shack (RS)**

Qty	FlagItem	Cat Pg	Part Number	Ea.	Ext.
3	Cable, 6', Shielded stereo audio 1/8" mini	413	172-3504	4.39	13.17 <b>M</b>
	or				
3	Cable, 6', Shielded stereo audio 1/8" mini	185	42-2420	2.69	8.07 <b>RS</b>

**Note:** qty above assumes that the connection to the rig is via the microphone and a line out or speaker out via a 1/8" connector. If the rig is interfaced using an accessory connector for both transmit and receive audio, change above quantity to 2.

**4.3.5 Rig Control Cables - Source Mouser(M) or Radio Shack (RS)**

Qty	FlagItem	Cat Pg	Part Number	Ea.	Ext.
1	12 inch, 4 twisted pair (8 conductor) CAT 5 type cable with RJ45 connector on one end, the other end connects to the rig microphone or auxiliary matching connector. Here are some ways to procure this cable:				
1	Category 5 patch cable 3 foot cut the patch cable at the required length	496	571-2192413	3.40	3.40 <b>M</b>

or

Go to your local radio shack store and have them make up a cable with CAT 5 cable and the RJ45 connector. They will usually do it for much less than the above price.

**4.3.6 Rig Microphone or Accessory Connector**

Qty	FlagItem	Cat Pg	Part Number	Ea.	Ext.
	The type of connector used for the microphone varies from transceiver to transceiver. Below are some sources for connectors. You will need (1).				
	<b>Some microphone connectors</b>				
	Connector, 8 pin, microphone	191	274-025	2.49	2.49 <b>RS</b>
	Connector, 4 pin, microphone	191	274-001	1.99	1.99 <b>RS</b>
	<b>Some auxiliary type connectors</b>				
	Connector, plug, 5 pin, DIN	273	274-003	1.99	1.99 <b>RS</b>
	Connector, plug, 8 pin, DIN	273	274-026	1.99	1.99 <b>RS</b>
	Connector, plug, 5 pin, DIN	460	171-0275	0.65	0.65 <b>M</b>
	Connector, plug, 6 pin, DIN	460	171-0276	0.66	0.66 <b>M</b>
	Connector, plug, 8 pin, DIN	460	171-0278	0.74	0.74 <b>M</b>
	Connector, plug, 6 pin, Mini-DIN	460	171-2606	1.06	1.06 <b>M</b>
	Connector, plug, 8 pin, Mini-DIN	460	171-2608	1.18	1.18 <b>M</b>
	Connector, plug, 9 pin, Mini-DIN	460	171-2609	1.57	1.57 <b>M</b>

## 5 Assembly

The assembly of the interface is done in four sections; PC board, cables, top panel, and enclosure.. They should be done in the order above, since the finished board is used for checking the cutout of enclosure hole patterns, and for alignment of installing the panel overlays.

### 5.1 Printed Circuit Board (PCB) Assembly:

The PCB can be assembled in one of two different configurations, -1 or -2 . See the discussion in the theory of operation section to determine which configuration is right for your rig. The differences are noted in the instructions below.

**5.1.1 Polarized Components** - There are some components which are polarized or keyed, so attention must be paid to the orientation of the components that go on the board. These polarized/keyed components will be marked with \*\* in the component stuffing chart, figure 5.3.

#### 5.1.2 Components Requiring Trim Before Insertion

There are three component types which must be trimmed before insertion. These are the LED, the Switch and the Potentiometers. The LED and Switch are mounted with the ends of the leads just even with the bottom of the board. When cut to the required dimension, this will align the parts with the bottom of the cover plate when the chassis is assembled. Refer to drawing 5.1, *Component Cut Dimensions*, for the dimension of lead cuts. The bottom nut on the switch is also adjusted to be positioned at the bottom of the cover plate. The potentiometer shafts need to be cut so that the knobs will be properly positioned above the cover plate when assembled. This dimension is also found on drawing 5.1.

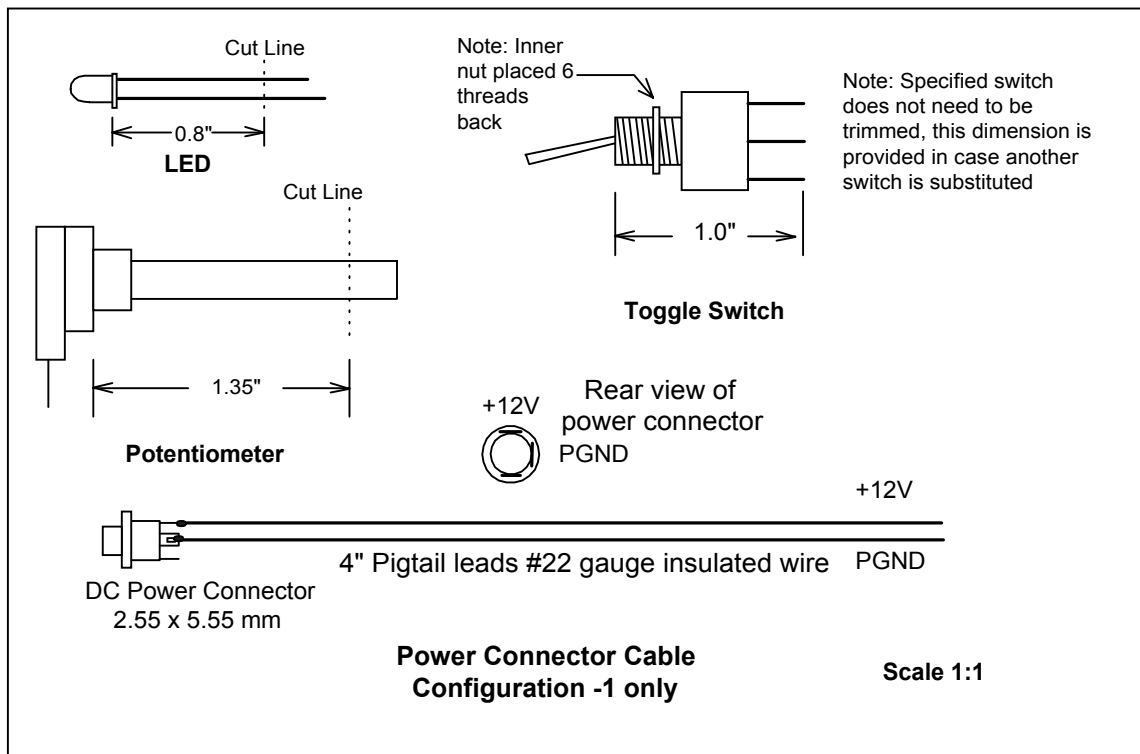
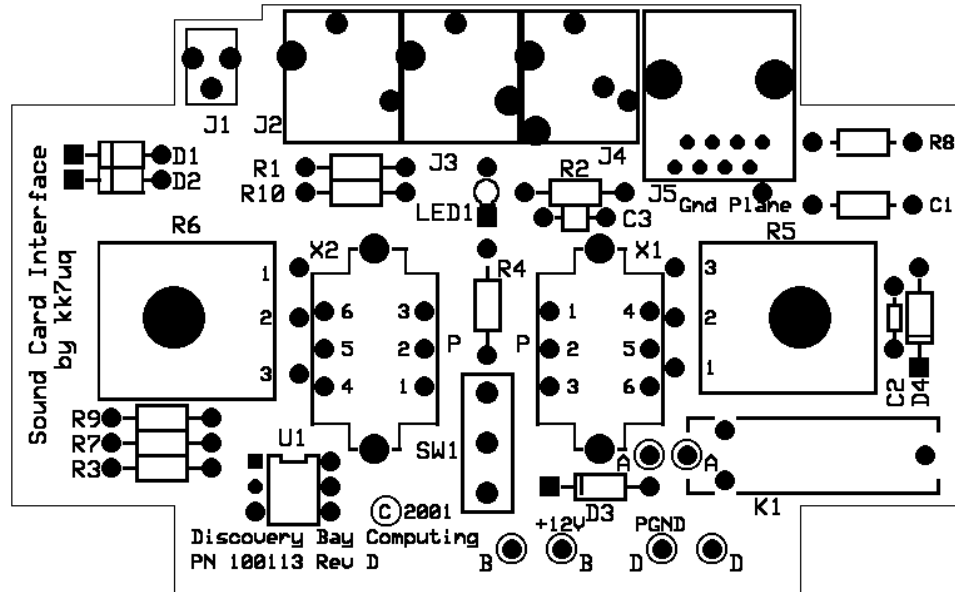


Figure 5.1 Component Cut Dimensions

**5.1.3 Order of Assembly** - A drawing of the component placements for the board is shown in figure 5.2, *Printed Circuit Board Assembly Diagram*, below. The list of components stuffed in the board and the order of assembly of the components is shown in 5.1.4 Component Stuffing List below..



