A Simple DIY Computer – Transceiver Digital Interface

Andrew Cornwall, VE1COR

I needed a computer-to-transceiver interface to enable my Yaesu FT-897 HF Transceiver to reliably communicate digitally – at least by means of Winlink Express ARDOP mode, WSPR and most of Fldigi's 15 digital modes (each with several variations).

"Fldigi is a computer program intended for Amateur Radio Digital Modes operation using a PC (Personal Computer). Fldigi operates (as does most similar software) in conjunction with a conventional HF SSB radio transceiver, and uses the PC sound card as the main means of input from the radio, and output to the radio. These are audio-frequency signals. The software also controls the radio by means of another connection, typically a serial port." – "Beginner's Guide to Fldigi" at http://www.w1hkj.com/beginners.html

These objectives, and more, were achieved with a very inexpensive modified simple DIY interface between a computer sound card and a transceiver. As a bonus other digital modes are also enabled such as FT8 and JS8call. The interface should work with transceivers having standardized data ports and most do. This article describes my interface. Figures 1A and 1B contain the circuit diagram of my modified simple DIY interface.

Excluding the box enclosure, the cost of constructing my modified simple DIY interface was $14 for parts at unit prices (parts are often sold in multiple units which suggests group purchasing). In addition, it cost $15 for the optional USB sound card.

A computer-to-transceiver interface does two things. First it conveys audio-like digital signals between a sound card in a computer and the data port of a transceiver. Second, it controls the transceiver's push-to-talk, (PTT) function.

Controlling PTT is a complex task. Every time the computer sends a data signal to the interface, the interface has to activate transmission by setting low the transceiver's data port PTT pin.

The typical simple DIY interface diverts a portion of the data signal to be rectified, smoothed and fed as a DC current into the base of a

