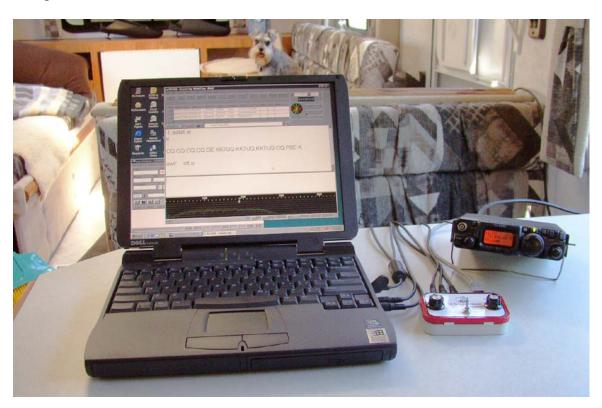# Getting Started with Digital Sound Card Modes with the Yaesu FT-817 Transceiver
by Clint Hurd KK7UQ

Abstract   This paper describes the steps taken to interface the Yaesu FT-817 transceiver to a computer sound card system to operate in one of the digital sound card modes such as BPSK31, QPSK31, BPSK63, MFSK16, RTTY, CW, Helleschreiber, SSTV, MT63, Throb, Packet and others.   Covered are the hardware interfacing requirements, the software control methods, the setup of the FT-817 menus, and operating procedures to use these modes.

Introduction   The Digital Sound Card Modes are well suited to QRP operation with rigs like the FT 817. In one week of testing with the interfaced rig, solid 20 meter DX contacts were made to Mexico, Thailand, Hawaii, Alaska, New Zealand, Fiji, New Caledonia, and Argentina as well as US stations in the South East, Mid West and South West. The antenna used was a G5RV up 45 feet. Power for all these contacts was done at *one watt peak output*. Modes used included BPSK31, MFSK16 and RTTY. The station (KK7UQ) is located in Port Townsend, Washington, USA.

A typical operating station consists of the FT-817 rig, a laptop PC and the interface. A picture of this setup, ready for portable operation in the travel trailer, is shown below. One optional accessory is the family Schnauzer, Flora, peering over the computer in the background.

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Test Setup   The following equipment and software was used during testing. Web references (in blue) are included to find more information about these products.

Rig   Yaesu FT-817 Transceiver

Interface   KK7UQ Model II Interface kk7uq.hfradio.org/index.htm

Computer   Desktop or Laptop PC with Sound Blaster 16 compatible
                sound card and one serial interface port

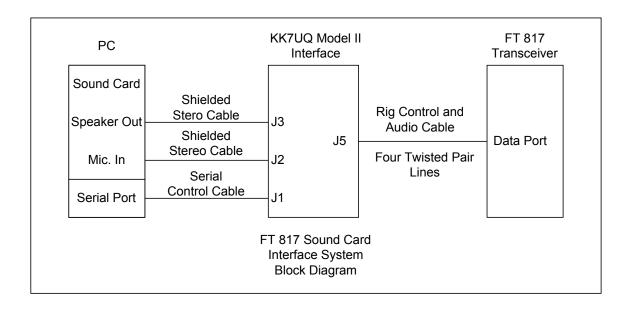Software   MixW32 Ver. 2.08   www.nvbb.net/~jaffejim/downloads.htm
                PSK Deluxe   hrd.ham-radio.ch/downloads.html
                Hamscope   www.qsl.net/hamscope/
                Digipan   www.digipan.net

Interconnections   The FT-817 Transceiver is connected to the PC Sound Card and Serial Port via the Sound Card Interface System. A block diagram is shown below. Modulated audio from the PC is delivered to the interface via a shielded stereo audio cable, transformer isolated and attenuated to appropriate levels, and then connected to the FT-817 Data Port via a twisted pair line. Audio from the FT-817 is sent to the interface via another twisted pair line, transformer isolated, attenuated and then connected to the Sound Card microphone input via a shielded stereo cable. PTT control for the rig originates in the serial port RTS line and connects via a serial control cable to the interface. It is isolated with an opto-isolator whose output is used to drive the PTT line of the FT 817 via another twisted pair line.