**Figure 5.2 - Printed Circuit Board Assembly Diagram**

**5.1.4 Component Stuffing List**

**Connectors**

- J1                    2.5mm stereo connector (3 pins)
- J2 J3                3.5mm stereo connector (3 pins)
- J4                    3.5mm stereo connector with switches (5 pins)
- J5                    RJ45 Jack

When mounting the four stereo connectors, ensure that the front of the body of the jack is flush with the edge of the circuit board.

**Resistors**

- R1                    8.2k ohm ¼ watt Gray Red Red
- R2                    100 ohm ¼ watt Brown Black Brown
- R8                    51 ohm ¼ watt Green Brown Black

Resistors are mounted on pads 0.4” apart. Bend the leads down on each side of the resistor. Solder and trim the leads.

**Capacitors**

- C1                    1.0 uFd ceramic 50v
- C3                    .0047 uFd disc ceramic 50v

Solder and trim the leads.

### Diodes

\*\* D1 D2 1N4148

The *cathodes are marked with a bar on one end*. They should be placed as shown on the silkscreen. As an additional guide, the cathode end pad on the pcb is a square pad. Solder and trim the leads.

### Integrated Circuit

\*\* U1 4N33

The Opto-Isolator integrated circuit is marked with a *notch* at the top edge, *or a dot* at the upper left hand edge, it should be aligned as shown on the silkscreen. Solder U1 to the board

### Transformers

\*\* X1 X2 1:1 Audio transformer 600 ohm

Audio transformers are *marked on one side with a "P"* (Primary) these should be aligned with the "P" on the circuit board silkscreen. Solder and trim the leads. Solder the mounting tab to the board.

### Switch

\*\* SW1 Toggle switch, SPDT, On Off On

The toggle switch is mounted on the top of the board, and has a *keying slot* on one side which aligns with a washer on the top panel of the enclosure. It should be oriented with the slot toward center of the board. The switch is raised above the surface of the circuit board, and positioned so that it fits through the top panel. See figure 5.1 for detail.

### LED

\*\* LED1 Red LED, T1<sup>3</sup>/<sub>4</sub>

The LED is polarized. The *cathode is marked with a flat side* on base of the LED. The cathode should be oriented toward the center of the board as shown on the schematic. If in doubt, use a multimeter to determine the polarity. The LED is mounted above the board such that it protrudes though a matching hole in the top panel. See figure 5.1 for dimensions for trimming the lead length.

### Potentiometers

\*\* R5 R6 Potentiometer, 1k ohm linear taper

The **potentiometers are mounted on the back side of the board**, with the shafts pointing up though the component side. Pre-cut the shaft lengths per figure 5.1. Use the flat washer on the top, and tighten the nut down until it is firm, do not over tighten. The tabs on the potentiometers should be oriented toward the center of the board, and aligned over their pads as shown on the silkscreen.

Use bare wire saved from the cut leads of the resistors and capacitors to make the connection from the tab to the pad directly below it. Be sure to push the wire through the pad until it just comes through the hole on the component side of the board. Solder from the bottom of the board.

**Configuration -1 Components** if you are building configuration -1 (relay) then stuff these parts now.

J6 2.5mm x 5.5mm DC Pwr Jack (mounted on 4" wires to pads on board) see figure 5.1  
R3 R4 4.7k ohm ¼ watt Yellow Violet Red  
C2 .0047 uFd disc ceramic 50v  
\*\* D3 1N4148 (see note on diode polarity above)  
K1 Relay, reed 1 amp, Form A

**Configuration -2 Components** if you are building configuration -2 (no relay) then stuff these parts now.

\*\* R7 4.7k ohm ¼ watt Yellow Violet Red  
 D4 1N4148 (see note on diode polarity above)  
 A-A B-B D-D Bare wire jumpers

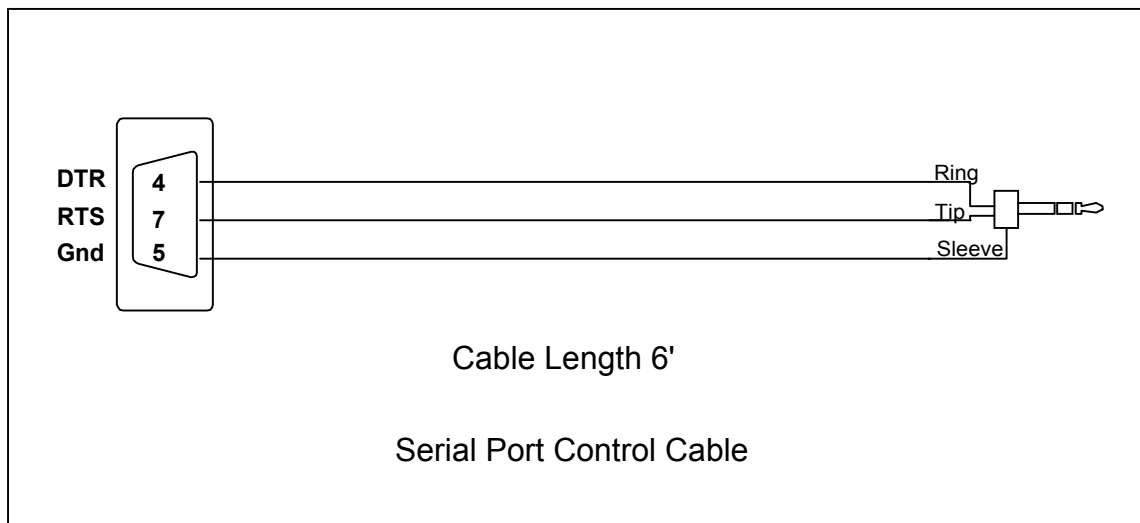
**Note:** if a laptop computer is used, the voltage on the RTS and DTR may be lower than that found on a desktop computer. If so, the LED will not be as bright, and the opto-isolator may not have enough drive to trigger the PTT reliably. If this is the case, add a 2.2k ohm, (Red Red Red.) resistor in position R9. This parallels R7 to decrease the resistance, and increase the current drive through the LED and the opto-isolator.

At this point, the wiring of the interface board is complete. Once the external cables are built, the board can be connected and tested before it is put into the enclosure. BUT FIRST ... check your assembly work, paying attention to polarity of the components, and quality of soldering. Then it is a good idea to clean the bottom of the board with a flux remover such as Radio Shack "Tronic Kleen".

## 5.2 Cable Assembly

There are two cables that must be fabricated for use with the interface: the Serial Port Cable and the SSB Rig Control Cable.

**5.2.1 Serial Port Cable** - The Serial Port Cable is a 6 foot cable with a DB9 on the PC end, and a three conductor 2.5mm stereo plug on the interface end. The two control signals RTS and DTR are carried on this cable. See Figure 5.3, *Serial Port Control Cable*, for details on construction of this cable. All parts for this cable are included in the parts list, except the wire for the cable.