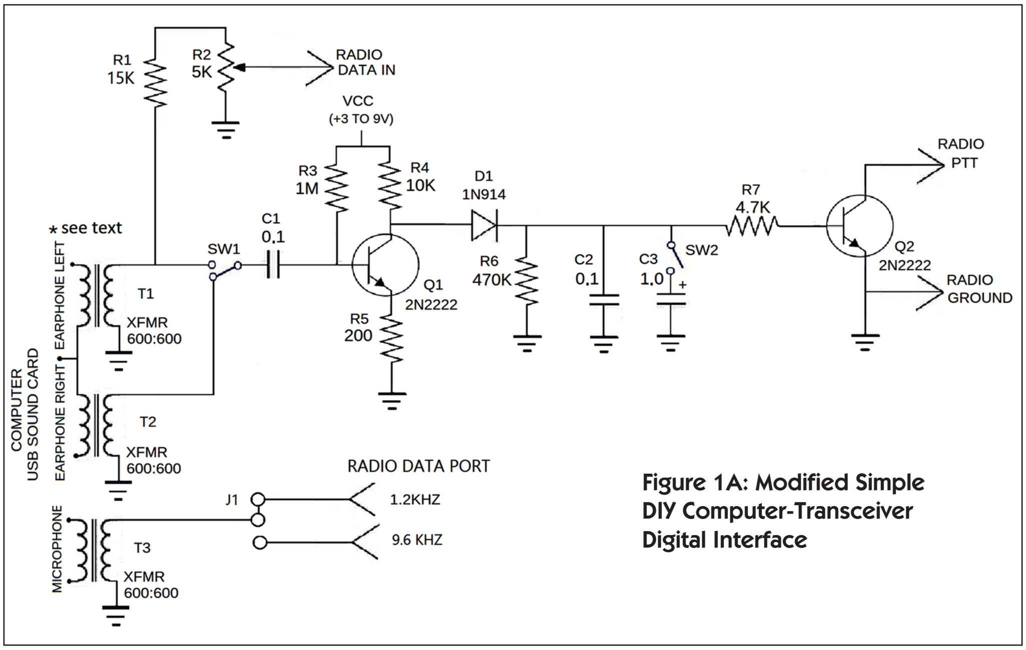

Figure 1A: Modified Simple DIY Computer-Transceiver Digital Interface

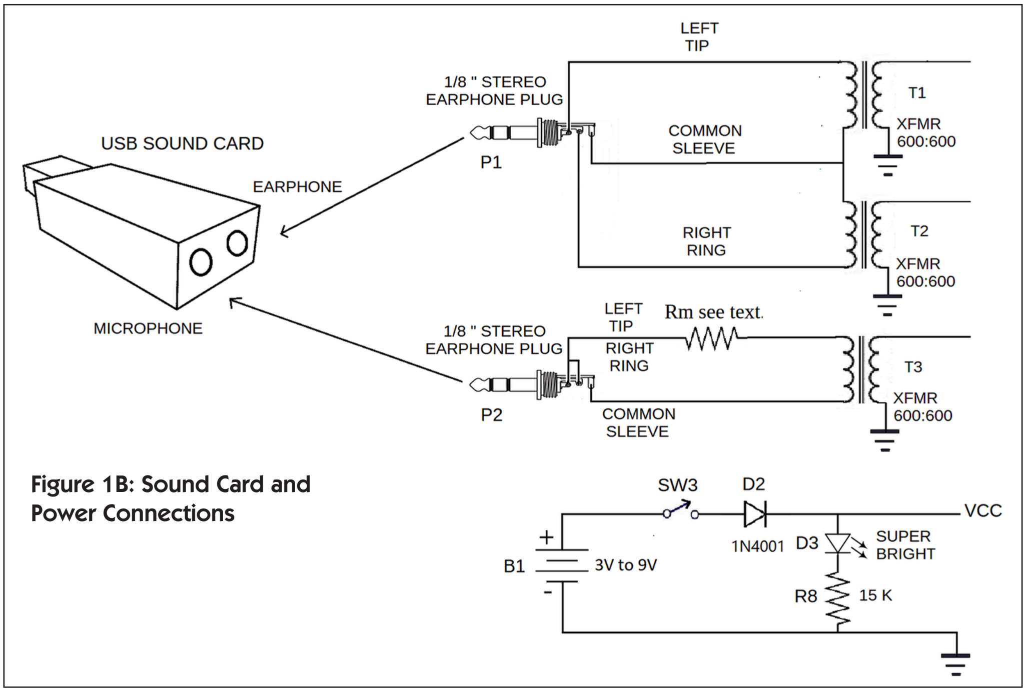

Figure 1B: Sound Card and Power Connections

PTT-controlling NPN transistor. In Figure 1A, at the top of the page, Q2 is the transistor.

The transceiver's positively-biased data port PTT pin is attached to the transistor's collector and its emitter is grounded to the transceiver. The transistor acts as a "switch" bringing the transceiver's PTT pin low whenever there is sufficient computer-generated signal going into the interface. Sometimes an optocoupler is used instead of a transistor, but the PTT action is the same.

A pivotal component in simple DIY interfaces is the smoothing capacitor (my use of the term "smoothing capacitor" is descriptive). The higher the value of the smoothing capacitor, the more energy it stores and the longer it can feed the base of the PTT transistor. Extended PTT within a packet or clustered data sequence is called "hang time". By continuing to feed the base of the PTT transistor, hang time enables transmission to continue during moments of low signal amplitude. With a high value smoothing capacitor it may take longer to charge at the beginning of the signal causing part of the signal to be missed, and may extend PTT when the transmission should have ceased.