PC   KK7UQ Model II   FT 817
                            Interface   Transceiver

Sound Card
              Shielded
Speaker Out   Stero Cable   J3   Rig Control and
              Shielded   J5   Audio Cable   Data Port
              Stereo Cable   J2
Mic. In
              Serial   Four Twisted Pair
Serial Port   Control Cable   J1   Lines

FT 817 Sound Card
Interface System
Block Diagram

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Interface

Interface The schematic diagram of the KK7UQ Model II interface is shown below. Features of this interface include:

Full isolation between the transceiver and the PC using transformers on the audio path and opto-isolators on the control path.
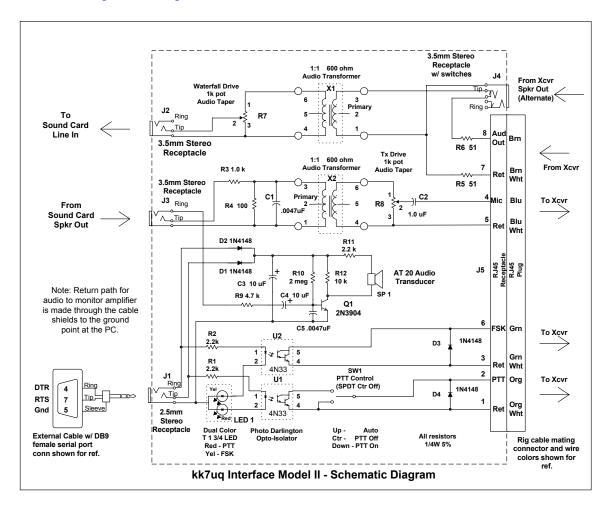
Level control of transmit and receive audio using audio taper potentiometers with external knobs for easy control of level when operating. The 10:1 Output signal level reduction to ensure that the signal level does not exceed the maximum level 1.0v p-p specified by Yaesu.

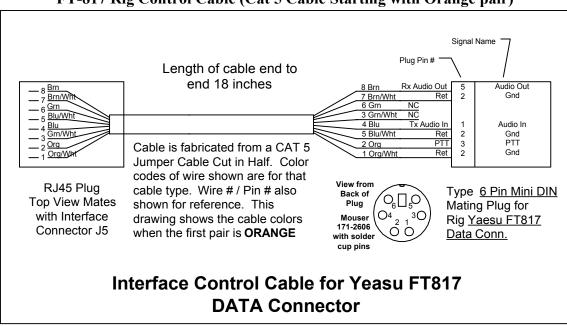Built in audio monitor with speaker so you can hear the signal being transmitted.

No external power supply required - all power needed for the audio amplifier is derived from the RS232 control signals.

Small, lightweight design - ideal for portable use, the entire circuit fits inside an Altoids ® box.

The full design and construction manual for this interface can be found at:
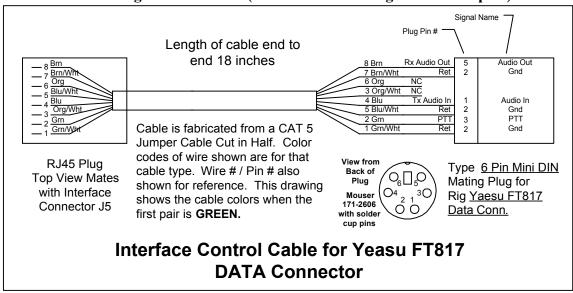kk7uq.hfradio.org/index.htm

kk7uq Interface Model II - Schematic Diagram

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Rig Control Cable The Rig Control Cable connects the interface to the FT 817 Data (6 pin mini-DIN) connector. The connector used to mate with the Data Port of the FT 817 is a 6 pin mini-DIN with solder cup contacts, Mouser part number: 171-2606. A CAT 5 jumper cable, cut in half is used to build this cable. The color coding of the wires in these cables comes in two versions: those that start with an Orange pair, and one that starts with a Green pair. Both are shown below. Check the cable before wiring.

