

FreeDV Plus Doc C

*** FreeDV plus Video Setup ***

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INTRODUCTION

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This document describes a setup for FreeDV plus Video. FreeDV is a popular digital voice mode using frequency division multiplex signals. FreeDV plus Video adds 36-line video at 1 frame/sec to the voice signal. Most FreeDV operation is on 14236 kHz, on the 20-meter amateur radio band.

NOTE: This video component of the FreeDV plus video signal described in this document is compatible only with the FreeDV "1600" mode (it is NOT compatible with the older "1400" mode).

See the FreeDV plus Video website for more information:

<http://www.qsl.net/wa6nut/FreeDVplusvideo>

Demo videos of FreeDV plus Video have been uploaded to YouTube:

<http://youtu.be/Ms0Ea4Ewghc>

<http://youtu.be/AE09qcg3eyk>

Three block diagrams are included in this PDF document.

PC Connections	Hardware configuration for the Video TX/FreeDV PC and Video RX PC.
Video RX PC Setup	Software configuration for the Video RX PC
Video TX/FreeDV PC Setup	Software configuration for the Video TX/FreeDV PC

A diagram showing the baseband spectrum for FreeDV plus Video is also included:

FreeDV plus Video Spectrum	Shows locations of the 66 subcarriers, including the B58 subcarrier used for tuning the received video signal.
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Four screenshots are also included.

FreeDV1	Shows Video RX PC screen (the receiving station is receiving live video, along with FreeDV voice, from WA6NUT).
FreeDV2	Same as FreeDV1, with

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other operator (WA6NUT)
closer to camera

FreeDV3 Same as FreeDV1, with
other operator holding
license plate up to
camera

FreeDV4 Shows Video TX/FreeDV PC
screen, displaying the
spectrum and ID from WA6NUT
(the receiving station is
preparing to send an AVI
video clip, WNDSURF1.AVI,
to WA6NUT).

Four applications are included, along with files
used with the applications (all files should be
located in the same folder):

RXfftDIFF7L.exe The application for
receiving the video portion
of the FreeDV plus Video
signal (used also for
recording received video as
a ".49" file)

TXfftC05L.exe The application for
transmitting the video
portion of the FreeDV plus
Video signal

TESTPATT.ini The text file used by
TXfftC05L.exe for the
text "crawl" below the
transmitted video (this
file can be edited in
Notepad for a customized
"crawl" -- up to 255
characters total). This
feature works best in
Windows XP.

WNDSURF1.AVI The Microsoft test video
useful for testing the
TXfftC05L.exe app.

RxReplay7A.exe The application for playing
back recorded ".49" files

WNDSURF1.49 A test file useful for
testing the RxReplay7A.exe
app (note the text "crawl"
below the video image)

PTTtoggle.exe A utility useful for test-
ing video without FreeDV
(In normal operation, the
PTT function is provided
by the FreeDV application).

Links are given below for the remaining apps
necessary to operate FreeDV plus Video.

The reader should note that your results may vary —
this document describes an optimum setup for my

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particular sound cards, operating systems and
transceiver -- you may need to experiment to find
the optimum setup for your sound cards, operating
systems and transceiver.

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HARDWARE
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Hardware is connected as shown in the PC Connections
block diagram.

Video TX/FreeDV PC (HP/Compaq nc8430 laptop)

USB Hub	Belkin F5U237 (or equivalent) Required only if Video TX/ FreeDV PC has only 1 or 2 USB ports.
USB-to-Serial Cable	Gigaware (Radio Shack P/N 26-949). Required only if Video TX/FreeDV PC has no serial port and sound card interface requires a serial port input for the PTT output to the transceiver.
USB Sound Cards (2)	Turtle Beach Amigo II (or equivalent)
USB Webcam	Logitech E3560 (or equivalent)
Powered Speakers	Cyber Acoustics CA-2014RB Radio Shack 55019356 (or equivalent)
Computer Mic	Cyber Acoustics CVL-1064RB (or equivalent)
Sound Card Cables (2)	6-ft shielded cable, 1/8" stereo plugs at each end Radio Shack 42-2387