**Figure 5.3 Serial Port Control Cable**

### Connector Material List

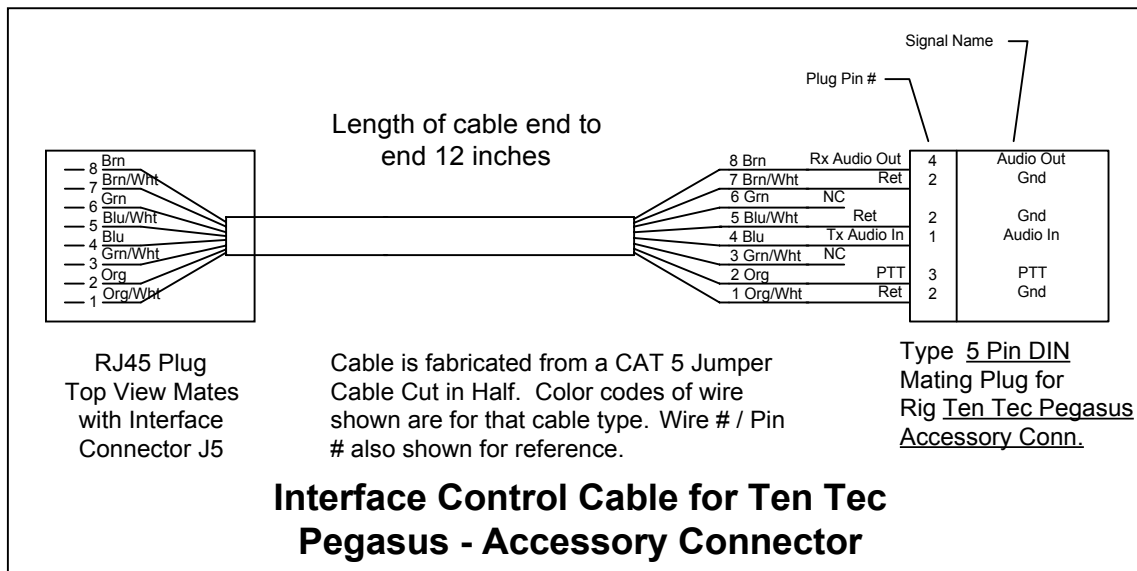
PC End	DB9 Female connector, solder pot	Mouser PN 156-1309
PC End	DB9 Cover, Plastic	Mouser PN 156-2009
Interface End	3 cond. 2.5mm plug	Mouser PN 171-3405
Wire	6' 3 conductor cable, #24 stranded wire	

**5.2.2 SSB Rig Control Cables** - The SSB Rig Control Cable is a 12” cable which connects the interface to the SSB Rig. There is a RJ45 8 wire connector on the interface end. The rig end has a connector which mates with either the microphone jack or the accessory jack. This cable can be built in two forms.

The first form is one that mates with the microphone jack which carries the audio and the PTT controls to the rig. In this case, the audio out from the rig is connected to the interface by a separate shielded audio cable.

The other form is intended to connect to the rig accessory port, and carries both audio to the rig and receives audio from the rig and sends it to the interface. The PTT controls are also carried on this cable.

The choice as to which form to use depends upon the rig. If there is an accessory port, you will probably want to use it. There is only one cable required, and you can leave your microphone connected if you want to. An example of use of the accessory port are shown in figure 5.4, *SSB Rig Control Cable Connected to the Accessory Port*, below. This example uses the Accessory Port of the Ten Tec Pegasus Transceiver.



**Figure 5.4 SSB Rig Control Cable Connected to the Accessory Port**

If there is no accessory port, use the microphone input for the audio to the rig and the PTT, and provide a separate audio cable for the audio out from the rig to the interface. You will have to decide which audio output to use for this second cable. If there is a “Line Out” port, it is probably the best since the output is usually independent of the AF Gain control. Its level out is usually controlled only by the RF Gain control.

If there is no “Line Out” port, you can use the external speaker output, or the headset jack. These two audio outputs do have a problem, since use of either one cuts off the sound from the speaker of the rig. To get around this, you can use a “Y” connector and use one side for the rig audio / interface cable, and the other to drive an external speaker or a headset.

Examples of cable which connect to the microphone connector for the Kenwood TS570 is shown in figure 5.5, *SSB Rig Control via the Microphone Connector*, below. A blank worksheet to use for your rig is shown in figure 5.6, *Work Sheet for Interface Control Cable*, below.

