

# PSK31

A Handbook for PSK31 Users,  
complete with dozens of transceiver  
to PC sound card interface diagrams.

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Buck Rogers K4ABT

## IT'S A "RAVE:"

To speak of it any other way, or in any manner other than; *It's a rave*, would be understating its presence and impact on the world of hobby communications. PSK31 is sweeping through the SWL and Amateur Radio ranks like a brushfire. Not since the early days of FM repeaters has any mode inspired so much interest in HAM radio and short wave radio monitoring than PSK31.

If you have a short-wave receiver that supports single-sideband reception, and a PC (486/100 MHz or above) equipped with a Creative Labs™ compatible SoundBlaster (SB16 or later) sound card, then you have the ingredients to receive PSK31.

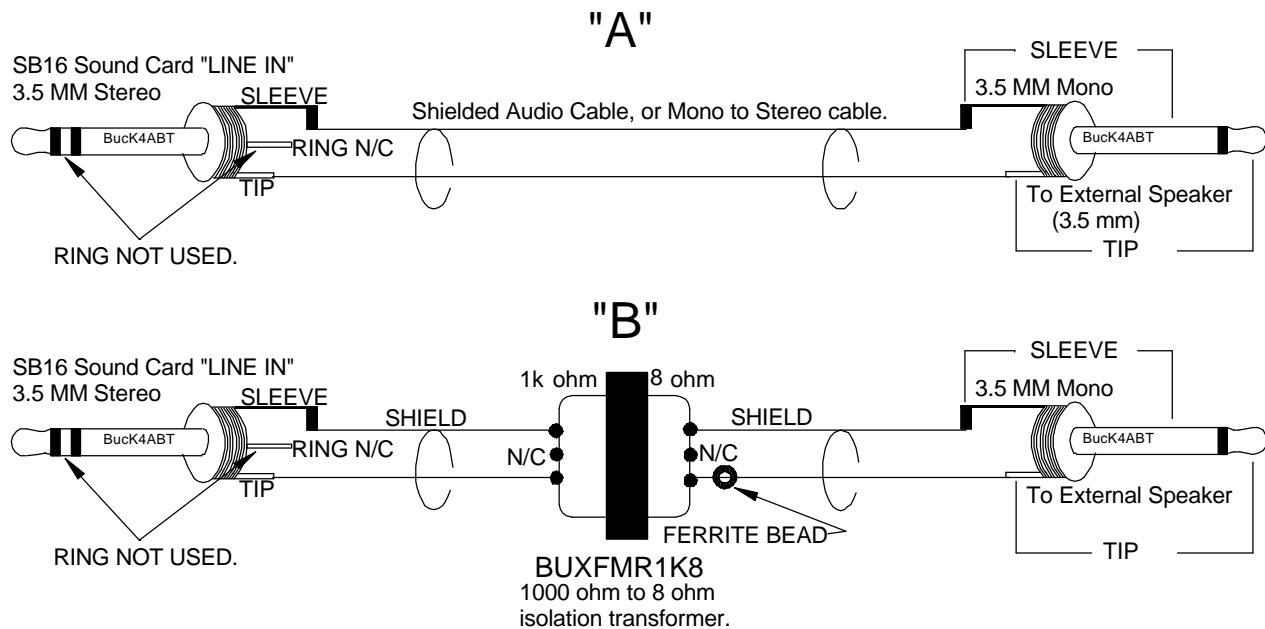


Figure 1

At *figure one*, I've drawn a very simple and basic interface diagram that makes receiving PSK31 easy for anyone with the two basic items I've listed above. You'll need the FREE software which I'll talk about later in the text, but first, I need to explain what PSK31 is.

## What is PSK31?

As the name implies, PSK (phase shift keying) modulates the phase of a carrier, and the number "31" references the actual bandwidth (31 Hz) occupied by the PSK31 signal.

The software that implements PSK31 with a Windows PC and soundcard is a program written and developed by *Peter Martinez G3PLX*. Two of the most significant features that make this the ideal mode for digital communications is the extremely narrow band width, and the fact that it is highly immune to noise and QRM.

Up front, phase modulation has more advantages than (morse code), CW. CW uses amplitude (On/Off) keying. In a noisy or distorted propagation environment, the amplitude of a signal will shift and vary much more than the phase of a signal. When compared to CW, PSK31 is a much more resourceful, and robust operating mode.

The baud rate used by PSK31 is 31.25 baud. This is fast enough to handle most operators manual typing capabilities, a speed of about 50 words per minute. It is intended as a means of keyboard to keyboard communication between two or more operators (oh happy day, we're talking to each other again), using a very small amount of frequency spectrum.

By comparing the small bandwidth of PSK31 and measuring its gain against a CW filter of 500 Hz;  $10 * \log(500/31)$  dB = 12 dB, quickly reveals that a CW transmitter must put out 15 to 18 times more power than a PSK31 transmitter, just to achieve the same signal to noise ratio at the receiving station. This is the reason the PSK31 operating mode has gained so much popularity in such a very short period.

