*** FreeDV plus Video Setup ***

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INTRODUCTION

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: The video component of the FreeDV plus Video signal is compatible only with the FreeDV "1400" mode (it is NOT compatible with the "1600" 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/MsOEa4Ewghc

http://youtu.be/AEO9qcg3eyk

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 64 subcarriers, including the B56 subcarrier used for tuning the received video signal.

Two screenshots are also included.

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

RXfftDIFF7K.exe	The application for receiving the video portion of the FreeDV plus Video signal (used also for recording received video as a ".49" file)
TXfftCO5K.exe	The application for transmitting the video portion of the FreeDV plus Video signal
TESTPATT.ini	The text file used by TXfftCO5K.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 TXfftCO5K.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 testing 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 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.

HARDWARE

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.w7yrc.org/Newsletters /2007/May07.pdf Substitute Triad TY-145P (Jameco P/N 630459) for Radio Shack transformers. http://jameco.com
HF Transceiver	Ten Tec Jupiter (older gray-case green-screen model)

Amplifier	HF Packer 2 with PSU-36V board for operation with 36 Vdc supply. http://www.hfprojectsyahoo.com/
Amplifier	Ameritron AL-811

INSTALLED SOFTWARE

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.0.97.1	Download: http://freedv.org Documentation: http://freedv.org
TXfftCO5K.exe	Included in this distribution

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

RXfftDIFF7K.exe	Included in this distribution
WinWarbler	Download: http://www.dxlabsuite.com/ winwarbler

SOFTWARE SETTINGS

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

See the Video TX/FreeDV PC screenshot

FreeDV v.0.97.1	TX/RX button on the FreeDV Graphic User Interface (GUI) will be used to control the transceiver PTT Tools --> Audio Config Receive

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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.

** 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 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.
TXfftCO5K.exe	Select Camera input, or File --> Open Select AVI file and click Open button (AVI file must be located in the same folder as TXfftCO5K.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 TXfftCO5K 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 RXfftDIFF7K.exe and winwarbler.exe

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

WinWarbler (winwarbler.exe)

AFC checkbox = checked

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.

RXfftDIFF7K.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 RXfftDIFF7K.exe and RxReplay7A.exe Apps" below.

RECEIVING THE VIDEO PORTION OF THE SIGNAL

See Software Settings for the Video RX PC above. Also see the Video RX PC screenshot (note the yellow B56 video subcarrier on the WinWarbler waterfall and the Freq readout = 2.100 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 B56 subcarrier

(B56 is the video subcarrier just above the highest FreeDV subcarrier). Click anywhere in the top WinWarbler textbox, then click on the B56 subcarrier on the waterfall. The B56 subcarrier will begin scrolling down as a yellow trace (depending on signal strength, you may need to repeat until the AFC locks to the B56 subcarrier).

2. If the WinWarbler Freq readout value is BELOW 2.100 kHz, tune the receiver DOWN in 1 Hz steps until 2.100 kHz is indicated. If the Freq readout value is ABOVE 2.100 kHz, tune the receiver UP in 1 Hz steps until 2.100 kHz is indicated. Further adjustment may be required to obtain the truest hues in the video image. If the indicated value is low (below 2.100 kHz), the video image will show greenish hues. If the indicated value is high (above 2.100 kHz), the video image will show reddish hues.

3. Unlike the FreeDV software, the RXfftDIFF7K.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 2.096 kHz to 2.100 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.

ADDED FEATURES IN THE RXfftDIFF7K.exe and RxReplay7A.exe APPS

Recording Received Video

RXfftDIFF7K.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.

RXfftDIFF7K.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

RECEIVING THE FreeDV PORTION OF THE SIGNAL

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.

TRANSMITTING ADJUSTMENTS

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.