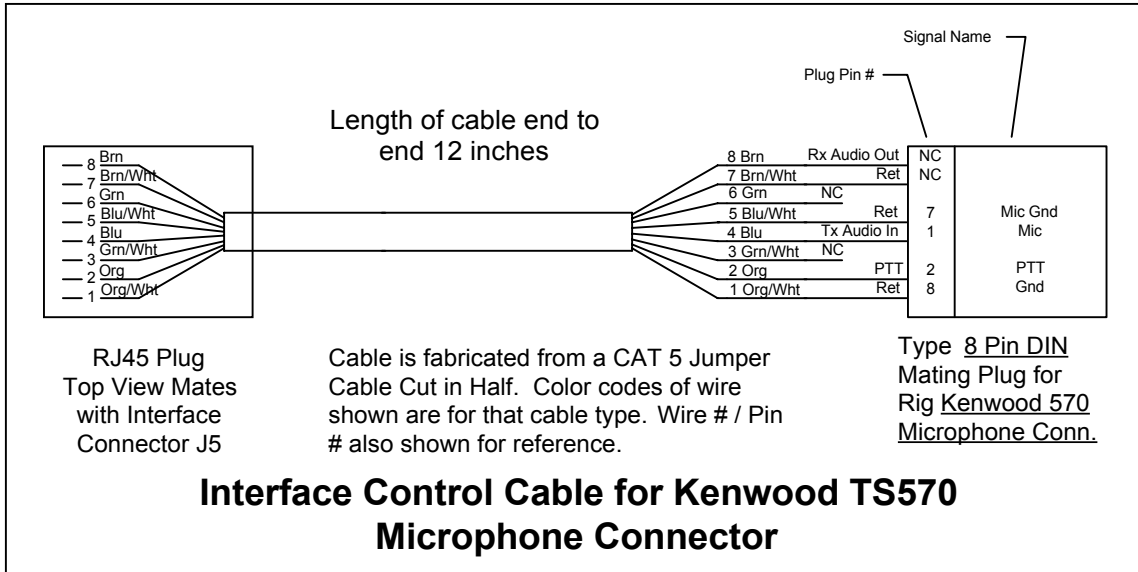


Figure 5.5 SSB Rig Control via the Microphone Connector

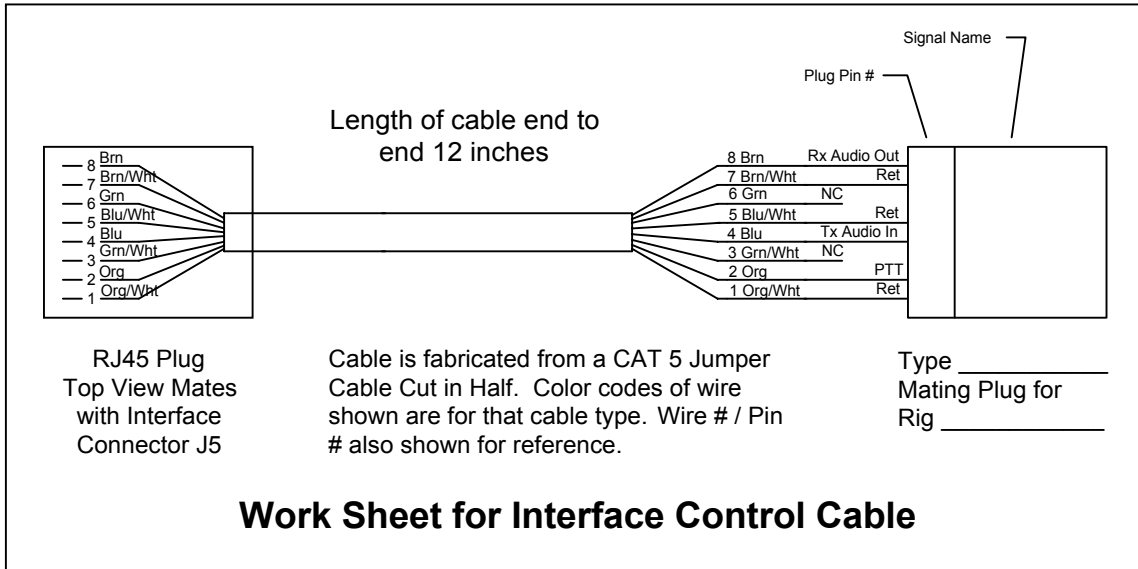
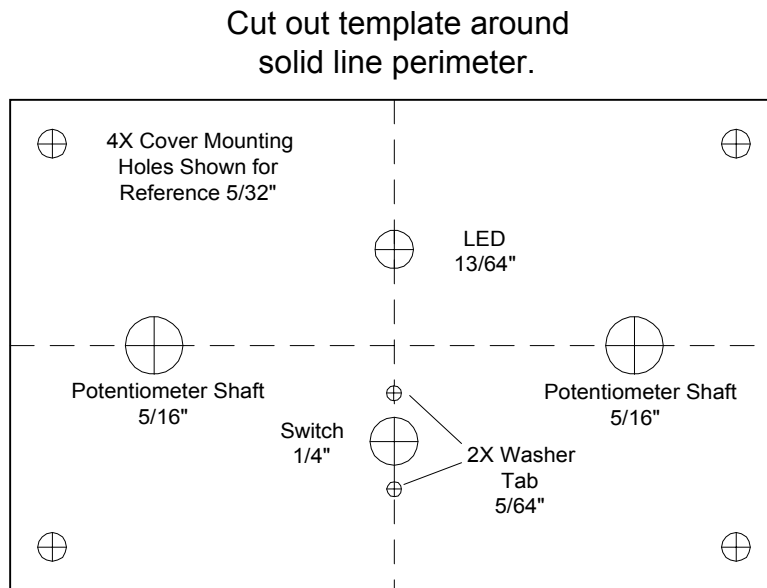


Figure 5.6 Work Sheet for Interface Control Cable

## 5.3 Cover Plate

**5.3.1 Drill Template** - the drill template for the cover plate is shown in figure 5.7, *Cover Drill Template*, below. An additional copy of the template is provided with the Interface Design Package supplied by Discovery Bay Computing. It can be cut to size and taped to the blue protective plastic on the top of the blank aluminum plate supplied with the enclosure. The four mounting holes are already drilled in the cover plate, and the template should be aligned over these holes. Once it is aligned, secure the template in place with clear tape. Use a sharp, pointed tool like an awl, a small center punch, or the tip of the exacto knife blade to mark the center of each hole to be drilled. Drill a 1/16" pilot hole for all hole positions. Once the pilot holes are drilled, remove the template and drill the actual hole size as shown below. Clean the rims of the holes by hand, using a larger drill bit or a counter sink bit to clean the edges. Once the holes are drilled and cleaned, remove the blue plastic from the top of the plate.

**Note:** Two washer tab holes are shown on the template. Normally only the top one is used, the second one is provided in case the switch was put in the other way around on the PCB. Instead of trying to remove the switch, just insert the washer with the tab down and use the bottom hole. The holes are covered by the overlay, and the hole in the overlay is created when the washer is installed the first time.



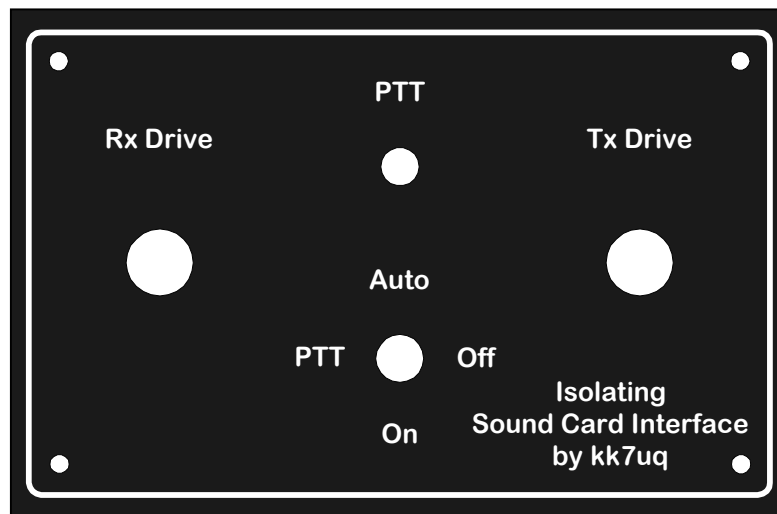
**Figure 5.6 Cover Drill Template**

**5.3.2 Panel Overlay** - the overlay for the top cover carries the legends and identification of all functions on the panel. It is produced with an ink jet printer onto photo quality paper, hence it is thicker than normal printer paper and has a glossy finish. A reproduction of the overlay is shown in figure 5.8, *Panel Overlay*, below. The actual overlay is included in the Interface Design Package supplied by Discovery Bay Computing. The overlay is made slightly larger than the panel size itself. This will be trimmed after the overlay is glued to the panel.

Cut the overlay just outside the outer black portion of the print. Then, with the exacto knife, cut the white circles out of the four holes in the center of the panel. (PTT, Rx Drive, Tx Drive and the hole for the switch. Leave the mounting holes in the corners intact. The PTT hole is the only one that requires close care about cutting just inside the black portion of the border. This hole will be a friction fit on the LED, and is slightly smaller than the hole in the panel. The other holes will be covered by either the knobs or the switch washer, so any “ragged edge” will be covered by this hardware.

Once the overlay has been trimmed, do a sample fit over the aluminum panel. Align the panel and the overlay at the four mounting holes. The easiest way to do this is to use a sharp, round pointed tool like an awl pushed through each hole far enough to just fill the white portion of the hole. In a pinch, a ball point pen will work for this. Once the four holes are punched, they should drop right into the aluminum panel. Verify that the holes in the overlay are positioned over their respective hole in the panel. The only critical hole for alignment is the PTT Hole.

Before you apply the adhesive to the back of the overlay, build a jig to help keep the overlay in alignment while the overlay with adhesive on the back is being lowered onto the panel. A description of this jig is found in section 5.3.2.1 below.



**Figure 5.8 Panel Overlay**

**5.3.2.1 Overlay Alignment Jig** - this jig is a piece of 4” x 6” x ½” wood with 1” roofing nails inserted at the location of the each of the four mounting holes of the aluminum panel. If no wood is available, use a piece of cardboard.

To make the jig: Place the bare panel on a piece of wood, and drill holes in the wood at the location of the four mounting holes on the panel. Use a 1/8” drill. Keep the drill as vertical as possible. Turn the wood over and counter sink the holes on the bottom side so that a 1” roofing nail can be inserted through the hole and the head will be countersunk into the board. The nail head should stick out on the top side about a ¼ to ½ inch. With nails inserted in all four holes, turn the wood back to the original position and ensure that the plate is centered on the holes. Then take the overlay and slide it down over the nails. The “cylinder”

made in the overlay paper on the four mounting holes should just slide into the gap between the nail and the hole in the plate. When you are sure that the overlay and panel align properly, remove the overlay and apply adhesive to the back of the overlay with spray on contact adhesive, per the instructions on the can. Then slide the overlay along the nails and drop the overlay in place on the panel. Smooth out the overlay from the center toward the outside in case there are any bubbles in the surface.