The end result is that a PSK31 station can operate with reduced power and smaller antenna installations. As an example; My 20 meter, 14.073 MHz, antenna, is located in the attic of my garage (about 14 feet above ground), and my DX70H runs around 35 watts output.

Now comes the real tease, just for the DX hounds among us. In the last three months, I've work over 75 countries, and each morning I spot a new one that I have not yet worked. It gets better! For some reason... I think it's because PSK31 is so much fun..., I'm finding more DX stations on PSK31 than I've ever encountered on SSB and other modes combined. At any given moment, day or night, it appears that 20 meters is always open.

Twenty meters is not the only band that has PSK31 activity, but it is a good place to start when you first begin operating PSK31.

#### **AND, IT'S ALMOST FREE:**

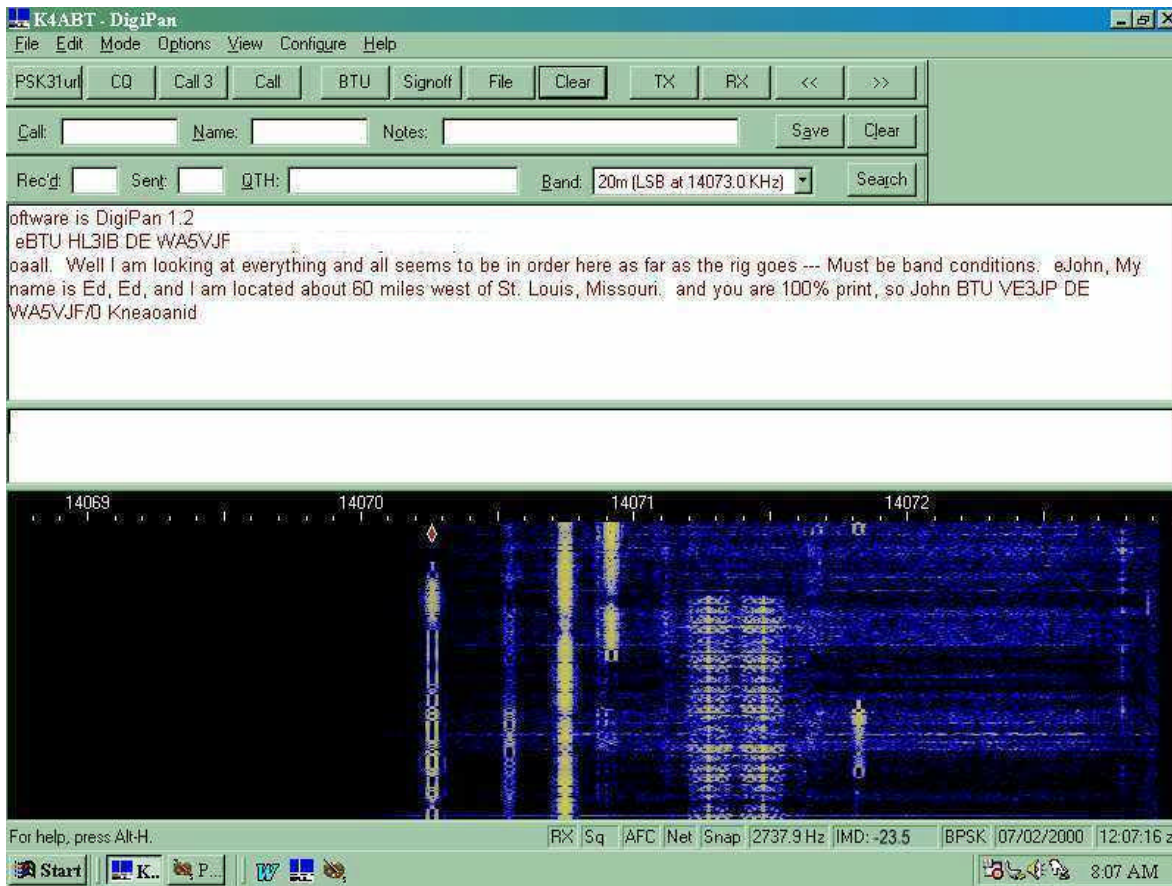
When the prospective PSK31 user discovers PSK31 for the first time, a look of both extreme pleasure, and amazed disbelief appears on their face. WOW, we've just discovered a mode that is so much fun, yet, it's almost FREE! After a few days of operating PSK31, the internet becomes obscured in the mist of all the fun we're having "doing" PSK31.

Nope, we don't have to purchase a special terminal controller, no special radio, no heavy outlay of cash, and all you have to do is obtain a copy of the "FREE" PSK31 software from the author of PSK31, Peter Martinez G3PLX.. at; <http://aintel.bi.ehu.es/psk31.html>.

Another site that offers a great PSK31 program (also FREE) is:

AirLink Express: <http://www.airlinkexpress.org/download.html>

I'll go into more detail later about the use of DigiPan II and how we interface our computer sound card and our transceiver. For now, take a moment to preview a screen shot of DigiPan 1.2, at **photo "A"**.