FT-817 Rig Control Cable (Cat 5 Cable Starting with Orange pair)

Length of cable end to end 18 inches

Signal Name

Plug Pin #

8 Brn	Rx Audio Out	5	Audio Out		
7 Brn/Wht	Ret	2	Gnd		
6 Grn	NC				
3 Grn/Wht	NC				
4 Blu	Tx Audio In	1	Audio In		
5 Blu/Wht	Ret	2	Gnd		
2 Org	PTT	3	PTT		
1 Org/Wht	Ret	2	Gnd		

8 Brn
7 Brn/Wht
6 Grn
5 Blu/Wht
4 Blu
3 Grn/Wht
2 Org
1 Org/Wht

RJ45 Plug
Top View Mates
with Interface
Connector J5

Cable is fabricated from a CAT 5 Jumper Cable Cut in Half. Color codes of wire shown are for that cable type. Wire # / Pin # also shown for reference. This drawing shows the cable colors when the first pair is **ORANGE**

View from Back of Plug

Mouser 171-2606 with solder cup pins

Type 6 Pin Mini DIN Mating Plug for Rig Yaesu FT817 Data Conn.

Interface Control Cable for Yeasu FT817 DATA Connector

FT-817 Rig Control Cable (Cat 5 Cable Starting with Green pair)

Length of cable end to end 18 inches

Signal Name

Plug Pin #

8 Brn	Rx Audio Out	5	Audio Out		
7 Brn/Wht	Ret	2	Gnd		
6 Org	NC				
3 Org/Wht	NC				
4 Blu	Tx Audio In	1	Audio In		
5 Blu/Wht	Ret	2	Gnd		
2 Grn	PTT	3	PTT		
1 Grn/Wht	Ret	2	Gnd		

8 Brn
7 Brn/Wht
6 Org
5 Blu/Wht
4 Blu
3 Org/Wht
2 Grn
1 Grn/Wht

RJ45 Plug
Top View Mates
with Interface
Connector J5

Cable is fabricated from a CAT 5 Jumper Cable Cut in Half. Color codes of wire shown are for that cable type. Wire # / Pin # also shown for reference. This drawing shows the cable colors when the first pair is **GREEN.**

View from Back of Plug

Mouser 171-2606 with solder cup pins

Type 6 Pin Mini DIN Mating Plug for Rig Yaesu FT817 Data Conn.

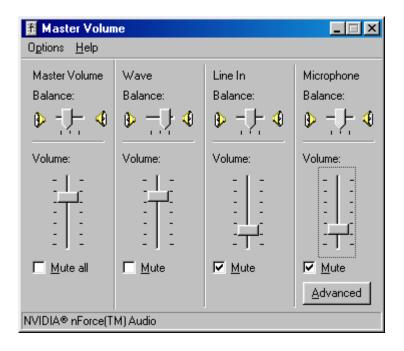### Interface Control Cable for Yeasu FT817 DATA Connector

Menu Setups in the FT-817

The FT-817 menu system must be accessed to set appropriate values for functions used for Digital Sound Card modes. These are enumerated below:

Menu 26	Dig Mode	PSK31-U	Sets to USB	change from default
Menu 25	Dig Mic	50	Sets dig mic gain to 50%	default
Menu 24	Dig Disp	0	0 Hz offset	default
Menu 27	Dig Shift	0	0 Hz shift	default
Menu 38	Op Filter	OFF	Turn off any filters	default
Menu 55	USB CAR	0	USB Carrier offset to 0	default

Op row 9 sw A	PWR MET		Set Power output FULL (no icon)
Op row 9 sw B	PWR MET	pwr	Set meter to display power
Op row 8	NB AGC sw B	fast	Set AGC to fast
Op row 8	NB AGC sw A		Set NB off

Clarifier (RIT)   OFF (0 offset)

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PC Output Volume Control Panel The PC Sound Card controls are used to set the level out of the PC for the audio output sent to the rig. Select this panel from your operating software *Configure/Output Volume* menu. The software control panel should look like the figure below.