Video RX PC (Acer Aspire 5516)

Sound Card Cables (2)	6-ft shielded cable, 1/8" stereo plugs at each end Radio Shack 42-2387
Y Adapter (1)	Accepts 2 1/8" stereo plugs, fits 1/8" stereo jack Radio Shack 274-313

Sound Card Interface	Homebrew Bruce Randall, W1ZE, "HF Digital Modes, a Lot of Fun", Yavapai Signal, May 2007, pp. 10-11 Yavapai Amateur Radio Club http://www.rahughes.net/signal/ wp-content/uploads/2015/10/
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May07.pdf
Substitute Triad TY-145P (Jameco
P/N 630459) for Radio Shack
transformers.
<http://jameco.com>

HF Transceiver	Apache Labs ANAN-10E (with PowerSDR software including PureSignal adaptive pre- distortion)
Amplifier	HF Packer 2 with PSU-36V board for operation with 36 Vdc supply. http://www.hfprojectsyadoo.com/
Amplifier	Ameritron AL-811

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INSTALLED SOFTWARE
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The PC Setup block diagrams show signal flow between the
software applications for each PC.

video TX/FreeDV PC (HP/Compaq nc8430 -- windows 7)

FreeDV v.1.1.0 Download:
<http://freedv.org>

Documentation:
<http://freedv.org>

TXfftC05L.exe Included in this distribution

Video RX PC (Acer Aspire 5516 -- windows Vista)

RXfftDIFF7L.exe Included in this distribution

winwarbler Download:
[http://www.dxlabsuite.com/
winwarbler](http://www.dxlabsuite.com/winwarbler)

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SOFTWARE SETTINGS
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Video TX/FreeDV PC (HP/Compaq nc8430 -- windows 7)

"SoundMAX Integrated HD Audio" = Motherboard sound card
"Turtle Beach USB Audio" = TX USB sound card
"2- Turtle Beach USB Audio" = RX USB sound card

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See the Video TX/FreeDV PC screenshot

FreeDV v.1.1.1.0 TX/RX button on the FreeDV Graphic User Interface (GUI) will be used to control the transceiver PTT

Tools --> Audio Config

Receive

From Radio: Device Sample Rate

Microphone (2- Turtle Beach USB Audio) 48000*

To Speaker/Headphones Sample Rate

Speakers (2- Turtle Beach USB Audio) 48000*

Transmit

From Microphone Sample Rate

Microphone (SoundMAX Integrated HD Audio) 48000*

To Radio Sample Rate

Speakers (SoundMAX Integrated HD Audio) 48000*

Tools --> PTT Config

Hardware PTT Settings**

Use Serial Port PTT --> COM1

Signal polarity

Use RTS --> RTS = +V

It may be necessary to drag the bottom of the FreeDV GUI down so that the "Clear" and "PTT" buttons are visible.

Check the "1400 v0.91" radio button, then click on the "Start" button.

The PTT button will be used to switch the transceiver between TX and RX modes.

See "Receiving the FreeDV Portion of the Signal" below.

* Type in "48000" if "Sample Rate" list comes up blank.

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** QST article: Steve Ford, WB8IMY,
"A COM Port Too Far", QST, July 2012
p. 60.

Sound Playback (FreeDV TX subcarrier level) "TX LEVEL 1" on Setup diagram

Control Panel --> Sound --> Playback

Highlight "Speakers (SoundMAX Integrated Digital HD Audio)"

Click "Properties" button.

Levels: Speakers slider sets level of FreeDV subcarriers with respect to video subcarrier level (set to "20").*

Line In: Muted
PC Beep: Muted

Recording Control (FreeDV TX subcarrier level) "TX LEVEL 2" on Setup diagram

Control Panel --> Sound --> Record

Highlight "Microphone (Turtle Beach USB Audio)"

Click "Properties" button.

Levels: Microphone slider sets level of FreeDV subcarriers with respect to video subcarrier level (set to "25").*

Sound Playback (TX Power Level) "TX LEVEL 3" on Setup diagram

Control Panel --> Sound --> Playback

Right-click on "Speakers (Turtle Beach USB Audio)"

Click on "Set as Default Device" (if not already set as default).