**Photo "A"**

Yes, there are a large number of PSK31 programs that support the PC, LINUX, and the MAC. We'll also cover them later in this article.

### **KUDOS ARE DUE THE AUTHORS OF PSK:**

Before I get into interfacing our HF transceivers and the sound cards, I would be remiss if I didn't give credit to the author(s) of PSK.

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*Here, in his words is the background and the PSK31 philosophy, of and by **Peter Martinez G3PLX**.*

PSK31 is the result of my belief that the present batch of "data" modes have left a gap in amateur radio operating, the gap that was previously filled by AMTOR or even traditional RTTY, in which two or more operators chat to each other on an open channel. Modes such as packet radio, Pactor, and others, are highly complex, are unsuited to multi-way conversations, and in particular, the long block lengths introduce an unacceptable delay in the processing of text such that even normal conversation is unpleasant and quick-break question/answer sessions are impossible.

The move to automated unattended message forwarding has left a gap in the person-to-person communication field, and PSK31 is an attempt to remedy this situation with a simple but efficient code structure coupled with the narrowest possible bandwidth, and with only enough error-correction to match typical typing-error rates, and with no time-consuming synchronization, changeover, and ARQ processes.

The 31 baud BPSK modulation system used in PSK31 was introduced by SP9VRC in his SLOWBPSK program. Instead of the traditional frequency-shift keying, the information is transmitted by patterns of polarity-reversals (sometimes called 180-degree phase shifts).

This process can be thought of as equivalent to sending information by swapping-over the two wires to the antenna, although, of course, the keying is more usually done back in the audio input into the transceiver. A well-designed PSK system will give better results than the conventional FSK systems that amateurs have been using for years, and is potentially capable of operation in much narrower bandwidths than FSK. The 31 baud data rate was chosen so that the system will handle hand-sent typed text easily.

There is a problem with PSK keying which doesn't show up with FSK, and that is the effect of key-clicks. We can get away with hard FSK keying at moderate baud rates without generating too much splatter, but polarity reversals are equivalent to simultaneous switching-off of one transmitter and switching-on of another one in anti-phase: the result being key-clicks that are TWICE AS BAD as on-off keying, all other things being equal.

So if we use computer logic to key a BPSK modulator such as an exclusive-or gate, at 31 baud, the emission would be extremely broad. In fact it would be about 3 times the baudrate wide at 10dB down, 5 times at 14dB down, 7 times at 17dB down, and so on (the squarewave Fourier series in fact).

The solution is to filter the output, or to shape the envelope amplitude of each bit which amounts to the same thing. In PSK31, a cosine shape is used. To see what this does to the waveform and the spectrum, consider transmitting a sequence of continuous polarity-reversals at 31 baud. With cosine shaping, the envelope ends up looking like full-wave rectified 31Hz AC. This not only looks like a two-tone test signal, it *IS* a two-tone test signal, and the spectrum consists of two pure tones at +/-15Hz from the center, and no splatter. Like the two-tone and unlike FSK, however, if we pass this through a transmitter, we get inter-modulation products if it is not linear, so we DO need to be careful not to overdrive the audio.

However, even the worst linear will give third-order products of 25dB at +/-47Hz (3 times the baud rate wide) and fifth-order products of 35dB at +/-78Hz (5 times the baud rate wide), a considerable improvement over the hard-keying case. If we infinitely overdrive the linear, we are back to the same levels as the hard-keyed system.

There is a similar line of reasoning on the receive side. The equivalent to "hard-keying" on the receive side is a BPSK receiver which opens a gate at the start of a bit, collects and stores all the received signal and noise during the bit, and then "snaps" the gate shut at the end. This process gives rise to the receive-side equivalent of key-clicks, namely side-lobes on the receiver pass band. So, although this "integrate-and-dump" method is 100% efficient in the task of sorting out signal from noise, it will only reject signals by 10dB at 3 times the baud rate wide and so on, the same spurious rejection figures that we got as spurious emission figures for the transmit side.

The PSK31 receiver overcomes this by filtering the receive signal, or by what amounts to the same thing, shaping the envelope of the received bit. The shape is more complex than the cosine shape used in the transmitter: if we used a cosine in the receiver we end up with some signal from one received bit "spreading" into the next bit, an inevitable result of cascading two filters which are each already "spread" by one bit.

The more complex shape in the receiver overcomes this by shaping 4 bits at a time and compensating for this inter-symbol interference, but the end result is a pass band that is at least 64dB down at +/-31 Hz and beyond, and doesn't introduce any inter-symbol interference when receiving a cosine-shaped transmission.

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My thanks and with credits to Peter for permission to reprint his PSK31 philosophy here.

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## THE QUICK BROWN "VOX"

For this discussion, we will NOT consider using the VOX (voice operated relay) circuits in our transceiver to control PSK31 changeover from transmit to receive and vice versa. Especially since most of us have a spare or extra serial comport(s) that we can use to do the same thing, and without having the transceiver hiccup a transmitted signal every time the sound card burps. As you will soon see, there is an easier way to handle the push-to-talk (PTT) function in PSK31.