The Sound Card WAVE function is used to generate the signal to be sent to the rig. ONLY the WAVE and Master Volume control are used - *all others should be muted*. Under Options on this panel, view Properties, and check all sources to verify that ONLY the microphone input is sele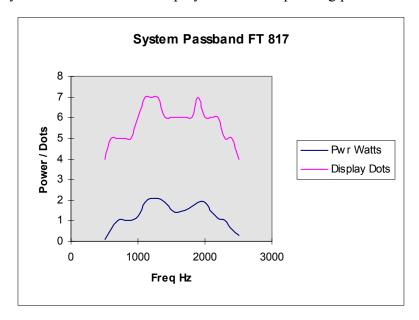cted, then reduce the size of the panel to display the Master Volume, Wave, Line In and Microphone. The Line In and Microphone are kept in view so that you can easily check that they are muted, since other programs may change the value of these controls when used.   An example of this panel is shown below.

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Input (waterfall) Control Panel   The PC Sound Card Recording Control is used to set the internal level of the audio received from the transceiver.   Select this panel from your operating software *Configure/Waterfall Volume* menu.

The example uses the microphone input as the waterfall port for this application. Select ONLY the microphone for input.   Under Options on this panel, view Properties, and check all sources to verify that ONLY the microphone input is selected, then reduce the size of the panel to display the Line In and Microphone as shown below.

Operating Passband - Transmit The pass band of the transmit audio system is shown in the chart below. The data for this chart was taken with a fixed value of the output potentiometer on the interface, and fixed values of gain on the sound card output and digital microphone gain within the transceiver. The chart shows that the effective pass band extends from about 700 to 2200 Hz. Substantial roll off occurs above and below these frequencies. In addition, the shape of the pass band curve in the operating range is anything but flat.

When switching from band to another, the audio level required to produce a given power output will also vary substantially. The output level control knob on the interface allows quick and accurate adjustment to control the output power to your particular requirements when operating in all of the digital modes.

It is very important to keep this chart in mind. If you try to operate in the area above or below the pass band, you may have to increase the drive level substantially to get the desired power output - this will result in a audio overdrive condition - causing distortion of the output. See the following sections for a discussion of proper level setting.

If the station that you want to contact is outside the pass band, move the transceiver frequency control up or down 1 KHz (or more) to bring the station *inside the operating area*.
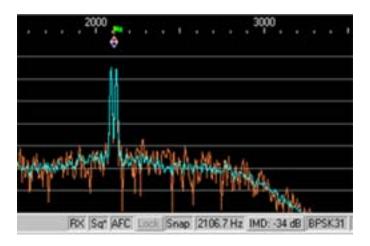
The two lines on the chart show power output represented in two ways. *Pwr Watts* is output measured on a power meter, measured in watts. *Display Dots* shows the number of dots displayed on the FT 817 PO display at the corresponding power level.

Caution Against Overdriving the Audio to the Rig When operating in digital sound card modes, and PSK31 in particular, it is important that the audio drive level be such that it is operating in a linear range inside the FT-817. Too much drive will activate the ALC system which is highly non-linear; the resulting non-linearity will cause severe distortion of the output signal with excessive output power in unwanted harmonics of the fundamental signal. Two pictures are presented below. One is of a system properly adjusted for audio level, with a very clean PSK31 signal occupying about 31 Hz of band width. The other, is an example of an overdriven signal, causing harmonics at band widths of 93 Hz and beyond.