Highlight "Speakers (Turtle Beach USB Audio)."

Click "Properties" button.

Levels: Speakers slider sets TX power level of composite TX signal (set to "30").**

See "Transmitting Adjustments" below.

Recording Control (FreeDV TX mic level)

Control Panel --> Sound --> Recording

Right-click on "Microphone (SoundMAX Integrated Digital HD Audio)"

Click on "Set as Default Device" (if not already set as default).

Highlight "Microphone (SoundMAX Integrated Digital HD Audio)."

Click "Properties" button.

Levels: Microphone slider sets mic

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Level to FreeDV encoder.

See "Transmitting Adjustments" below.

Recording
Control
(FreeDV
RX input
level)

Control Panel --> Sound --> Recording

Highlight "Microphone (2- Turtle
Beach USB Audio)."

Click "Properties" button.

Levels: Microphone slider sets the RX
input level to the FreeDV decoder.

Sound Playback
(FreeDV RX
Output Speaker
Volume)

Control Panel --> Sound --> Playback

Highlight "Speakers (2- Turtle Beach
USB Audio")

Click "Properties" button.

Levels: Speakers slider sets the
FreeDV output level from the USB
speakers.

* The TX LEVEL 1 and TX LEVEL 2 slider
controls are used to set the level of
the FreeDV subcarriers with respect to
the the level of the video subcarriers
(the middle FreeDV subcarrier level
should be set just below the level of
the surrounding video subcarriers).

** The TX LEVEL 3 slider control sets the
level of the composite signal (the
transmitted power level).

Proper adjustment of these controls will
ensure reduced IM products between the
FreeDV and video subcarriers, resulting
in video with little or no noise.

TXfftC05L.exe Select Camera input,
 or File --> Open

Select AVI file and click Open
button (AVI file must be located
in the same folder as
TXfftC05L.exe) First frame of
AVI file will be displayed on
GUI. Click on Pause/Play button
to start video (does not control
transceiver TX/RX).

It may be necessary to drag the
bottom of the TXfftC05L GUI down
so that the Pause/Play button is
visible.

Video RX PC (Acer Aspire 5516: windows Vista)

"Realtek HD Audio" = Motherboard sound card

See the Video RX PC screenshot

Recording (RX input level) Control Panel --> Sound --> Recording

Right-click on "Microphone (Realtek HD Audio)."

Click on "Set as Default Device" (if not already set as default).

Highlight "Microphone (Realtek HD Audio)."

Click "Properties" button.

Levels: Microphone slider sets RX level to RXfftDIFF7L.exe and winwarbler.exe

See "Receiving the Video Portion of the Signal" below.

winwarbler AFC checkbox = checked

(winwarbler.exe) Click Config button --> Soundcard

Set PSK soundcard = "Realtek HD Audio"

Set Phone soundcard = "Realtek HD Audio"

Drag GUI up (mouse remaining clicked on upper border of GUI) making more of the waterfall (at lower part of GUI) visible

See "Receiving the Video Portion of the Signal" below.

RXfftDIFF7L.exe

+ half pixel	= checked
Interpolate vertical pix	= checked
Filter horizontal pix	= checked
Noise filter (light)	= checked
Brightness slider control	= 25% up
Contrast slider control	= 100% up
Fine Tune slider control	= center (default)
Coarse Tune slider control	= center (default)
Colour Balance slider control	= 67 (default)
Saturation slider control	= 100 (default)

See "Added Features in the RXfftDIFF7L.exe and RxReplay7A.exe Apps" below.

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RECEIVING THE VIDEO PORTION OF THE SIGNAL

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See Software Settings for the Video RX PC above. Also see the Video RX PC screenshot (note the yellow B58 video subcarrier on the WinWarbler waterfall and the Freq readout = 2.175 kHz)

The FreeDV portion of the received signal is tuned AFTER the receiver is tuned for a good quality video image.