### ATTENUATOR; YES OR NO:

Yes, we should consider the use of some level of attenuation either into the sound card or out of the sound card into the transceiver. I think the easiest way to approach this is to understand first that modern day transceivers are designed for inputs into the transceiver for SSB, FM, AFSK, RTTY, and in some cases, SSTV. We should maintain the levels similar to those we normally use when using a microphone.

Since many transceivers that we will be using are beyond ten (10) years since their purchase, some of us will be using the microphone port for our PSK31 input. If this is the case, and you plan to drive the microphone with your sound card (LINE OUT), then the level from the sound card should be comparable to the output level of your microphone.

But I've already said that haven't I? YES, I have, but I want to stress a point. In this case, we will need to employ padding of about 40 DB. I refer to these attenuators as "pads." This term comes from a time when we referred to it as "padding the signal down." For the new HAM, padding down of a signal can reference either audio or radio frequencies (AF / RF).

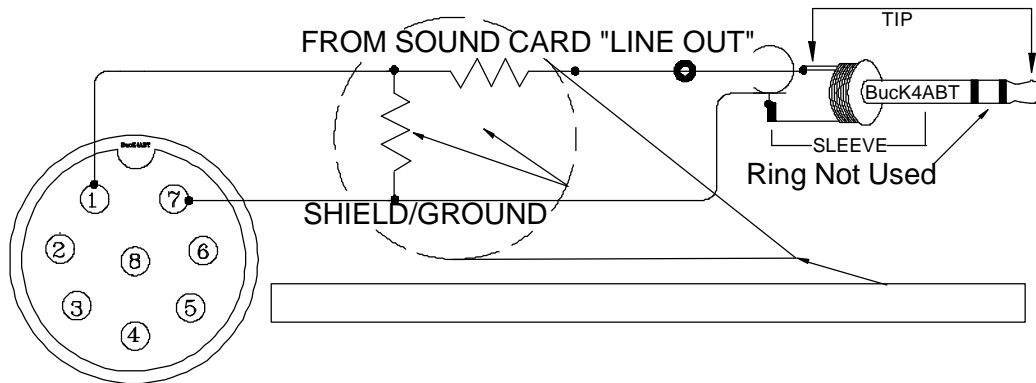


Figure 2

To keep it simple, I've drawn an attenuator "pad" at *figure two*. Again, it is a device that is simple to build since it employs only two resistors. Unless your sound card is a slam-dunk'n, speaker popper, you should be able to get by with quarter watt sized resistors.

While many sound blaster™ compatible sound cards have the capability to be set for high or low level outputs, they are almost always providing outputs which are much too high for the input level to the microphone port of our transceiver.