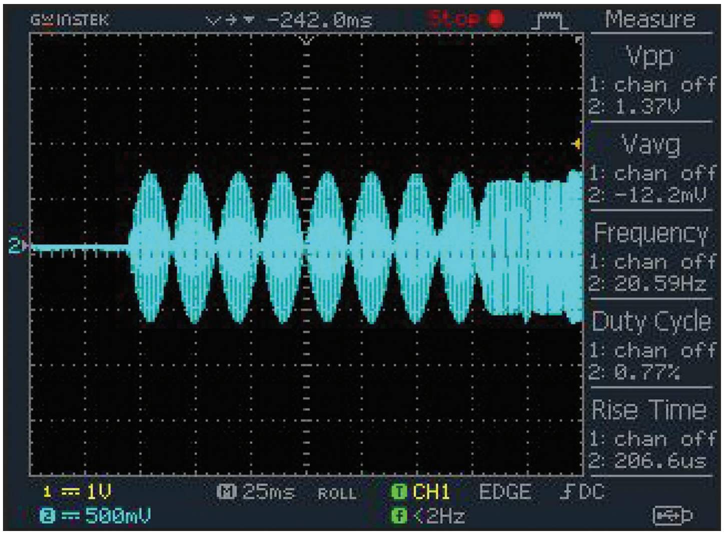

Figure 2A: ARDOP initial pulses

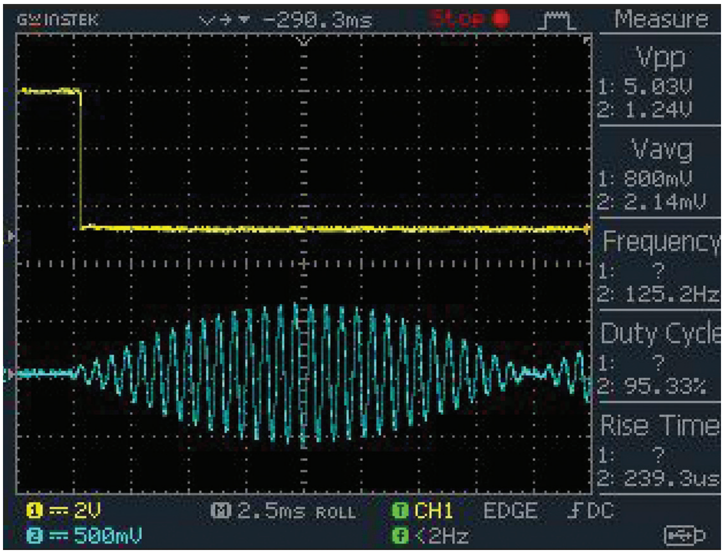

Figure 2B: ARDOP initial pulse close up.

In my final circuit design of the model DIY interface the smoothing capacitor, C2, is 0.1 uF in parallel with R6, a 470K resistor that experimentally improved the charging-discharging action. A marginally lower value for C2 may do the same. There is an auxiliary 1.0 uF capacitor, C3, that can be switched in by SW2 to further suppress relay chatter. C3 can be helpful, but not always.

My first experience with a simple DIY interface was disappointing. I bread-boarded a circuit taken from the online newsletter of a computer club in the United States. When trying this interface with a Winlink Express ARDOP signal, my Yaesu FT-897 transmit-receive relay clattered mercilessly.

Figures 2A and 2B show oscilloscope traces of the problematic signal (going from the computer to the transmitter via the Interface). Figure 2A focuses on the very beginning of the Winlink ARDOP data sequence where there are eight quick pulses. Magnifying the sweep rate by a factor of 10, Figure 2B shows the first pulse (bottom) steadily rising from zero then falling to zero again. Also shown is a PTT control signal (top) that is referred to later in this article.

In this situation the beginning of the ARDOP sequence presents a series of pulses that are too short and have too small an