1. First, the winwarbler AFC is locked to the B58 subcarrier (B58 is the video subcarrier just above the highest FreeDV subcarrier). Click anywhere in the top winwarbler textbox, then click on the B58 subcarrier on the waterfall. The B58 subcarrier will begin scrolling down as a yellow trace (depending on signal strength, you may need to repeat until the AFC locks to the B58 subcarrier).
2. If the winwarbler Freq readout value is BELOW 2.175 kHz, tune the receiver DOWN in 1 Hz steps until 2.175 kHz is indicated. If the Freq readout value is ABOVE 2.175 kHz, tune the receiver UP in 1 Hz steps until 2.175 kHz is indicated. Further adjustment may be required to obtain the truest hues in the video image. If the indicated value is low (below 2.175 kHz), the video image will show greenish hues. If the indicated value is high (above 2.175 kHz), the video image will show reddish hues.
3. Unlike the FreeDV software, the RXfftDIFF7L.exe software does not incorporate an AFC feature. So it will be necessary to adjust the receiver tuning slightly to compensate for frequency drift in the other station's transmitter and/or the local receiver. Both transceivers should be operated in the split mode so that the receiver is tuned independently of the transmitter (both transmit frequencies should remain unchanged). The AFC in the FreeDV software should easily track the small changes in receiver tuning required to maintain good quality in the video image.

Expect 4 Hz shift (from 2.171 kHz to 2.175 kHz) in the indicated frequency when changing from an all-black video image (such as the title frame of WNDSURF1.AVI) to a full-color motion image.

4. Set the Microphone slider control low enough so the WinWarbler "Receive soundcard overload!" message is not displayed.

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ADDED FEATURES IN THE RXfftDIFF7L.exe and RxReplay7A.exe APPS

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Recording Received Video

RXfftDIFF7L.exe can be used to record the video portion of the received signal for later playback using the RxReplay7A.exe application. This feature is especially useful when an .AVI video clip has been transmitted at 1 frame/sec, because RxReplay7A.exe will permit replay at 10 frames/sec. Thus replay is possible as full motion video.

RXfftDIFF7L.exe records the received video as a ".49" file.

Processing of Recorded Video

The RxReplay7A.exe app can only play back ".49" video files. Each frame of the ".49" file is sent to the windows Clipboard as it is displayed.

If live video was recorded in the ".49" file, the jerky 1 frame/sec video can be processed into smooth 10 frames/sec video using special software. The author uses AVI Constructor to convert the ".49" file, sent frame-by-frame to the Clipboard from RxReplay7A.exe, to an .AVI file. Then MotionPerfect is used to provide frame interpolation, converting the 1 frame/sec .AVI file to another .AVI file at 10 frames/sec.

Trial versions of both AVI Constructor and MotionPerfect are available online. See:

<http://www.aviconstructor.com/>

<http://www.goodervideo.com/download/index.html>

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RECEIVING THE FreeDV PORTION OF THE SIGNAL

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See Software Settings for the Video TX/FreeDV PC above. Also see the Video TX/FreeDV PC screenshot.

TUNING: After the video portion of the received FreeDV plus video signal has been tuned using the above procedure, the FreeDV AFC should ensure that the FreeDV signal is correctly tuned.

SQUELCH: The Squelch (SQ) slider should be set low enough to avoid missing syllables and high enough to avoid digital ("R2D2") noise in decoding.

SNR: Signal-to-Noise Ratio (SNR) peaks of 8-11 should be expected with FreeDV plus Video operation with strong (S6) signals. Without video (FreeDV alone), SNR readings of 15-17 should be obtained.

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TRANSMITTING ADJUSTMENTS

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See Software Settings for the Video TX/FreeDV PC above. Also see the Video TX/FreeDV PC screenshot. This discussion assumes that the TX LEVEL 1 and TX LEVEL 2 slider controls have set the correct FreeDV subcarrier levels with respect to the video subcarriers.

Mic Gain

Set the motherboard sound card Mic gain slider control (SoundMAX Integrated Digital HD Audio in the author's setup) so that, while transmitting, the peaks of the audio waveform on the FreeDV GUI are about +/- 60% of full scale.