A good adhesive is Elmer's "Craft Bond Multi Purpose Spray Adhesive". Other contact adhesives suitable for mounting photographs in albums will also work. Follow the instructions on the can. **DO NOT OVERSPRAY.**

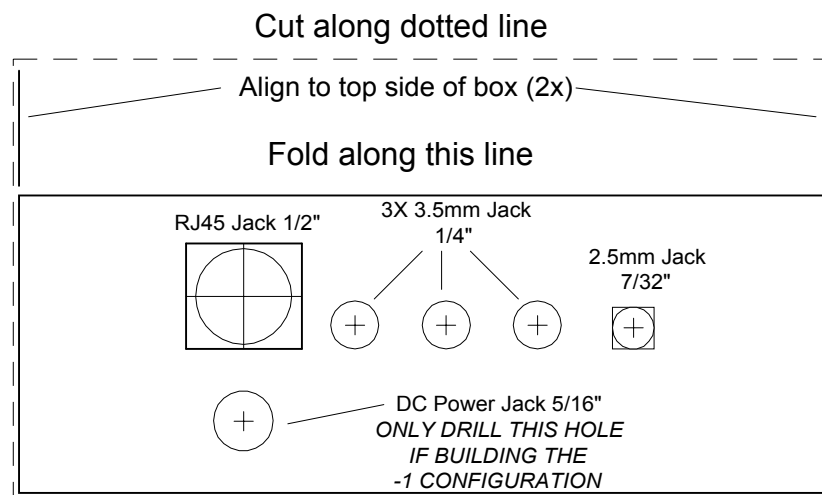
Let the completed assembly dry for a few minutes, then remove the panel/overlay from the jig and turn the panel face side down on a surface that you can cut on. Remove the excess overlay paper around the edges of the panel with an exacto knife. The panel/overlay should be ready for use at this time.

**Note:** if you are unsure about being able to apply the overlay with the adhesive on it, the overlay can be used without the adhesive, it will be held in place fairly well by the four mounting screws and the switch washer and nut.

## 5.4 Enclosure

The enclosure is a black plastic box, 4.1" W x 2.7" D x 1.6" H. Holes will be drilled and cut in the back of the box.

**5.4.1 Drill Template** - the drill template for the enclosure is show in figure 5.9, *Enclosure Template*, below. The drill templates are provided in the Interface Design Package from Discovery Bay Computing., where you can cut the templates from the sheet using scissors. Cut out the template along the dotted line. Fold the template along the top line, place this over the side of the enclosure. Line up the side edges of the enclosure with the lines at the top. Once aligned, tape the template to the box using clear tape. Mark the center of each hole to be drilled with a sharp pointed tool such as an awl, or the tip of the exacto knife. Next use the knife to score through the template on the lines of the square cutouts for the 2.5mm jack and the RJ45 jack. After this has been done, you can remove the template and proceed with drilling and trimming the enclosure. Note that the hole at the bottom left is only marked and drilled if you are building the -1 configuration. Be careful to drill the holes in the exact positions shown since they must align with the components of the circuit board.



**Figure 5.9 Enclosure Template**

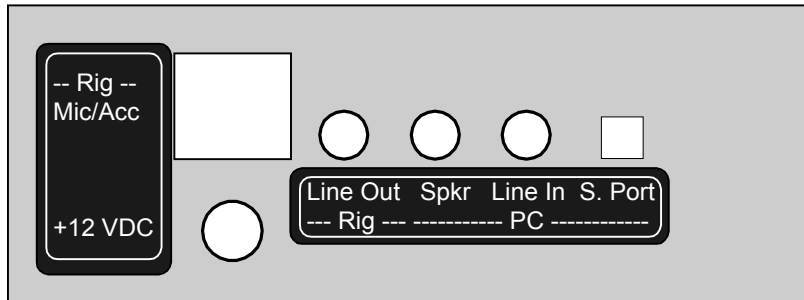
**5.4.2 Assembly of the Parts** - After the enclosure has been drilled and trimmed, and if you are building configuration -1, mount the DC jack attached by the pigtail to the printed circuit board in the back of the

enclosure. Next mount the PC board assembly in place, put the knurled nuts on the jacks on the back of the panel. Tighten the nuts down until they are snug.

Then place the panel/overlay on the top, over the assembled board, with the LED and the switch sticking up through the overlay. There is a washer for the switch that goes over the top, with a “nib” on one side that will go through the overlay into the small hole in the panel beneath. Next align the washer over the switch onto the panel, and push it in place. A small hole will be punched by the washer in line with the alignment hole below. Apply the nut on the switch, and tighten down until snug. Screw in the four mounting screws in the corner. All of these parts should be assembled before the legends are applied to the back of the enclosure.

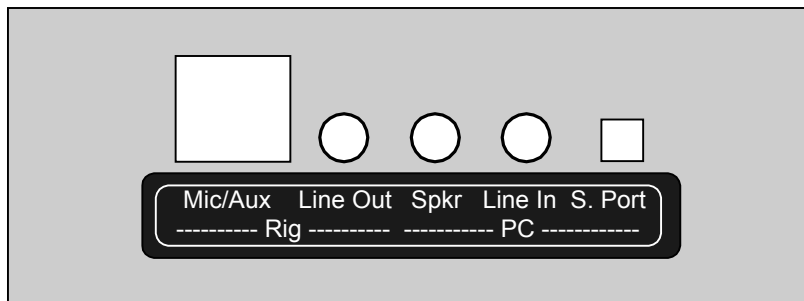
Next, apply the legend overlays to the back of the enclosure, as described below. In the drawings below, the enclosure is shown in gray. This is done to make the legends stand out. The color of the actual unit is such that the black of the legend blends into the black color of the enclosure.

**5.4.3 Legend Overlay Configuration -1** - reproduction of the legends for the back side of the enclosure as applied to the back of the enclosure is shown in figure 5.10, *Legend Overlay Installed on Back of Enclosure Configuration -1 (Relay)*. These legends should be cut along the black edges of the periphery with no white showing. Apply adhesive to the back of each legend. Align the Mic/ACC & +12v legend to the left of the RJ45 and DC Power jacks. Align the Line Out ... S.Port legend below the knurled nuts of the jacks. Smooth the legends when they are in place.



**Figure 5.10 Legend Overlay Installed on Back of Enclosure Configuration -1 (Relay)**

**5.4.4 Legend Overlay Configuration -2** - reproduction of the legend for the back side of the enclosure as applied to the back of the enclosure is shown in figure 5.11, *Legend Overlay Installed on Back of Enclosure - Configuration -2 (No Relay)*. This legend should be cut along the black edges of the periphery with no white showing. Apply adhesive to the back of the legend, carefully align it against the bottom edge of the round nuts on the phone jacks and smooth in place.



**Figure 5.11 Legend Overlay Installed on Back of Enclosure - Configuration -2 (No Relay)**

**6 Software Sources** - there are several sources for software to control digital modes using a sound card. Listed below are some of the popular current software offerings. The name of the program, the website where you can get free copies, log support, modes supported, the author, and comments about the software are listed below. For PSK31, the most popular software used today is Digipan, followed closely by Hamscope and Zakanaka. MixW is also gaining in popularity. New versions of these programs are released from time to time offering more features and better operation. Try several of these and decide for yourself which is right for your operation.

- Digipan**      <http://www.members.home.com/hteller/digipan/>  
Has an internal log which supports name & qth pop on subsequent qso.  
Has waterfall display that covers 4000 Hz  
Monitors two channels  
Modes supported: PSK31 (BPSK and QPSK)  
Written by KH6TY, UT2UZ, UU9JDR
- Hamscope**      <http://users.mesatop.com/~ghansen/>  
Supports YPLOG  
Has both waterfall and spectrum displays that cover 2800 Hz  
Monitors two channels  
Supports PSK31 (BPSK & QPSK); MFSK16; RTTY; CW  
Written by KD5HIO
- Helleschreiber**      <http://iz8bly.sysonline.it/>  
Internal log  
Supports PSK31 (BPSK & QPSK), Hellschreiber  
Written by IZ8BLY
- MMSSTV**      <http://www.geocities.com/mmhamsoft/>  
Internal log  
Supports SSTV  
Written by JE3HHT, who also wrote MMTTY
- MMTTY**      <http://www.geocities.com/mmhamsoft/>  
Internal log, supports name and qth pop on subsequent qso, has contest mode  
Supports RTTY  
Considered the best sound card implementation of RTTY available as freeware, both Hamscope and Zakanaka use the MMTTY engine for their RTTY modes  
Written by JE3HHT
- MixW**      <http://tav.kiev.ua/~nick/mixw2/>  
Internal log which supports name and qth pop on subsequent qso.  
Supports PSK31 (BPSK & QPSK), MFSK, RTTY, Hellschreiber, Throb, SSTV and many more  
Demo versions are available for no charge, but the registered version is a for fee product  
Written by UT2UZ, who also wrote Digipan
- Stream**      <http://iz8bly.sysonline.it/>  
Internal log  
Supports PSK31 (BPSK & QPSK), MFSK8 and MFSK16 modes  
Written by IZ8BLY
- WinPSK**      <http://www.qsl.net/ae4jy/>

Supports PSK31 (BPSK & QPSK)

Written by AE4JY.