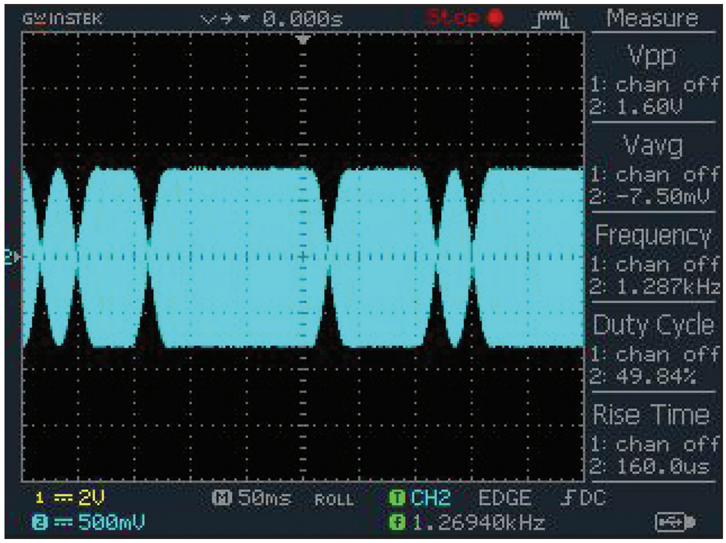

Figure 3: BPSK31

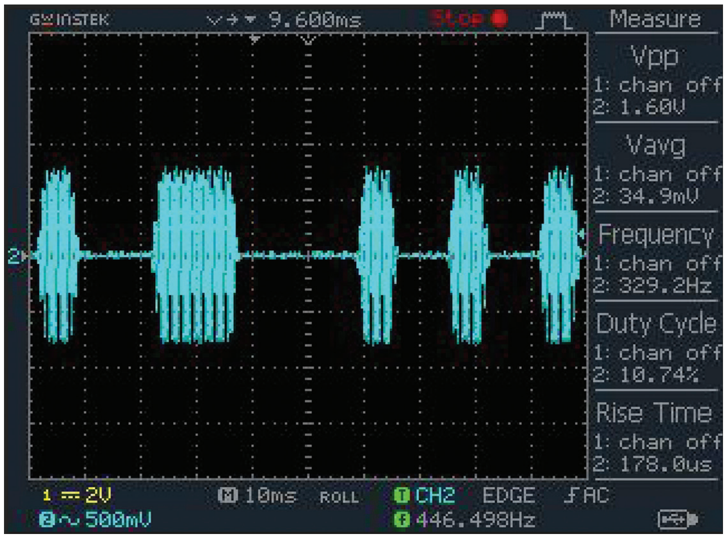

Figure 4: Feld-Hell

average amplitude for the bread-boarded interface to activate sustained PTT control. Experimenting with higher values for the interface's smoothing capacitor did not help. Other examples of problematic signals are presented below.

The bread-boarded interface PTT control worked properly with some digital modes but not with others. Whether the circuit can charge the smoothing capacitor sufficiently to do its job depends on the rapidity, amplitude and other variations in the digital signal. Indeed, signal variations are the nature of digital modes. For example, compare the limited variation within a stream of PSK31 characters shown in Figure 3 – which most simple DIY interfaces can handle – with that of a Hellschreiber Feld-Hell character stream shown in Figure 4 – which simple DIY interfaces cannot handle.

Note: *changes in amplitude do not necessarily mean a signal is amplitude modulated, most are not. Often amplitude changes are caused by nulls between characters or packets, even by the addition of a TXID at the beginning of a signal stream.*

Instead of trying other mostly similar circuits, the initial experience led me to modify the simple DIY interface with two PTT related advances.