Output Power Level

These transmitting adjustments are made while transmitting into a dummy load and monitoring output power with an RF power meter.

On the Video TX/FreeDV PC, open the windows Sound Playback GUI. Set the TX USB sound card ("Turtle Beach USB Audio" in the author's setup) speaker level slider (TX LEVEL 3) control to 0% (left). Click the FreeDV TX button, keying the transceiver into the TX mode. SLOWLY slide the speaker level slider control to the right until the RF power meter indicates approximately 20% of the rated output power for your transceiver or amplifier. This will be the setting for best SNR -- higher settings will provide more power, but will result in poorer decoding due to distortion.

Adaptive Predistortion

FreeDV plus Video combines digital voice and video using a technique called "Frequency Division Multiple Access" (FDMA). FDMA is particularly susceptible to intermodulation distortion (IMD) caused by nonlinearity in the transmitter hardware. IMD can cause interference on neighboring frequencies. Adaptive distortion, a feature available on some SDR transceivers, generates a correction signal to cancel the nonlinearity ("PureSignal" is the software implementation of adaptive predistortion in SDR transceivers from Apache Labs). The quality of the FreeDV plus Video signal is greatly improved when used with transceivers employing adaptive predistortion.

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ACKNOWLEDGMENTS
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Thanks to Con Wassilieff, ZL2AFP, for kindly allowing me to modify his analog OFDM NBTv software for use with FreeDV.

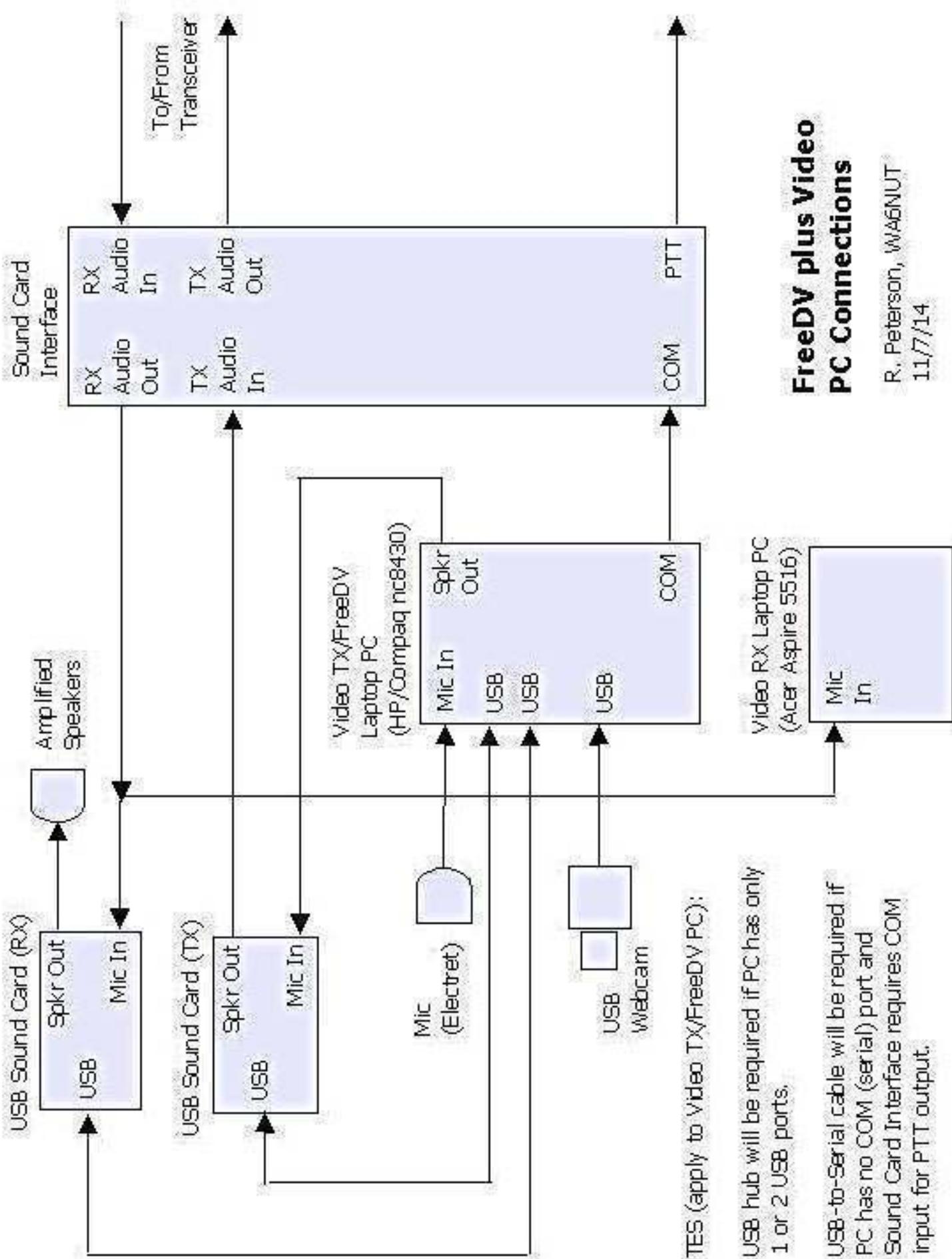
Thanks also to Mel Whitten, KØPFX, and Gerry Helder, N4DV, for their patient on-the-air help to improve the SNR of my FreeDV signal.