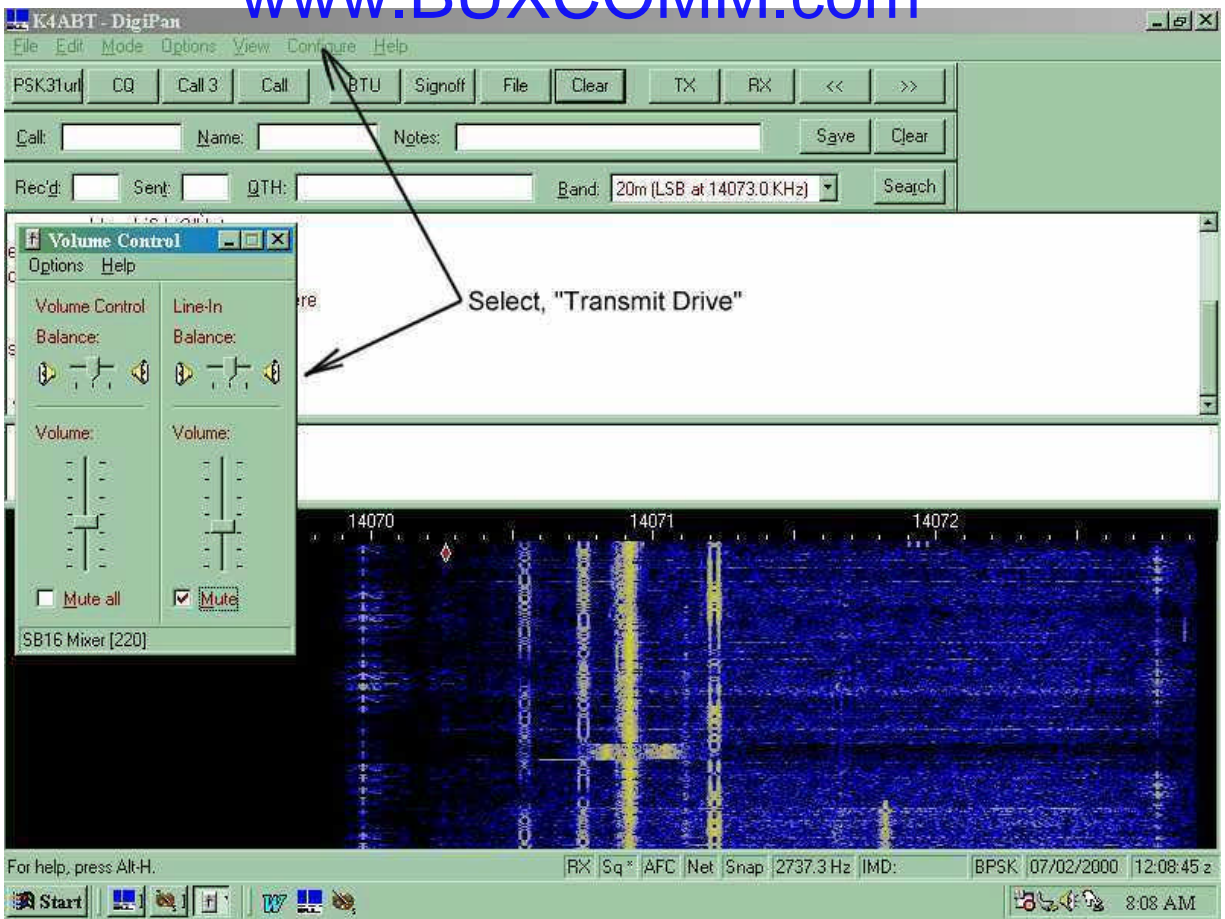


Photo "B"

If you cannot use the sound card "Control Panel" in Windows (or DigiPan, see **Photo B**) to decrease the output level of your sound card to meet the level requirements of your microphone input, then you are about to construct the resistive attenuator shown at **figure two** to reduce the LINE OUT level to your transceiver MIC port. The idea is to keep your signal at a low enough level to have a clean PSK31 signal on the air.

With PSK31, the first thing I do is set my transceiver for normal single side-band (SSB) operation. I turn off any speech processing and after I have the microphone level properly set for PSK31, I don't change this setting again.

All future levels are set into and out of the sound card using the volume and wav controls built into the sound card "control panel" software. In DigiPan II, these controls are easily accessed from the task bar at the top of the screen. Simply click on "configure" and use the "Transmit Drive" (**Photo B**), command to properly drive the transceiver so that *no ALC action* is observed. This is how I avoid causing phase distortion or overdriving the inputs of my transceiver.

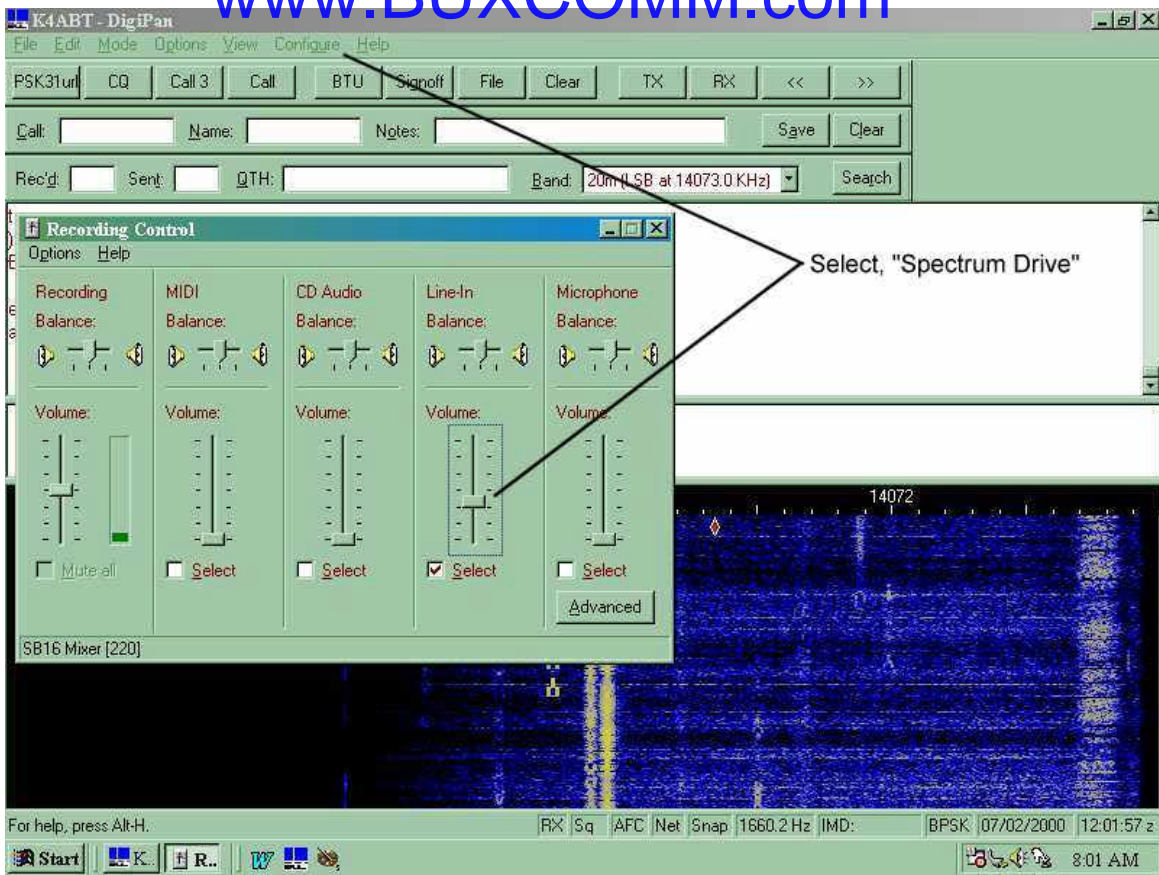


Photo "C"