TCA

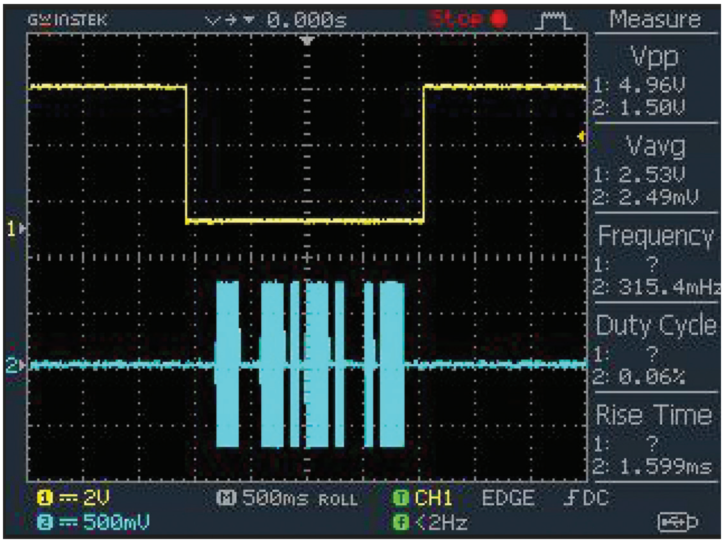

Figure 5: CW with PTT

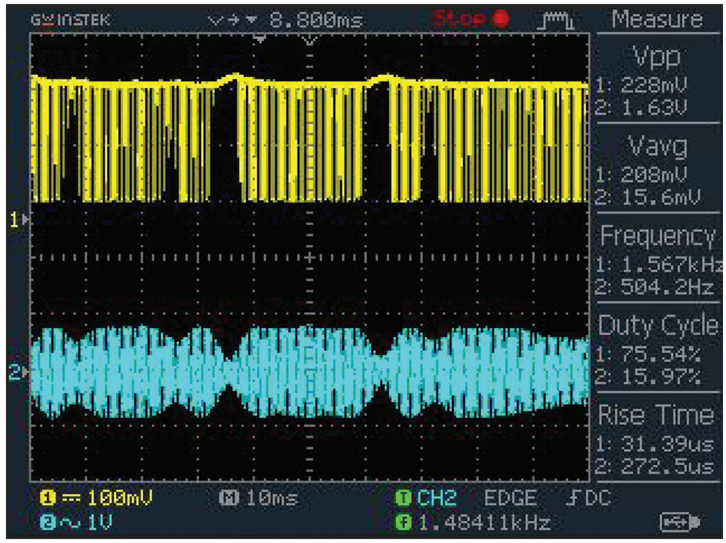

Figure 6: Q1 collector and Contestia

One of the PTT advances is the adoption of Fldigi's Right Channel Speaker Tone Output feature which can be activated in Fldigi's setup. With right speaker tone output enabled, whenever Fldigi sends a digital signal, even CW, from the computer sound card's left earphone/speaker channel, it concurrently sends a steady 1 kHz tone over the right earphone/speaker channel. The tone is continuous from the beginning to the end of the digital signal, allowing for unambiguous PTT triggering for the duration. The effectiveness of this feature is evident in Figure 5 which shows a very irregular CW signal (bottom) and related stable PTT line (top) from the interface.

Note: *In this article a "speaker" refers to the earphone output of a computer sound card.*

A very simple interface circuit designed by W5ZIT dedicated to utilizing the right speaker tone output feature is documented in Fldigi's online Users Manual at: http://www.w1hkj.com/FldigiHelp-3.21/html/w5zit_rt_channel_page.html. Other digital communications programs may also have Tone Output of some kind, but I have yet to encounter any.

Building right speaker tone output functionality into the interface requires three interstage audio transformers: T1, T2 and T3. Most simple DIY interfaces have only two. The purpose of the transformers is to electrically isolate the computer and transceiver from each other while conveying signals between the interface and the computer's sound card.

T1 transfers data signals to the interface from the left stereo channel of the computer sound card earphone/speaker jack. Transformer T2 transfers the right speaker tone output used by Fldigi for PTT control to the interface from the right stereo channel of the sound card earphone/speaker jack. If the digital mode computer program does not have right speaker tone output, then switch SW1 diverts the data signal from T1 to be shared by both the PTT circuit and the transceiver data port IN pin. When the transceiver is receiving, T3 conveys the signal from the transceiver's data port OUT pin to the computer sound card microphone jack.

The second advance in my modified simple DIY interface, adding transistor Q1 to the circuit, significantly improves smoothing capacitor charging and is particularly useful when a right speaker tone output is not available. Since the action of Q1 is unique, this addition is described in detail. The role of Q1 is an amplified fast switch. At quiescence, Q1 is saturated causing voltage at the collector to be low. Any voltage appearing at the collector is dissipated in diode D1's forward voltage loss.

The computer-supplied data signal is fed into Q1's base via C1. Any part of the data signal having a more positive voltage than Q1's quiescent base has no effect as the transistor is already saturated. However, any part of the signal that is negative compared to the base's quiescent voltage offsets the base current and tends to turn off the transistor, raising voltage at the collector. This is a sensitive effect as shown in Figure 6. The bottom trace is a Contestia signal and the top trace is Q1's collector voltage. The duty cycle is highly skewed. When a data signal is present, ignoring nulls, the duty cycle is 85% ON and 15% OFF.

Figure 7 is a highly slowed down view of Contestia, bottom trace, and PTT line, top trace. Contestia's irregularities, evident in Figure 6, are compressed from view, but the consistency of PTT is evident. PTT is not utilizing right speaker tone output.