ACKNOWLEDGMENTS

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

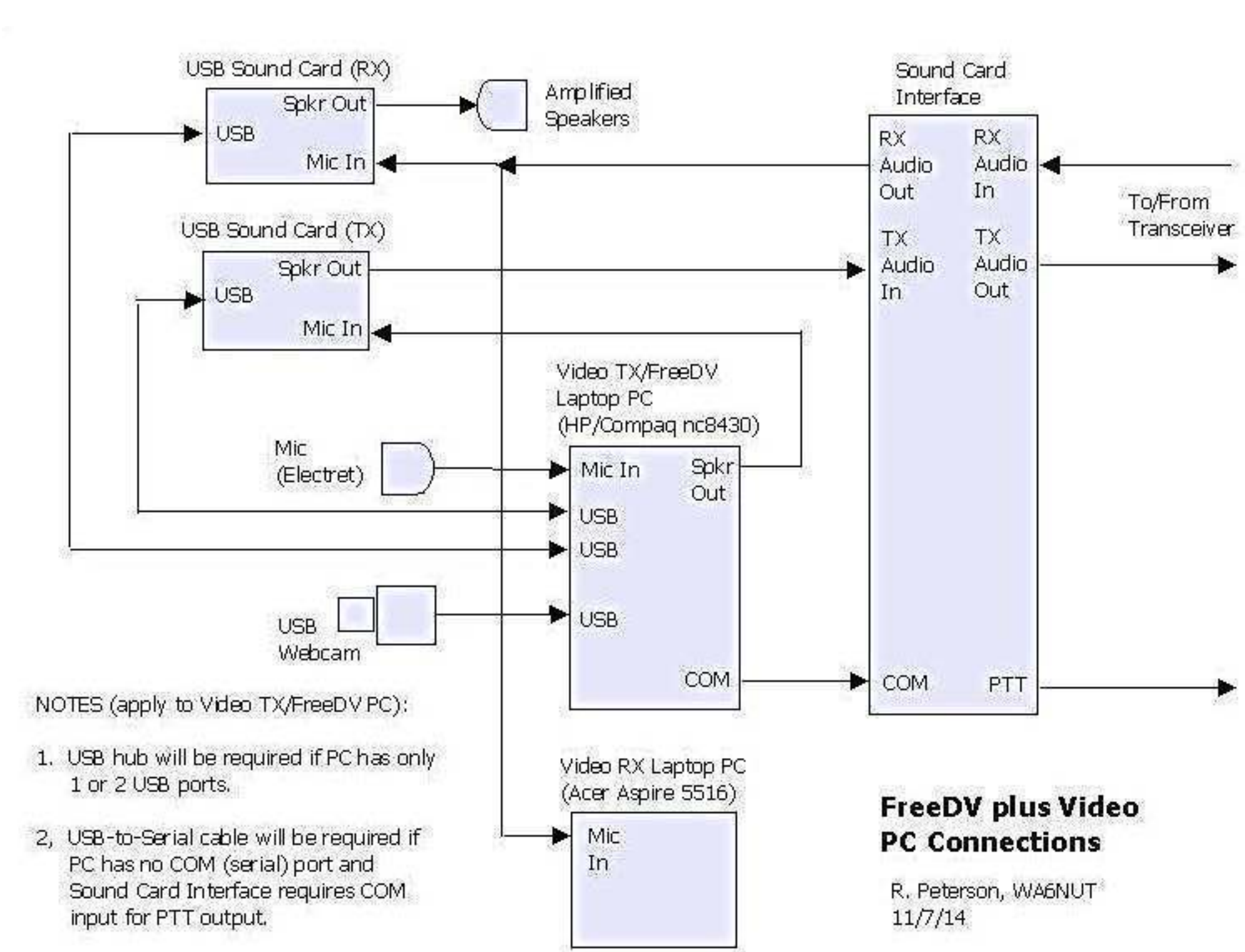
Thanks also to Mel Whitten, KØPFX, and Gerry Helder, N4DV, for their patient on-the-air help to improve the SNR of my FreeDV signal.