The measurement system used to obtain these readings is a second rig and computer, operating the MixW ver. 2.08 software in Spectrum display mode.   The test FT-817 is operated at 2.5 watt peak output power, and is connected to a G5RV antenna using an MFJ 969 tuner. The Inter Modulation Distortion (IMD) measurement is done by the MixW software on the second receiver. The IMD measurement is taken by measuring the energy of the signal at the fundamental of ±15.63 Hz and comparing it to the level at the third harmonic ±46.88 Hz. The IMD value is in -dB comparing the fundamental to the third harmonic. For example, an IMD of -34 means that energy of the harmonic at ±46.88 Hz is 34 dB down from the fundamental at ±15.63. In this case it is near the noise level of the system. If the IMD were at -15 dB, the energy at the third harmonic is only 15 dB below the fundamental.   A good operating number to shoot for is 24 dB down or more. 24 dB represents about 4 S units on the rig. A properly adjusted FT817 PSK system should produce IMD of -30dB or better.
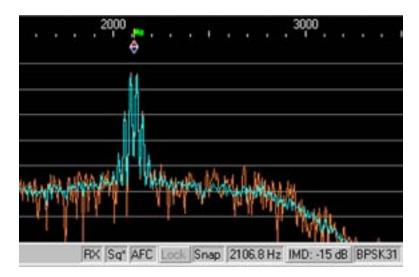
Example 1 - Properly Adjusted Audio Level This example is of an FT-817 operating in PSK31 mode. The signal is Idling (no typing, output buffer empty) at 2.5 watt peak output power. FT-817 Power menu setting is FULL. PO reading is at 5 dots. ALC is showing few (0 to 2). Measured IMD of -34db (excellent) and no visible side harmonics on the signal. The blue trace on the display is a smoothed (averaged) version of the orange (non smoothed) trace. The horizontal lines are 10 dB apart.

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Example 2 - Overdriven Audio Level This example shows the FT 817 PSK31 in Idle at 2.5 watt output. Power out setting is Liii. PO reading at 5 dots. <u>ALC showing at 5 dots</u>. Note IMD of -15db (bad) and two visible side lobes of signal on each side of the main signal.

The problem with using the Liii level setting is that the output peaks near 2.5 watts with no ALC showing. Continued increase of the drive level does not increase the power output very much, but the ALC levels start to rise, causing non linearity in the audio path of the FT 817 and degradation of the radiated signal. When overdriving the audio, the useful part at ±15.63 Hz is somewhat reduced, while some of the energy is shifted into the harmonics. This also causes interference to other stations on the band by increasing the used bandwidth from 31 Hz to 93 Hz or more.

It is better operating practice to set the rig power output control to FULL, and control the actual output level by using the Transmit Level control on the interface to set the actual power output to 2.5 watts or less. That way, you can monitor one display on the rig and still be operating in the linear range. It is a good idea, however, to periodically check the ALC level to be sure that you are not activating that system.

If you need to operate at Liii, because you are on battery, or you just want to be sure that you are not running your rig with too much power, an alternative is to monitor your IMD with an instrument such as the IMD Meter (kk7uq.hfradio.org/index.htm) or a PSK Meter (www.ssiserver.com/info/pskmeter/) while you are transmitting to ensure that your system is clean.

Recommended Operating Procedure   As shown in the previous discussion, the system audio must be operated in the linear area when transmitting. Use your power meter to ensure that you are operating at no more than ½ of the rated CW output - in this case at 2.5 watts or less. This will ensure that you are in the linear area of the audio system. This also ensures that the rig is not being operated at too high a power level which may damage the rig output amplifier.

When observing power, use the PEAK number shown - either on the rig power display (dots) or on a meter. PSK operates at about 80% duty cycle when sending data. A bit lower when idling. Other modes such as RTTY, MFSK and others operate at 100% duty cycle.

During testing, for all contacts done with the FT 817, the rig was operated at about 1 watt peak output power with good success on finding and maintaining contacts on 20 meters.