This was one of the first Windows supported PSK programs, the “look and feel” design have been licensed for use on Hamscope and WinWarbler

**WinWarbler** <http://www.qsl.net/winwarbler/>

Supports PSK31 (BPSK & QPSK)

Monitors three channels

Written by AA6YQ

**Zakanaka** <http://www.qsl.net/kc4elo/>

Has excellent support of the Logger program written by the same author.

Supports PSK31 (BPSK & QPSK), RTTY (using MMTTY engine)

Written by K4CY

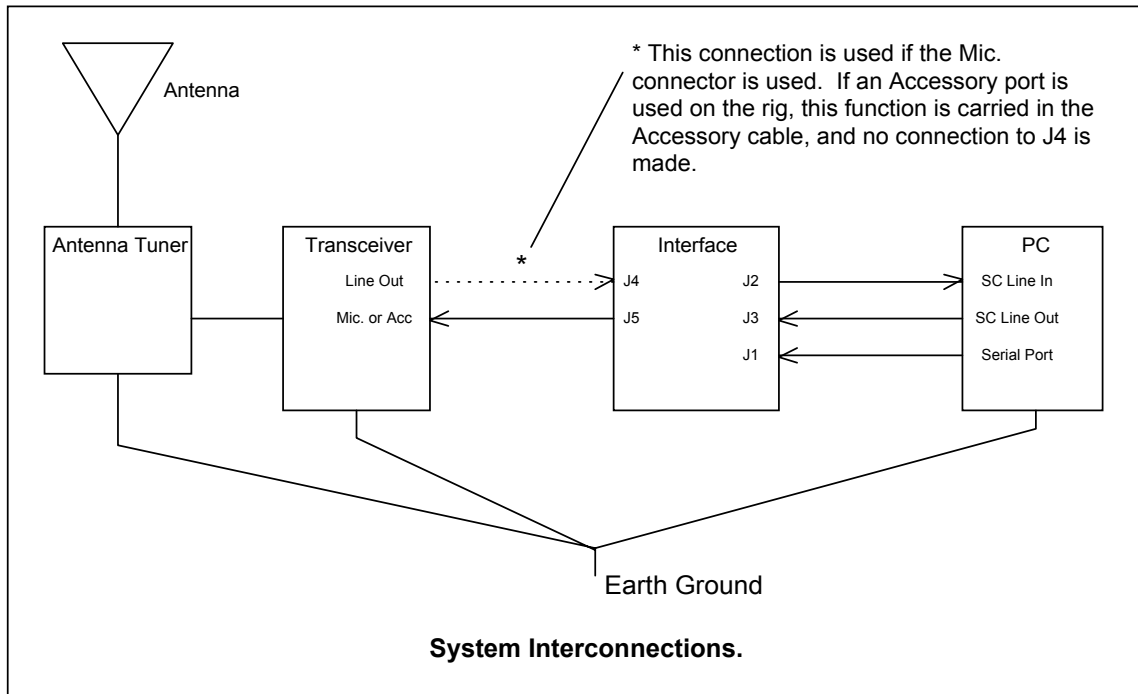
## 7 System Setup and Test

This section describes the procedures for setting up your system to run sound card applications. You should select one of the programs in section 6 to use for testing and setup purposes. The examples given below are for the Hamscope program. This program is chosen because it provides both a waterfall and a spectrum display for monitoring band activity.

**7.1 Load the Sound Card Program** - Load the program and select "Settings / General Setup" at the top of the screen. Enter your callsign in the callsign panel, and enter the COM Port Number of the Serial Port used for PTT control.

Before you hook up your interface and rig, try out the program to get familiar with the sounds coming from it and the operation of the macros. Later on, once you get familiar with the operation of the software, you will probably want to customize the macros for your own operation.

**7.2 Hook Up Your Rig** - At this time, be sure that you have good ground connections to your PC the SSB rig and the tuner. Now, hook up the rig, interface and PC as shown in figure 7.1 below. Put the PTT control switch on the interface to the "Off" (center) position for initial tests.

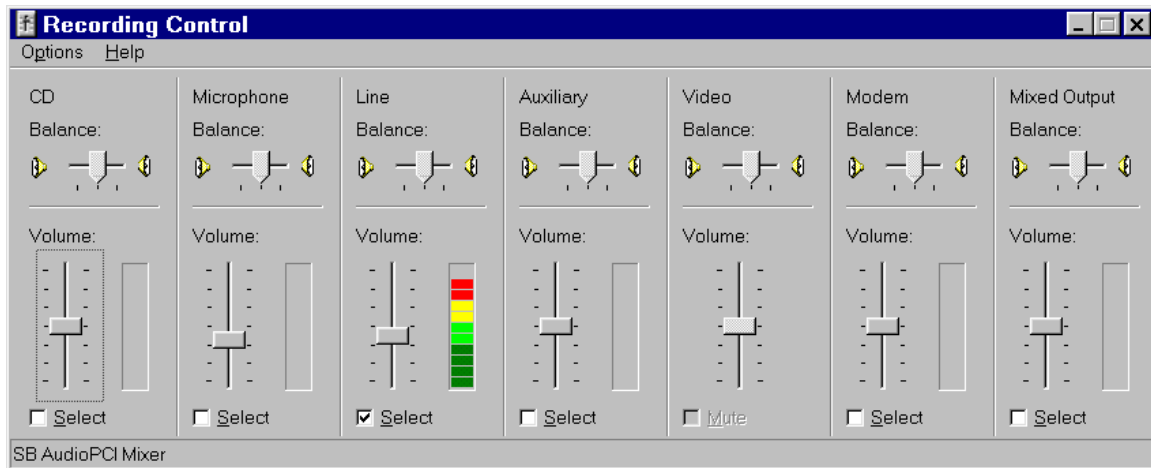


**Figure 7.1 System Interconnections**

**7.3 Receive Settings** - The next thing to do is to set up the Sound Card Receive control to receive sound only from the interface.

On the Hamscope window, go to "Settings" / "Rx Level Adjust" on the control bar at the top of the window. This will bring up a window to allow you to set up which sound sources will be selected for processing by the sound card. Select "Options / Properties", set it to "Adjust volume for recording" and then click on all sources shown at the bottom of the panel. Click on "OK" and you will see the sliders for all possible sources for the sound card input. Click "Select" ONLY on the

“Line” slider. This is the one that the interface is tied to. At this time, you can select “Options” again and unclick all of the sources except the Line In if you want to. Set the slider for about the middle of the range.



**Figure 7.2 PC Rx Volume Control Panel**

Set your SSB Rig to 14.070 USB (If your rig is LSB only, set it to 14.073 LSB). Listen for warbling tones on the frequency. If you hear tones, you should see signals on the waterfall display or the spectrum display. On the waterfall display, there should be a set of “tracks” going down the screen where a signal is being shown. You may need to adjust the Display Gain on the screen to see the signals. Set the Interface Rx Level Control knob to about mid range.

If you do not see signal activity on the screen, but hear tones, check your connections. If they are all right, take the interface card out of the box and look at the solder connections on the board to be sure that all connections are soldered, and no shorts are apparent. Also be sure that the rig is set up to send audio from the output connector you have selected.

When you see signals on the screen, set the AFC button on the Hamscope Receiver control and click on the center of the signal using the left mouse key. The top receive display should start printing data from the signal.