LAST REVISION

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 document last revised: 11/13/14



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

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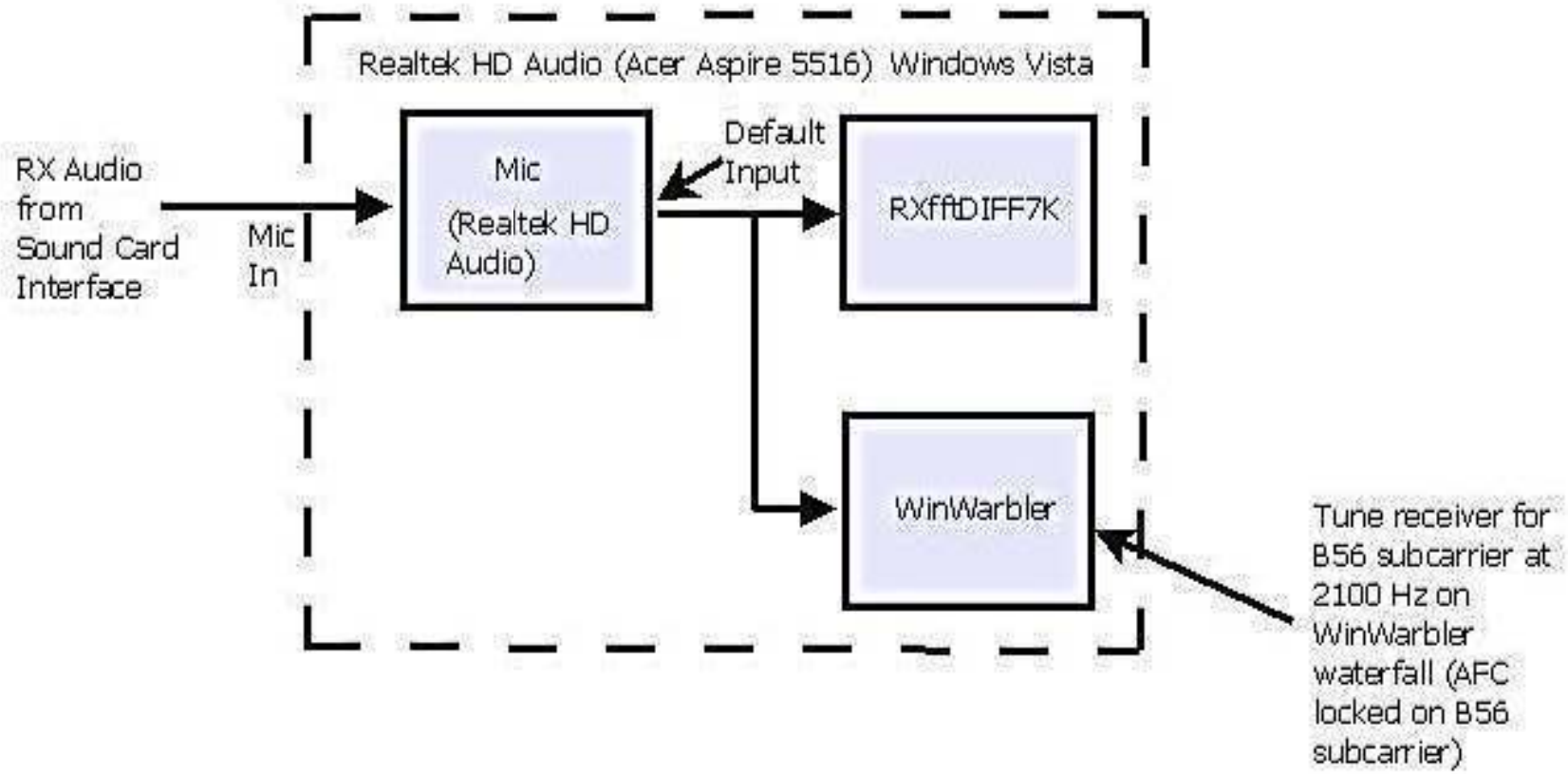