It is a good idea, especially when first operating in PSK mode, to ask the station you have contacted for an IMD reading. A well adjusted station will have IMD numbers of 24db down or more. One note of caution about IMD readings: The method used in the software compares the energy at the fundamental at ±15.63 Hz to the third harmonic at ±46.88 Hz. If your signal is being received at levels near the noise level the number reported to you will be lower than the "real" number. Try to get reports from stations where you have reasonable signal level, say S5 or better. IMD measurement can only be taken when you are in IDLE mode when transmitting. IDLE is defined as no typing, and an empty buffer. This produces a 31.25 Hz wide signal on the system.

One other note about IMD, f you are giving a report to another station. If it is really strong - above S9, the number displayed on your screen may not be accurate. Reduce the RF level control of the signal until the signal level on the waterfall display starts to drop. The value of IMD will probably improve because you have removed the possibility of flat topping in the front end of the FT817, or the Sound Card input A/D converter.

Modes of Operation Most of the discussion to this point has been on the BPSK31 mode. Many other modes are available to you with software available off the Web. The same setup that you use for BPSK31 is used for these modes. Follow these rules when operating other modes (except for 80 and 40 meter SSTV see note below):

> Use a peak output level of 2.5 watts or less on all of these modes.
> Stay within the operating pass band (700Hz to 2200Hz)
> Operate with NO ALC showing.
> Use the DIG mode on your FT-817 (PSK USB)

RTTY - when operating RTTY, the Yaesu manual recommends that you use RTTY - Lower. Don't do that. Use PSK Upper for this mode. All of the software used for RTTY with sound cards is set up for USB operation. Also, you don't have to operate at the "normal" offsets of 2100 Hz for RTTY, you can set the offset at around 1200 Hz and the resulting signal will be the same. The frequency that you are actually transmitting will be the base frequency set on your FT-817 display plus the audio offset (1200 Hz).

MFSK16 - this mode is a very effective mode for QRP work. It excels on contacts at low Signal to Noise ratios, and on connections with Multi Path distortion such as long DX or polar paths.

SSTV - Slow Scan TV is a special case for digital work. SSTV contacts are normally initiated with a voice contact, identifying the station and the mode to be used. The SSTV data is sent after this voice setup. The SSTV areas are in the phone part of the band, and follow the normal rules for USB or LSB operation which are band sensitive for phone. (80 and 40 are LSB, others are USB). The design of the FT-817 is such that if you are using the microphone, you must be in either LSB or USB mode for the mic to be active. When you transmit using the Data Port, you must be in DIG mode. Hence you must switch modes on the panel of the FT-817 between phone and DIG. If you are operating on 80 or 40, then set DIG to PSK-L and phone on LSB. On other bands, use PSK-U and USB.   The frequency chart on the next page shows the assigned frequencies for SSTV operation.

CW from the computer - the rig can be operated in CW mode using the sound card to generate the signal. Set up your operating software to "CW Out Using Soundcard" set the cursor on the waterfall at 1000 Hz. This will generate signals at the rig base frequency plus 1 KHz, and produce a side tone when listening of 1 KHz. Use your waterfall display and move the frequency dial on your rig to bring desired signals to the 1000 Hz point on the display.   Your transmitted signal will be right on frequency.   The CW data detection of the software is "fair" - use it on strong signals with an operator with a good fist. You will not be operating in break in mode - the receiver is off until you return to the RX mode.

CW modes using the key or paddle - some operators prefer to use the key or paddle when transmitting, and use only the computer in receive mode as a tuning aid, and as a back up for copying CW. If this is your mode of operation, set the mode to CW. You can still see the signal on your waterfall display. You just won't be able to transmit code under computer control.

Optional Filter Use - If you have the optional 500 Hz filter available, set it for use in the SSB mode and use the Pass Band Tuning on the rig to center the filter over the signal of interest on the waterfall. For PSK operations, the filter is normally not needed and you are better off with the full bandwidth display. For CW operation, since you are probably copying the code from the audio, the filter can be very useful.

Web Links Listed below are links to useful web pages having to do with Amateur Radio.
see also : kk7uq.hfradio.org/links_to_ham_pages.htm for updates to this list.