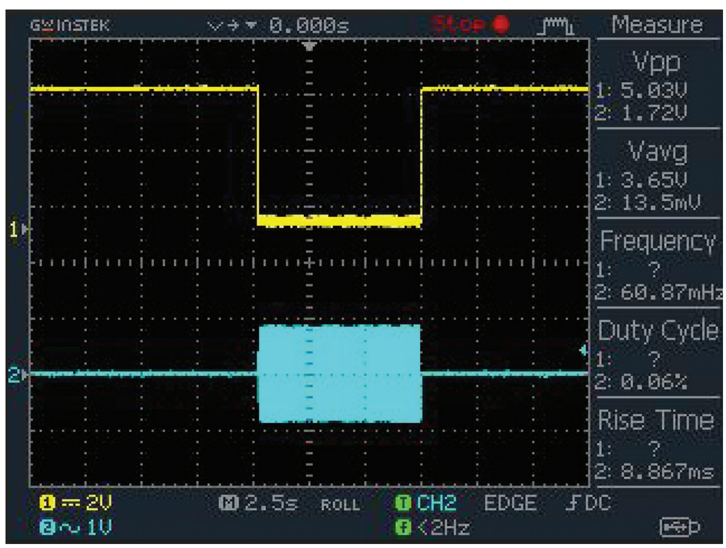

Figure 7: Contestia with PTT

A 10 K resistor, R4, at Q1's collector, limits collector current depending on VCC. At a VCC of 3 volts the collector current is no higher than about 0.2 mA, and at 9 volts about 0.8 mA. This limitation makes saturation very easy to achieve. Thus the base bias resistor, R3, can be quite high; in this case 1 megohm suffices. The limited transistor current also means only a small amount of power is needed to operate the interface.

The 200 ohm resistor R5, between Q1's emitter and the circuit ground, has three effects. First it raises Q1's quiescent base voltage by a small amount, for instance by 0.04 volts with VCC of 3 volts, and 0.16 volts with VCC of 9 volts.

Second, R5 causes the circuit current gain of Q1 to be limited to approximately 50. In the absence of R5 (direct connection of the emitter to ground), the gain of a single transistor amplifier is determined by the transistor's HFE. The minimum HFE specified for a 2N2222 is 75, but it is usually greater than 100. Using the circuit to limit gain means its performance is not subject to individual transistor gain as long as the HFE is at least 50, in this case.

The third effect of R5, at 200 Ohms, is that the base input impedance of Q1 is raised to at least 15 K assuming an HFE of 75. The impedance will be proportionally higher with a transistor having a higher HFE. The high impedance reduces the circuit's load on the data signal, provides for more equitable sharing with the transceiver, and reduces the opportunity for signal frequency roll-off by C1.

The quickness by which the modified simple DIY can respond to the presence, or absence, of a digital signal is impressive. For example, with Winlink Express ARDOP the transceiver's data port PTT pin is activated within 0.2 ms of the instant the first pulse starts, as shown in Figure 2B, and remains "on" until 8 ms after the completed packet ends. Typical PTT activation and release times for digital modes having sharper start and ending wave forms are 0.1 ms and about 18 ms respectively. However, there are digital signals which are so irregular that Fldigi's right speaker tone output feature is needed – for example Feld Hell, Throb and Morse code.

Sound card signal levels to and from the interface are adjusted in the computer's audio settings. The sound card earphone/ speaker output level establishes the volume going into the interface. This is further modified by resister R1 and potentiometer R2 to set the sound level going to the transceiver.