Similarly, you can use the DigiPan II "configure" Icon on the task bar and select "Spectrum Drive" (**Photo C**) to set the *receive* level to the sound card **LINE IN**.

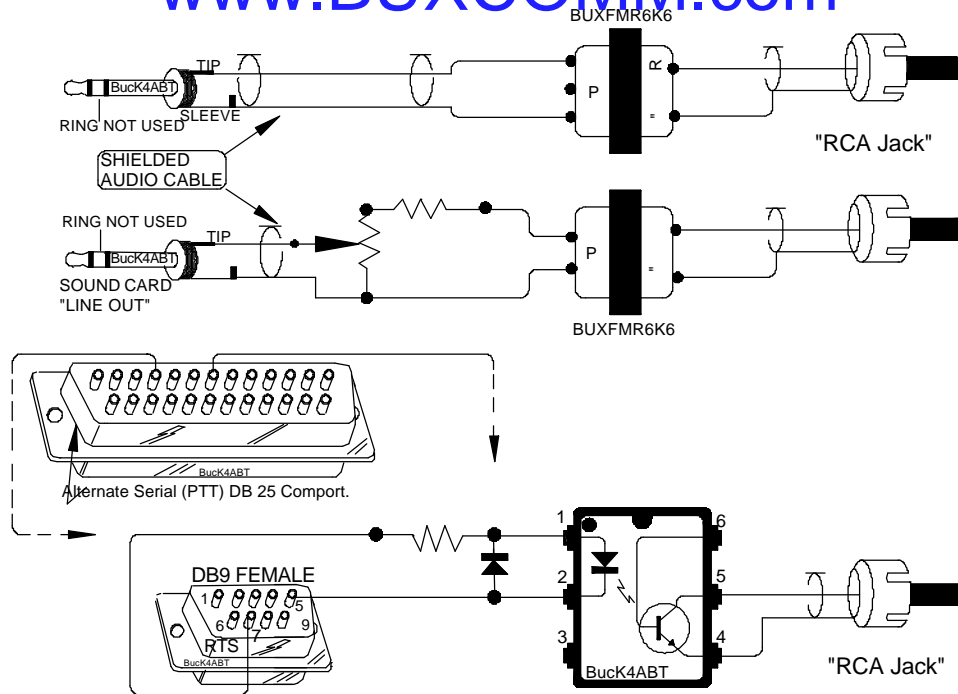
While we're discussing sound card I/O levels, in case of feedback (usually "motorboating"), which may be caused by the common ground of the soundcard input and output, "MUTE" the "line in" ON THE "VOLUME CONTROL" panel under Windows or in DigiPan configure/transmit/check 'Mute'. This change will stop the sound in your PC speakers, but it may also stop the motor-boating of your PSK31 transmit signal.

Let me say it again, in another way, so the message is well understood. The Microphone and Line inputs on the Volume Control panel, controls the SOUND to the speakers (not the spectral display) and muting these inputs will render no sound (receive) from the computer speakers, but the *transceiver* speaker can still be used to audibly monitor the PSK31 signal if you so desire.

If you are using the external speaker jack for receive audio to the sound card, then a 3.5 MM plug and two-jack splitter may be required to feed both an external speaker and the sound card. This is because the internal *transceiver* speaker will be muted by the closed-circuit (opened) jack.

### LET'S GET BUSY:

In figures 3, 4, 5, 6, and 7, I've drawn several full blown interface drawings and diagrams for specific makes and model transceivers. Please notice that in most of the diagrams, I've use transformer coupling for both transmit and receive audio paths/signals. In addition, I've used opto-coupling devices to further isolate and prevent any RF from reaching the transceiver input or the sound card LINE IN or LINE OUT ports.



(TIP)  
As a starting point, go into the sound card parameters and set "LINE OUT" half open, and set "LINE IN" half open.  
Ten-Tec OMNI series "Patch IN, Patch OUT, and PTT" ports to PC Sound Card for PSK31 mode.

**Figure 3**

If you are taking the constant level output of audio from your transceiver and driving the sound card then you can rest assured you need to be very critical of levels into the sound card. Read your transceiver manual as it should tell what the levels are at the various inputs and output jacks.

**READY, SET, PSK31:**

As an author of many books and magazine columns for the past 40 years, my typing speed is fluent at 60 to 70 words per minute. My point is that I am hard pressed to keep up with the speed in which PSK31 handles my typing speed to the target station. It's not uncommon to read most stations at 30 to 50 wpm.