FreeDV plus Video

Video RX PC Setup

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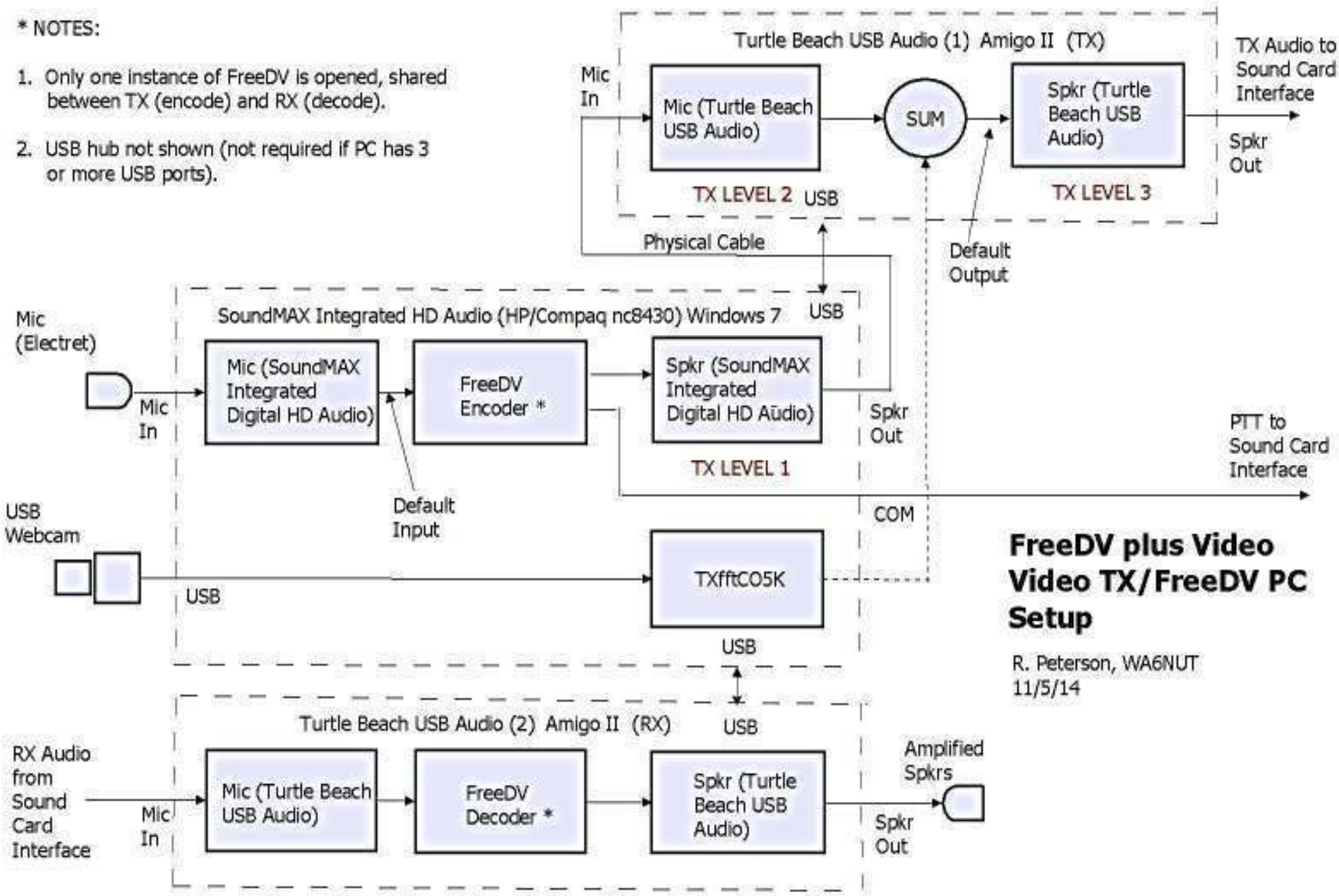
3/2/13