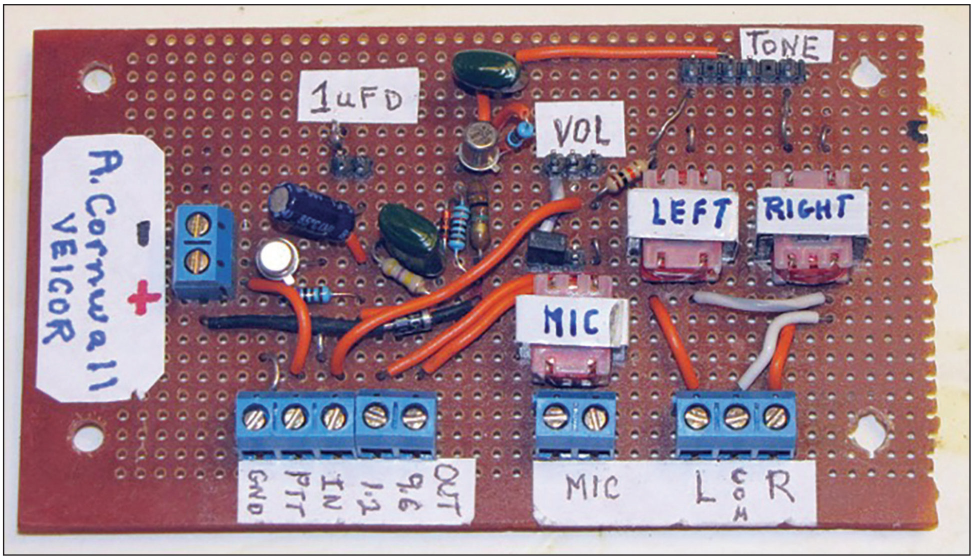

Figure 8: Perfboarded circuit mounted in a metal box.

Microphone volume, set in the computer's audio control, determines the strength of the data signal feeding the data communications program when the transceiver is receiving. Figure 1B shows a 15K resistor, Rm, at the cable from the interface to the sound card microphone jack. The purpose of the resistor is to make the computer sound card microphone control less sensitive to adjust. I determined a value of 15K by trying different resistances and picked the one that provided sufficient signal input for the computer programs I use when the computer microphone volume is set at about half-way.

The power supply for my modified simple DIY interface is not critical. I've powered it with voltages ranging from 3 volts to 9 volts. I now use four AA batteries for a nominal total of 6 volts, and the interface circuit draws about 0.5 mA.

As shown in Figure 1B, there is an LED, D2, power switch "ON" indicator consisting of a low-current blue LED, in series with a 15K Ohm resistor, R8. Amazingly, the LED draws just 0.4 mA when glowing bright enough to do its job. The interface circuit and LED together draw less than 1.0 mA, suggesting an interface-on alkaline battery life of a couple thousand hours. Also shown in Figure 1B are the battery power supply, ON-OFF power switch, SW3, polarity protecting diode, D3 and USB sound card dongle interface.

My modified simple DIY interface works well with computer built-in sound cards that I've tried, but my preference is an external USB sound card dongle that plugs into a computer's USB port, making the interface somewhat more transportable between computers. This setup is shown in Figure 1B. A sound card dongle can be purchased for about $15. In this article references to a computer sound card also apply to a USB sound card dongle.

Figure 8 shows the perfboarded modified simple DIY interface circuit. The method of assembly is (obviously) not critical. On the perfboard are four blocks of screw terminals to attach cables making connection to the power supply, sound card and transceiver data port.

The left-most block, at the end, has two connectors for power: "+" and "–". Next on the bottom left are five connectors in a block for a cable going to a transceiver's data port pins. The individual wires, left to right, are labelled ground, PTT, data in, 1.2 kHz (data out) and 9.6 kHz (data out).

Jumper J1, in circuit diagram 1A, determines which data out pin, 1.2 kHz or 9.6 kHz, should be used in conjunction with the digital data communications program. I have not tried 9.6 kHz; note, SignaLink uses 1.2 kHz exclusively. To the right of the transceiver's data port is a two-connector block for the cable going to the computer sound card microphone input. The connector orientation of the two microphone wires does not matter.

The rightmost, three-connector block, connects the computer sound card left and right stereo earphone/speaker channels.

Modified Simple DIY Interface Cable Wiring To A Standard Transceiver Data Port				
RJ-45 Plug Pin Number [1]	**Wire Colour**	**Data Port Mini DIN Pin Number**	**Purpose**	**Circuit Board Label**
1	Orange / White Stripe	1	Data In	In
2	Orange	2 [2]	Ground (GND)	Ground (GND)
3	Green / White Stripe	3	PTT	PTT
4	Blue	4	Data Out 9.6 BPS BPS	9.6 (Out)
5	Blue / White Stripe	5	1.2 K BPS	1.2 (Out)
6	Green	6	SQL	Not Used

Notes:

[1] This information assumes a standard RJ-45 patch cord. Rating does not matter.