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LAST REVISION
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The original document has been revised with references to windows XP deleted and replaced by references to windows Vista and windows 7.

This latest revision also adds provisions for adjusting the FreeDV subcarrier level with respect to the video subcarrier level, to ensure better video quality. This revision also describes software compatible with the "1600" FreeDV mode.

This document last revised: 3/14/16

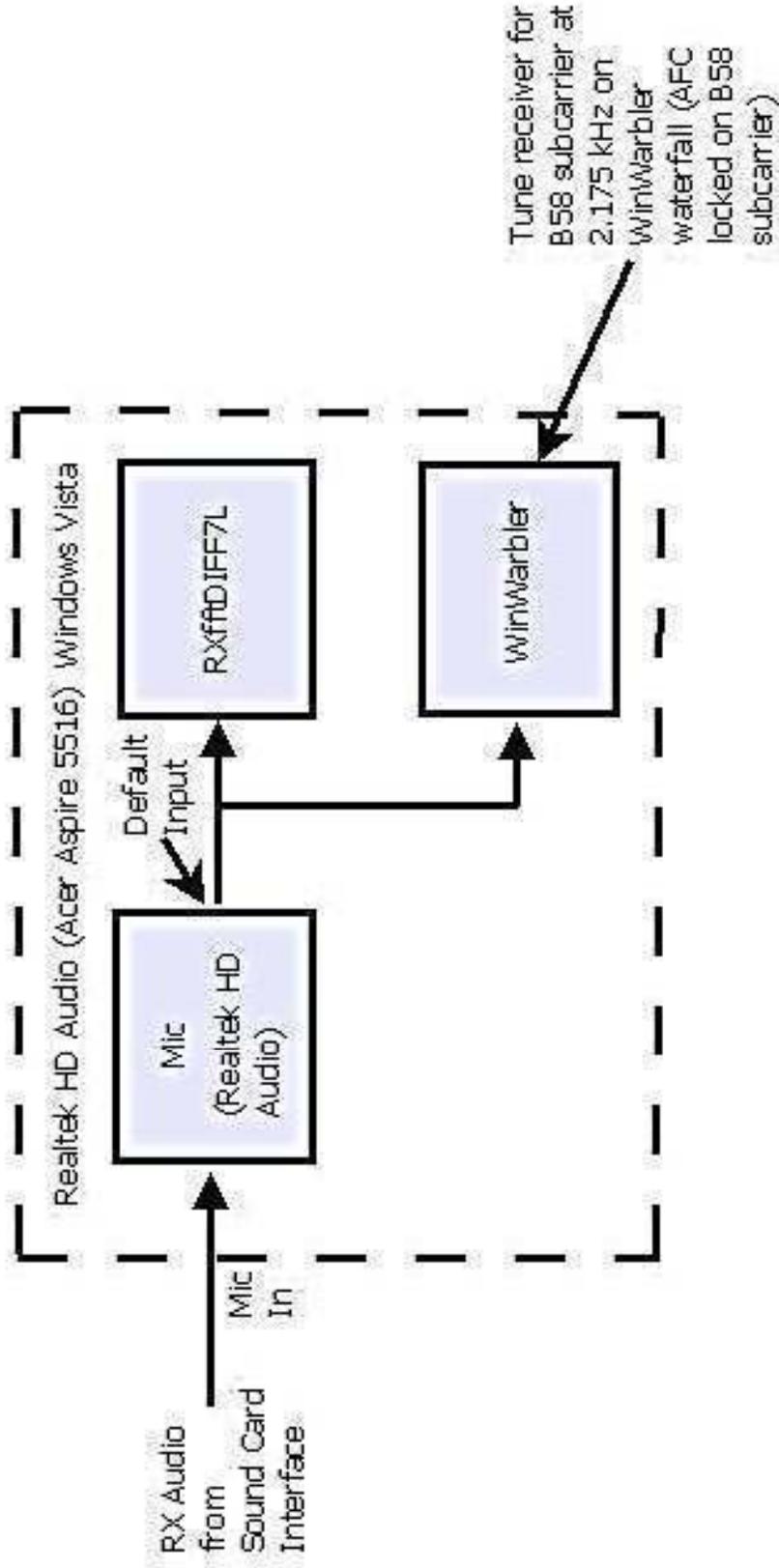


NOTES (apply to Video TX/FreeDV PC):

1. USB hub will be required if PC has only 1 or 2 USB ports.
2. USB-to-Serial cable will be required if PC has no COM (serial) port and Sound Card Interface requires COM input for PTT output.