PSK31 offers us plenty of fun and so far, it's been a "rush" for me. In my 50 years as a HAM, this mode is the most seductive of them all.

Download the program and connect only the sound card LINE IN, to your HF transceiver external speaker port and tune to 14073.00 LSB and watch the waterfall screen for vertical, yellow, scrolling, PSK31 signals. It won't be long before your back at this page, looking up the transceiver to sound card interface diagram so you can begin full operation with PSK31.

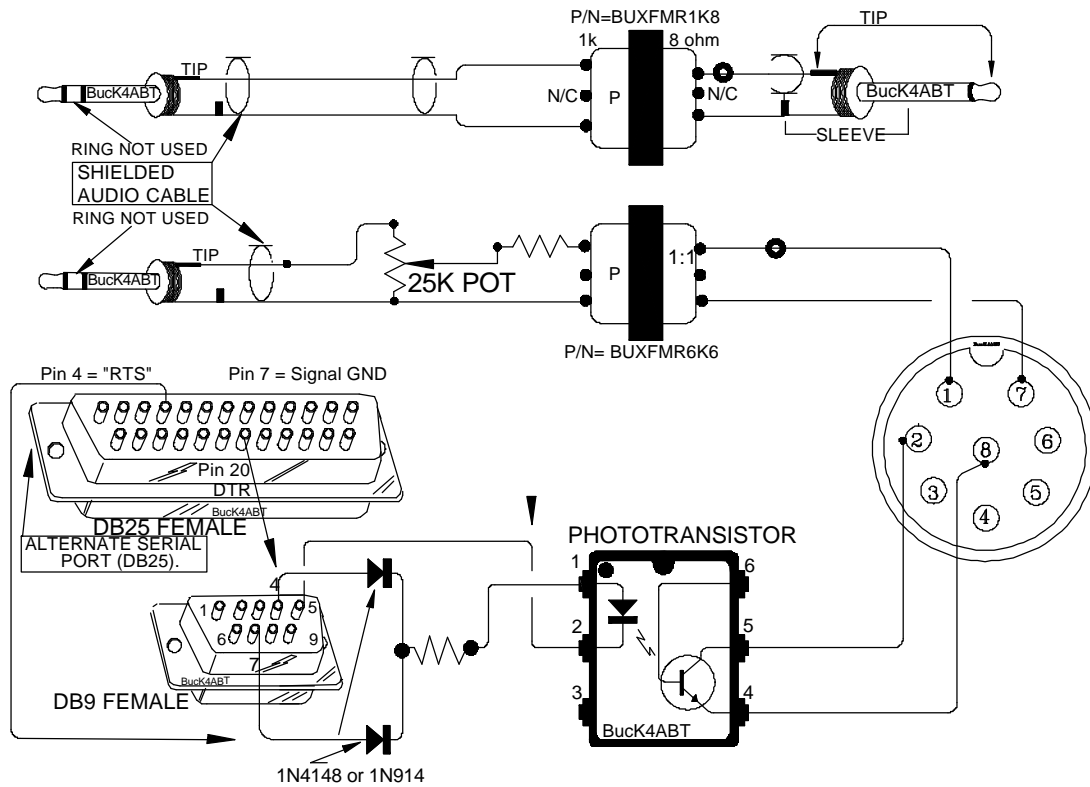
*The following is a list of frequencies (in kHz) where you may find more PSK31 activity are:*

- 1838.150**
- 3580.150**
- 7035.150**
- 10140.150**
- 14070.150**
- 18100.150**
- 21080.150**
- 24920.150**
- 28120.150**



Because I am most familiar with the DigiPan 1.2/1.4 PSK31 software, I will use it as a reference during my explanation for setting up the transceiver and sound card levels.

First we'll set the soundcard output level to approximately one third to half-scale (click the speaker symbol on the Windows taskbar). Connect a dummy load to the transceiver antenna output and click on the DigiPan 'TX' menu button.



ALINCO or KENWOOD HF TRANSCEIVER WITH 8 PIN MICROPHONE PORT.

Figure 4

Next, let's make sure we have our transceiver set for LSB (lower side-band) operation, and the AGC set for Slow (recovery). We're now set to begin our on-the-air (dummy-load) setup.

The easiest way to perform this one-time procedure is to set the transceiver frequency to 14073.000. Set the DigiPan 'View' 'Frequency Display' selection to 'LSB' and the 'Configure' "Spectrum Start" (see **Photo D**) frequency to "14073.000." Notice the graduation of the frequency is 14069... to 14073, left to right.

Using your favorite watt meter and dummy load connected to the output of your transceiver, click on the DigiPan 'TX' menu button and adjust the Speaker volume slider on the Windows taskbar tray for an output power reading of about one third to one half the power you would normally see when operating CW. DO NOT operate your transceiver above half its maximum power level rating!

Once you have the power level set, type a few characters and watch the power meter. As you type, the text you are sending should cause the meter pointer to have a slight jitter. If you have the LINE OUT/MIC IN level set properly, you should see the power move slightly upwards. At no time should you see the power level go above 50% or your transceiver's rated power output. If it does go higher, simply turn the Transmit Drive level down, using the "configure/transmit drive/volume control/ in DigiPan 1.2.