[2] Old PS2 computer keyboard cables have a six-pin mini DIN but often lack a pin 2-connection. The cable's ground wire connected to the DIN shell may be substituted for the missing pin 2 when making a GND connection to the interface circuit board. Using a female to female RJ-45 gender changer provides an adapter that may be used by a SignaLink type cable at a transceiver.

Which part of a stereo 1/8-inch diameter plug carries the left and right channels is shown in Figure 1B.

There is no connection between the metal box and the circuit, cables or batteries. All of the circuit's components and related items electrically float inside the box.

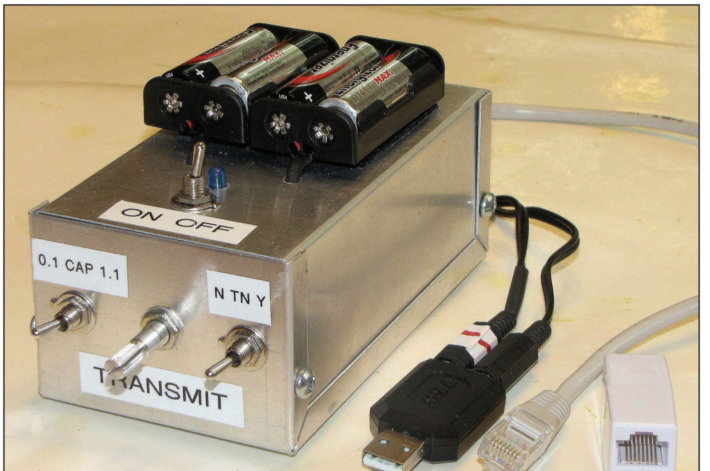

Figure 9: Assembled interface.

The modified simple DIY interface assembled in a metal box is shown in Figure 9. On the top can be seen the 6 volt, AA battery power supply, the ON/OFF power switch, SW3 and power-on LED D3. On the front is a switch, SW2, to select between a 1.1 uF or 0.1 uF value for PTT smoothing capacitance, a volume control, R2, to set the interface to transceiver signal level, and a switch, SW1, to turn on the right speaker tone output feature. "Y" indicates that such a tone is available in the digital communications program and "N" indicates that it is not.

Cables are coming from the back of the box, around to the right side. The earphone and microphone cables are plugged into a USB sound card dongle. The cable with the band on the plug connects to the earphone jack. Next to the USB sound card is a cable for connection to the transceiver data port, with an RJ-45 plug which, when inserted in an RJ-45 female-to-female gender changer, also shown, provides a SignaLink type RJ-45 port.

The intent is for a cable with an RJ-45 jack at one end, and a six-pin mini DIN male connector at the other, to mate a modified simple DIY interface with a transceiver standard data port, just as if it were a SignaLink interface.

The table on the left provides a guide for attaching to the circuit board the coloured wires of a LAN cable with an RJ-45 plug at one end and a six-pin mini DIN male connector at the other to interconnect the modified simple DIY interface with a transceiver standard data port.

Every transceiver needs an ability to operate digital modes. I have a commercial interface dedicated to one transceiver, but I was reluctant to spend $200 for another commercial unit to use with my Yaesu FT-897. The commercial unit set a high bar for performance that was not met by my trial of a typical simple DIY interface.

With the addition to the circuit of Fldigi's right speaker tone output feature and Q1 as an amplified fast switch, I consider my modified simple DIY interface to be as capable as the commercial unit for my digital communications interests. These include the many modes supported by Fldigi (and any other program having a similar right tone output feature), plus Winlink Express ARDOP, WSPR, FT8, JS8Call and more.

The modified Simple DIY interface is not complicated to build and is easy to connect to a computer/sound card and a transceiver – similar to a SignaLink. Now my trusty FT-897 has its own digital interface – at a very affordable cost.

Andrew (Andy) Cornwall received his Basic Amateur Radio certification in 1992 (now Basic with Honours) with call sign VE1COR. He also has a General licence in the United States with call sign KB1RSE.

Andrew's hobby is electronics and radio communications. He is retired from careers as an Economist and as a Director of an information technology section. He lives in Enfield, Nova Scotia.