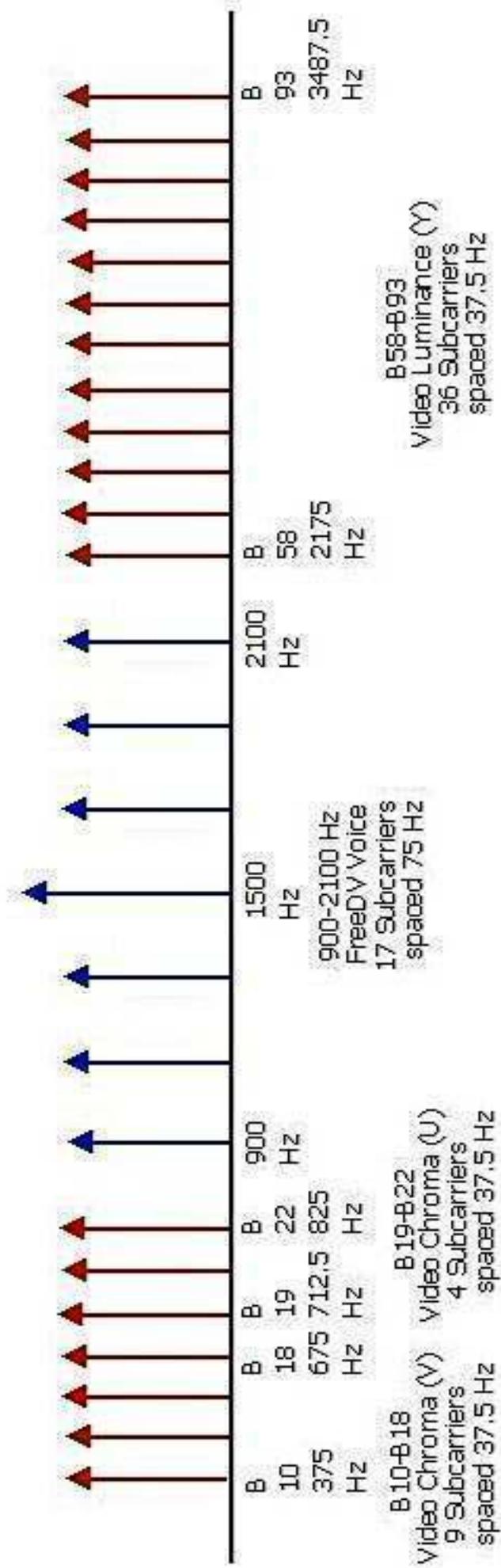
FreeDV plus Video PC Connections

R. Peterson, WA6NUT
11/7/14



FreeDV plus Video Video RX PC Setup

R. Peterson, WA6NUT
3/8/16



FreeDV plus Video Baseband Spectrum

R. Peterson, WA6NUT
3/8/16

Microphone Properties

General Levels Enhancements Advanced

Microphone

Microphone Boost

OK Cancel Apply

Grid Your Freq [0] Spot Log Help

DKCC Config

Multi-carrier Colour/Monochrome TV receiver (FreeDV+)

File Screen Size Adjust input Noise filter Help

+ half pixel
 Interpolate vertical pix
 Filter horizontal pix
 Noise filter (light)

Brightness Contrast

.....Fine Tune..... 0.0 Hz

.....Coarse Tune.....

.....Colour Balance..... 67

.....Colour Balance..... 100%

MOND<.....Saturation.....>COLOUR

Open file to save Close file Start save

0 frames saved

Receive Channel 0 (BPSK31 USB)
 Freq: 2.174

Transmit (BPSK31 USB)
 Freq: 3.707

Mode: CW PSK31
 Phone PSK63
 RTTY

Tuning Display
 Vert height
 Horiz zoom
 Horiz pan

QSO Sat Freq Start CW ID Stop Abort

F1 F2 F3 F4 Esc
 F5 F6 F7 F8 F9 F10 F11 F12

sh F5 sh F6 sh F7 sh F8 sh F9 sh F10 sh F11 sh F12

IMD p: ~ 55

Microphone Properties

General Levels Enhancements Advanced

Microphone

Microphone Boost

OK Cancel Apply

Grid Your Freq Spot Log Help

Multi-carrier Colour/Monochrome TV receiver (FreeDV+)

File Screen Size Adjust input Noise filter Help

+ half pixel
 Interpolate vertical pix
 Filter horizontal pix
 Noise filter (light)

Brightness Contrast