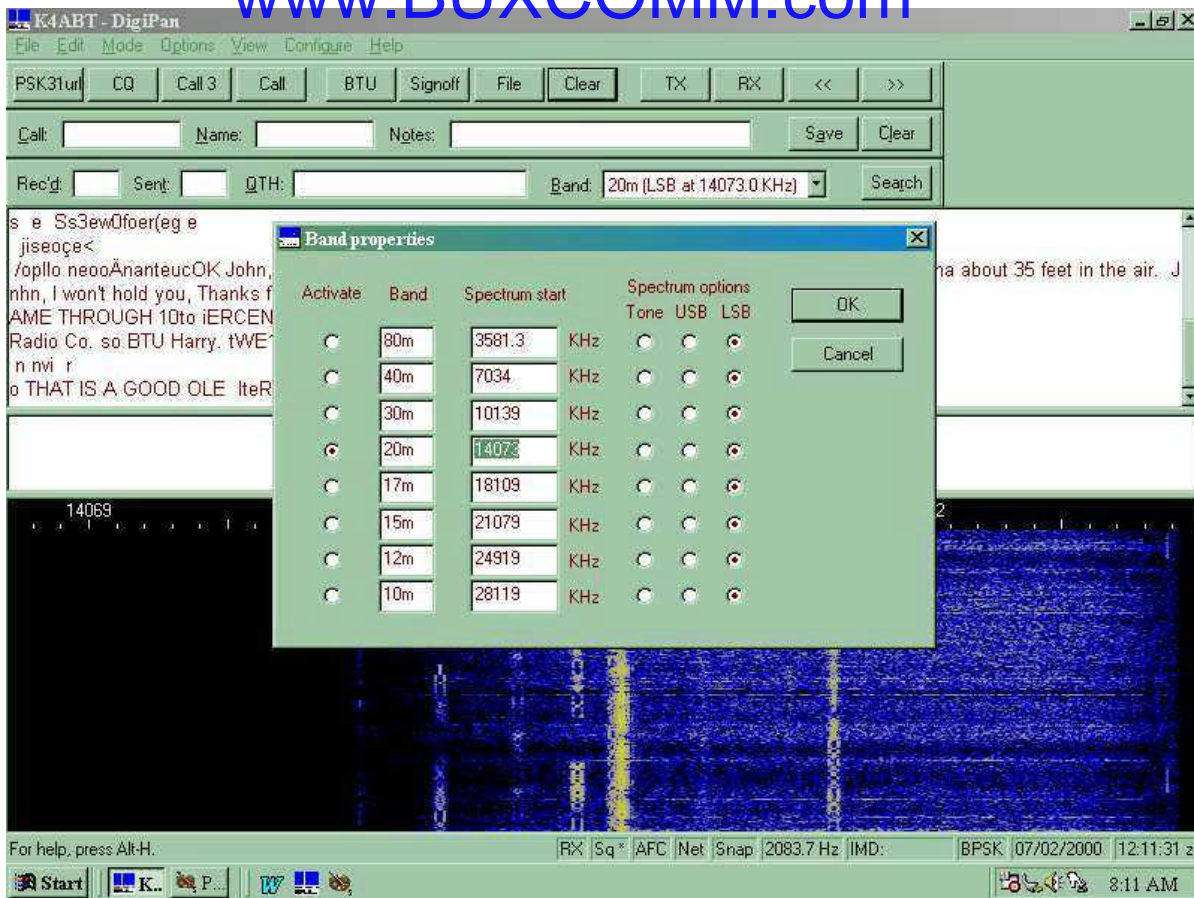


Photo "D"

**SOFTWARE, SOFTWARE, EVERYWHERE:**

There's plenty of software to help you get on the air with PSK31. You can choose the one you like best and of course some of your decisions will be based on the particular operating system for your computer.

Be sure you read the PSK31 software user's manual or the "help" files that relate to the software you plan to use.

In the next few paragraphs, I'll try to name a few software packages for PSK31 operation. Before I go there, I'd like to point out that so much of this software is FREE, however, the software writer and author cannot live by bread alone; He/she must have peanut-butter, and peanut-butter cost money!

Which ever software you finally choose, remember the author of that software package dedicated his or her time to making your hobby more fun. If you like the software, send the author a small donation as a sign of your appreciation for their contribution to making your hobby fun and exciting. By sending a small contribution to the software author, you are also encouraging them to extend additional effort to add more features and updates for your future enjoyment.

**DECISIONS, DICISIONS:**

The main distribution point for Peter G3PLX's implementation reference software, is at: <http://www.kender.es/~edu/download/p31sbw.zip>

The ISO-KIT numbers beneath each set of diagrams above reference their catalog numbers on the web pages at: <http://www.packetradio.com/psk31.htm>

You may wish to visit this site for updates and new additions to the PSK31 interface diagrams.

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