URL	Author	Comment
www.psk31.com	K1VY	Neil Rosenburg's website for psk31
www.qsl.net/wm2u/interface.html	WM2U	Ernie Mills very complete psk31 site
www.K1DWU.net/ham-links	K1DWU	4500 Ham-Links
www.teleport.com/~nb6z/	NB6Z	Griff's Digital and Antenna pages
www.ssiserver.com/info/psk31	KF6VSG	"PSK-31 101", Excellent presentation given to Pacificon
www.kv7x.com	KV7X	Station set up for Digital Use with excellent section on Pegasus/Jupiter
www.ham-radio.ch/	PE1MHO	Interface and Software for FT817 Applications

Frequencies for Various Digital Modes

Band	BPSK31 BPSK63 QPSK31		MFSK16, Throb, Helleschreiber MT63	
80 meter	3.580 MHz	USB	3.580 MHz	USB
40 meter	7.070 MHz	USB	7.037 MHz & 7.080 MHz USB	
30 meter	10.139 MHz	USB	10.147 MHz	USB
20 meter	14.070 MHz	USB	14.080 MHz	USB
17 meter	18.095 MHz	USB	18.104 MHz	USB
15 meter	21.070 MHz	USB	21.080 MHz	USB
12 meter	24.920 MHz	USB	24.929 MHz	USB
10 meter	28.120 MHz	USB	28.080 MHz	USB

SSTV

80 meter	3.845 MHz	LSB (voice & SSTV) use LSB for voice DIG-L for SSTV
40 meter	7.228 MHz	LSB (voice & SSTV) use LSB for voice DIG-L for SSTV
20 meter 1	14.230 MHz	USB (voice & SSTV) use USB for voice DIG-U for SSTV
20 meter 2	14.233 MHz	USB (voice & SSTV) use USB for voice DIG-U for SSTV
15 meter	21.340 MHz	USB (voice & SSTV) use USB for voice DIG-U for SSTV
10 meter	28.680 MHz	USB (voice & SSTV) use USB for voice DIG-U for SSTV

Digital Mode Software **Popular software available for various Sound Card modes are listed here:**

Program	Web URL
Author	**Modes supported**
Digipan	www.digipan.net/
KH6TY	PSK31, PSK63
Hamscope	www.qsl.net/hamscope/
KD5HIO	PSK31, MFSK16, RTTY & CW
IZ8BLY Stream	iz8bly.sysonline.it/Stream/streamsetup.exe
IZ8BLY	PSK31, MFSK8, MFSK16
MixW	www.mixw.net/
	(US Site): www.nvbb.net/~jaffejim/downloads.htm
UT2UZ &	FSK31, PSK31, PSK63, MFSK, RTTY, CW, Throb, SSTV
UU9JDR	Packet, Pactor, Amtor, MT63, Helleschreiber, Fax

Note: MixW is the only software with a user fee ($50 one time). It is a very complete package, covering all the digital modes in one package.

MMSSTV	www.qsl.net/mmhamsoft/mmsstv/
JE3HHT	SSTV
MMTTY	www.qsl.net/mmhamsoft/mmtty/
JE3HHT	RTTY

The RTTY engine used in MMTTY is also used in Hamscope and other software

PSK Deluxe	www.ham-radio.ch/
HB9DRV	PSK31, PSK63
	Also integrated FT-817 CAT & PSK31/63 packages available
WinPSK	www.qsl.net/ae4jy/
AE4JY	PSK31
Winwarbler	www.qsl.net/winwarbler/
AA6YQ	PSK31, RTTY
W1SQLPSK	www.w1sql.com/
W1SQL	PSK31
Zakanaka	www.qsl.net/kc4elo/
K4CY	PSK31

The popular Logger program is integrated with the Zakanaka software

Acknowledgments: Thanks to Chris Jones, N7ZW, for loan of equipment, elmering on operation of the FT-817, and getting me hooked on QRP/PSK with the FT817.

Comments? Need Additional Info?

Email Clint Hurd kk7uq at: discobay@waypt.com