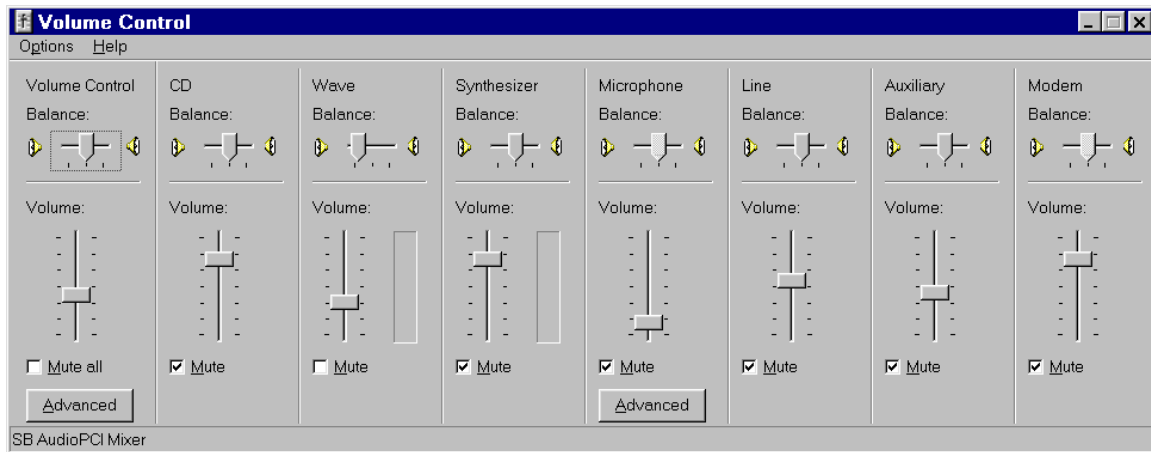
You may see a red warning on the waterfall to “Reduce Input Level”. This indicates that the signal is too strong, and nearing the maximum dynamic range of the Sound Card. Use the Rx Level knob on the interface to reduce signal level on input if necessary. The best setting for the Rx Level knob is just under the point where you get the warning message. This will keep the maximum signal coming into, but not overloading, the Sound Card.

Other controls that affect the receive level are the RF gain of the receiver, and the receive volume control slider on the PC. The RF gain of the receiver can be used to reduce level of the signal sent to the sound card. The best use of the RF gain is to reduce levels when you are copying a very strong signal on the waterfall. Reducing gain helps reduce some distortion when the signal is driving the AGC of the receiver. You will see in the next section, that the IMD measurement can be affected by these strong signals.

Take some time to monitor signals and get a feel for the style of QSO used on PSK31.

## 7.4 Transmit Settings -

**7.4.1 PC Tx Level Adjust** - Go to the Hamscope Screen, and select “Setting/Tx Level Adjust”. The volume control panel for the sound card volume control should appear. On that screen select “Options/Properties”. The Button for “Playback” should be set. In the panel at the bottom, click on all of the sources so you can view their settings. Click “OK”. The full Volume Control panel should appear, and should be similar to the view in figure 7.3, *PC Tx Volume Control Panel*, below.



**Figure 7.3 PC Tx Volume Control Panel**

**7.4.1.1 Mute Unused Sources** - Check the Mute box on each panel except the “Volume Control”, and the “Wave”, as shown in the figure above. Muting all but the intended active sources ensures that other signal sources within the PC (like the mike on your monitor) can not be mixed in the audio you are using to modulate your rig. Also, external signals (like RF) that enter the sound card on these channels will not be amplified and be sent to the output.

The two controls not muted are: Wave, the control for the output level of the signal created by the Hamscope program; and Volume control, the general output level control for all sources. The combination of the two determines the actual output level sent to the interface and the rig.

If you like, you can now go back to “Options/Properties” and unclick on the view selections for all but the Volume Control and the Wave Control. This provides a smaller window, viewing only the activated sources.

**7.4.1.2 Set the initial PC audio level** - Set the sliders on volume control to the positions shown in figure 7.2. Volume around half, Wave around one third.

**7.4.2 Getting Ready to Transmit** - at this point you are ready to try transmit controls.

**7.4.2.1 Reduce the rig power level and connect to a dummy load** - It is a good idea to use low power and transmit into a dummy load during initial tests. Connect the transmitter to a dummy load, and set the output level control to around 5-10% of maximum.

**7.4.2.2 Set the transmitter frequency** - Set the transmitter frequency to USB, 14.070 MHz. The actual transmit frequency will be the combination of the SSB rig frequency (14.070), plus the audio tone created by the software (in the range of 200 to 2500 hz). The audio frequency is set by clicking on the waterfall at a particular audio frequency. If you are connected to an antenna, choose a point that doesn't have a signal on or near it.

**7.4.2.3 Transmit Audio offset should be between 800 and 2100 Hz** - The waterfall shows signals from about 200 Hz to 2800 Hz above the frequency set on the rig. When you transmit, you should limit yourself to a tighter range, using offsets between about 800 to 2100 Hz. There are two reasons for this. First, your rig has a transmit audio passband that rolls off around 2100 Hz. Operating above that point will cause distortion. Second, don't go too low, as the passband filter starts to roll off on the low end too. To work signals outside this range, move the rig frequency to get the desired signal in this limited range. Some software, like Digipan, has a waterfall width of about 4000 Hz, so be careful.

Some good news: There are some special single board transceivers built for PSK31 use which have a wider passband, so check your manual to determine your particular rig's width. There are also some general purpose rigs, like the Pegasus, which have output audio passband which can be set up to 3900 Hz.

**7.4.2.4 Set the Initial Transmit Level controls** - Set the Tx Level knob on the interface to full CCW. Leave the PTT switch on the interface to the "OFF" position. Set the rig mic gain to about 20%. Set the PC TX Volume control and the Wave control to about 50%.

**7.4.2.5 Set the Audio Monitor Level** - Now, click on the big "RX" button on the Hamscope screen. It's legend should change to "Tx". Normally you would be transmitting now, but we left the PTT control in the OFF position so everything is being performed except actually keying the rig. This lets you set up your monitor level without actually transmitting. You should hear a tone coming out of the PC speaker. It is probably too loud. Click on the "TX" button to turn it off.

Next, disconnect the left channel speaker on the PC, and go back to the Tx Level Adjust window in Hamscope's "Settings". At the top of the Wave panel, there is a Balance slider that goes left / right. Slide the pointer to the left. This is an "attenuator" control for the speakers. Sliding it to the left attenuates the right channel, while leaving the left channel at full output. (The left channel is where your interface is connected). Turn on the "Rx" button again, and adjust the level of the tone in the speaker by moving the slider to the left until it is at the level you like. This is the advantage of using only one channel from the sound card. Click on the "Tx" button again to return to Rx mode.

**7.4.2.6 Test the PTT** - At this time, you should check that the PTT of the rig is operational. Move the Interface PTT control switch to the "On" position. You should see a transmit indication on the rig. Now, move the switch back to the "Off" position. The rig transmit indication should go off.

Now you are ready to actually try transmitting a signal to the dummy load. Put the interface PTT control switch to the "Auto" position, and click on the Hamscope "RX" button again. You should see several things. The PTT LED on the interface should come on, and the rig TX indicator should come on. The interface Tx Level knob has been turned to the lowest position, so there should not be any power showing on the meter of the rig or antenna tuner. Now rotate the knob clockwise toward the half way position. You should see the power level increasing up to the level you set the output gain control. The final step will be to get the right settings for the PC Wave level, and the microphone gain on the rig, such that the power is at the "normal" level when the interface knob is at the half way (straight up) position. Return the Interface Tx Level control to full CCW. Turn off the transmitter by clicking on "TX" button.