Fine Tune..... 0.0 Hz
Coarse Tune.....
Colour Balance..... 67
Saturation.....>COLOUR 100%

MOND<.....> COLOUR
 Open file to save Close file Start save
 0 frames saved

Receive Channel 0 (BPSK31 USB)
 Freq: 2.174 56 IMD p:

Transmit (BPSK31 USB)
 Freq: 3.707 net tune ID:
 QSO Sat Freq Start CW ID Stop Abort
 F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 sh.F10 sh.F11 sh.F12

Mode
 CW PSK31
 Phone PSK63
 RTTY

Tuning Display
 Vert height
 Horiz zoom
 Horiz pan

Microphone Properties

General Levels Enhancements Advanced

Microphone

Microphone Boost

OK Cancel Apply

Grid

Your Freq

DKCC

Spot

Log

Config Help

Multi-carrier Colour/Monochrome TV receiver (FreeDV+)

File Screen Size Adjust input Noise filter Help

+ half pixel
 Interpolate vertical pix
 Filter horizontal pix
 Noise filter (light)

Brightness Contrast

.....Fine Tune..... Coarse Tune.....

.....Colour Balance.....

MOND<.....Saturation.....>COLOUR

Open file to save Close file Start save

0 frames saved

Receive Channel 0 (BPSK31 USB)
 Freq: 2.174

Transmit (BPSK31 USB)
 Freq: 3.707

Mode: CW PSK31
 Phone PSK63
 RTTY

Tuning Display
 Vert height
 Horiz zoom
 Horiz pan

Receive: F6 sh F6 F7 sh F7 F8 sh F8 F9 sh F9 F10 sh F10 F11 sh F11 F12 sh F12

Transmit: QSO Sat Freq F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12

IMD p:

0 1 2 3



EN < > WinWarbler 4.5.0 ... Sound

FreeDV 1.1

Multi-carrier Col...

Ortho Ver. K

FreeDVPlusDistroC

11:07 AM