**7.4.2.7 Power settings** - A word about power settings. Your rig has been rated for SSB voice or CW operation, which run duty cycles of 50% or less. The digital modes are transmitting at nearly 100% duty cycle so you should not run your rig at more than one half the "rated" power level. If you have a 100 watt transceiver, run it at 50 W peak or less. Also, the PSK31 signals have multiple frequency content because of the modulation system. The audio path MUST be operated in the linear range when running PSK31. This means that you can NOT use the

compression system, if you have one, and you should not operate at levels that use the ALC (automatic level control),

**7.4.2.8 Adjust the Mic Gain and the Wave level** - Move the Tx level knob back to CCW, and turn the output level control of the rig to 100%. From this point forward, you will be adjusting the power output level with the interface Tx level knob. Turn on the transmit signal with the Hamscope "RX" button again and slowly move the knob back toward the half way point. Use the peak reading setting on the power meter of the tuner or rig. Do not adjust the power above your half power point. If it is reached before the knob is at half way, reduce the mic gain on the rig until the knob can be set at straight up, producing one half rated output power. If you cannot reach the half power point when the knob is straight up, increase the audio level from the PC Wave control to bring it into range. The object here is to get the mic gain and the PC Wave gain settings to the point where there is adequate "head room" on the interface Tx level knob. Once you have the levels adjusted, turn off the transmitter by clicking on TX button on the Hamscope screen. You are now ready for your first QSO.

**Note:** Once the mic gain and pc audio level settings are set up, write them down so you can set them there again if they get moved. All Tx level setting done in normal operation is done with the knob on the interface. You will find that the output power at a particular knob setting will vary from band to band, and sometimes within the frequency range of the audio waterfall. That is the beauty of having the knob control on the interface - you will not have to change the mic gain or the PC Wave level very often, if at all.

**7.4.3 Your First QSO** - When the settings are finalized, you are ready to try your first qso. You will use observations by other hams to determine the quality of your signal, and to help in any fine tuning of levels. This section will help you understand what they are reporting and what you can do if they see a problem.

**7.4.3.1 Tune up away from other stations** - Tune up the transmitter to your antenna at a frequency on the waterfall that is not near an occupied spot (more than 100 Hz away)

**7.4.3.2 Look for a CQ** - You will find that hams operating PSK31 and other sound card modes are very willing to welcome and help newcomers to the mode. You will be doing the same yourself, very soon! Look for a signal that is reasonably strong calling CQ. Double click on the CALLSIGN in the receive window. It will be copied to the "Call" field at the top left of the Hamscope screen. When you click on the "Call" Macro button to call back, it will use the value in the "Call" Field in the macro, along with your own callsign that you entered in the general setup at the beginning.

This is what should happen. When you click on the macro, it will turn on your rig, send the CQer's call sign, put in your call sign, and then turn your transmitter off. If the macro does not turn off the transmitter after everything is set, click on the "TX" button to revert to RX mode. Some macros have not been set up to return to RX mode at the end. You should fix those macros by adding <RX> at the end of the macro.

**7.4.3.3 Getting an IMD report** - If you are lucky, the called party will come back to you and you are on your way. After your normal greetings, ask "what does my signal look like" and ask for an IMD report.

**7.4.4 The IMD Report** - IMD (InterModulation Distortion) measurement is a standard way of representing the quality of a PSK31 signal. It is part of most of the software packages, including Digipan, Hamscope and others. It is measured when your system is IDLING (no typing, buffer empty). Idle generates a two tone signal 31 Hz wide centered on your audio "carrier". The receiving station software then looks at the harmonic at 62 Hz and measures the signal level there. The drop in signal between the fundamental and the harmonic is the IMD measurement, represented as a negative dB number. A good signal will have the harmonic 24 dB down (-24 dB

on the display) or more. Acceptable signals can run down to -18 or -20 but you should strive for -24 or better. Really clean stations run at -30dB or better. A bad signal will be around -10 to -12 dB. You will learn to recognize them because you will see "sidebars" on the waterfall or spectrum display.

If the report is "clean", say around -24dB, you are done with your set up. If your report is poor, you might try reducing power a bit, say from half power to quarter power and see if the IMD goes up.

If you do get a low IMD number, but the report is that you "look pretty good", it may be that there is a problem in the IMD measuring system. Low level signals operating near the noise level will have poor IMD measurements. So will signals that are very strong (S9 or more) if the receiving party has not reduced their RF gain to inhibit their local AGC action. Get reports from several hams until you are satisfied that you have a clean station.

Other problems that can be reported are: spurs of your signal a few hundred Hz above or below your main signal; signals about 120 hz apart (hum) on your signal; broadband noise in the band when you are transmitting. These problems and their cures are covered in section 7.5.

If you have a good ground, are using shielded cable, have low levels of RF in your shack, are using an isolating interface, and have followed the setup procedure above, you should be getting good reports. Enjoy these modes and good DX!

## 7.5 Common Problems and Their Cures

In spite of your best efforts, sometimes there may be quality problems with your signal. This section describes common problems and offers some cures for them.

**7.5.1 Spurs on Your Signal** - this is characterized by a signal appearing several hundred Hz above or below your signal when you transmit. It may have data on it and oddly, it is the same data that you are transmitting! This is a spur or harmonic of your modulated audio carrier appearing in the output audio passband of your transceiver. It may be caused by:

- Your compression being ON - turn it off.
- Your Tx audio signal level being too high - reduce the drive level.
- Your transmitter RF output being set below the level you would normally transmit at if the RF gain had not been reduced. Turn it up higher and control your level with the Interface Tx Level control instead.
- Non-linearity in the audio path of your transceiver. Try changing the mic gain setting to see if there is a level which works better.
- The reporting station has an improperly set up receiver. If the signal is strong, and the receiving station is using a tight filter, spurs can be generated in his receiving equipment. The receiving station should reduce the receive RF gain and go to a broader receive filter to check this.
- You are operating outside of the audio passband of your transceiver. See section 7.4.2.3.

**7.5.2 Hum on Your Signal** - characterized by signal appearing 60Hz or 120Hz apart as viewed on the observing parties waterfall whenever you transmit. It may be caused by:

- Poor shielding on your audio cables - are they really shielded?
- Poor grounding of system components. Check system grounding.
- RF Feedback getting into your Sound Card - modify your audio cables as described in 7.6 below.

**7.5.3 Wideband Noise on Your Signal** - as seen on the observers waterfall. Appears when you transmit. Your IMD and actual signal may be fine, but there is all this NOISE being generated too! It may go away when you reduce your drive level.

- RF feedback getting into your system. Use an isolated interface like the one described in this document.
- RF feedback getting into the sound card Line In (or other slot) and being amplified. Filter your cable as described in section 7.6 below.
- RF feedback getting into the sound card through other inputs - deselect all sources for the Rx level control on the PC as described in 7.3.1 above and mute all sources for output as described in section 7.4.1 above.
- Reduce RF levels in the shack by using coax from the tuner to the antenna.

**7.5.4 Other Strange Audio Being Produced by Your Signal** - these sounds may be recognizable, like music or voices from the shack, or strange audio tones moving up and down the band, or PC sounds like Windows alerts.

- Voices, music or other sounds from the shack is getting into the mic of the transceiver. Some rigs have their microphone active when using the accessory port. Disconnect the microphone.
- Another microphone is on your PC, sometimes mounted in the monitor. Mute the sources as described in section 7.3.1 and 7.4.1 above.
- Weird tones moving around like a slow sawtooth oscillator are caused by RF getting into unused inputs on the Sound Card. Section 7.3.1 and 7.4.1 again.

**7.5.5 Break Up of Your Audio When Transmitting** - gaps in your transmitted signal when sending data. You may also notice that the PTT light goes on and off while transmitting.

- Other programs on your PC are stealing too much time from the sound card program. De-activate the other programs, or get a faster PC
- Bad connections in the interface, check soldering on all joints on the circuit board.
- Bad connections in the audio cables or in the rig control cable
- Transceiver problems

**7.6 Filtering the Audio Cables** - most problems which are RF related are cured by using the isolating interface described in this design document, using shielded cables and grounding the system properly. But there are some tough environments that still manage to get RF into the sound card system through the "Line In" cable.

Some success in curing this has been found using ferrite beads on the audio cable just before it plugs into the sound card "Line In", Same idea works on the audio line going into the rig too. Two sources for ferrite beads are Amidon and Palomar-Engineers.

Amidon	<a href="http://www.amidoncorp.com">www.amidoncorp.com</a>
Palomar-Engineers	<a href="http://www.palomar-engineers.com">www.palomar-engineers.com</a>