* NOTES:
1. Only one instance of FreeDV is opened, shared between TX (encode) and RX (decode).
2. USB hub not shown (not required if PC has 3 or more USB ports).
Turtle Beach USB Audio (1) Amigo II (TX)
Mic In
Mic (Turtle Beach USB Audio)
SUM
Spkr (Turtle Beach USB Audio)
TX Audio to Sound Card Interface
Spkr Out
TX LEVEL 2
USB
TX LEVEL 3
Physical Cable
Default Output
SoundMAX Integrated HD Audio (HP/Compaq nc8430) Windows 7
USB
Mic (Electret)
Mic In
Mic (SoundMAX Integrated Digital HD Audio)
FreeDV Encoder *
Spkr (SoundMAX Integrated Digital HD Audio)
Spkr Out
TX LEVEL 1
PTT to Sound Card Interface
Default Input
COM
USB Webcam
USB
TXfftCO5K
USB
FreeDV plus Video
Video TX/FreeDV PC Setup
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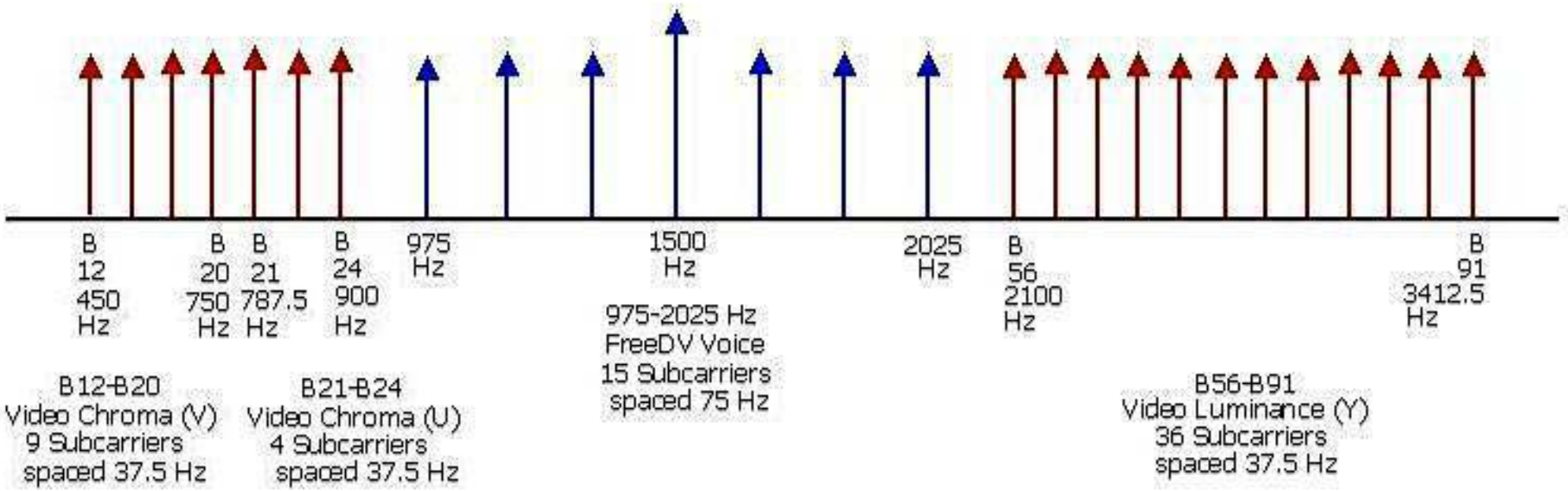
Turtle Beach USB Audio (2) Amigo II (RX)
USB
RX Audio from Sound Card Interface
Mic In
Mic (Turtle Beach USB Audio)
FreeDV Decoder *
Spkr (Turtle Beach USB Audio)
Amplified Spkrs
Spkr Out



FreeDV plus Video Baseband Spectrum

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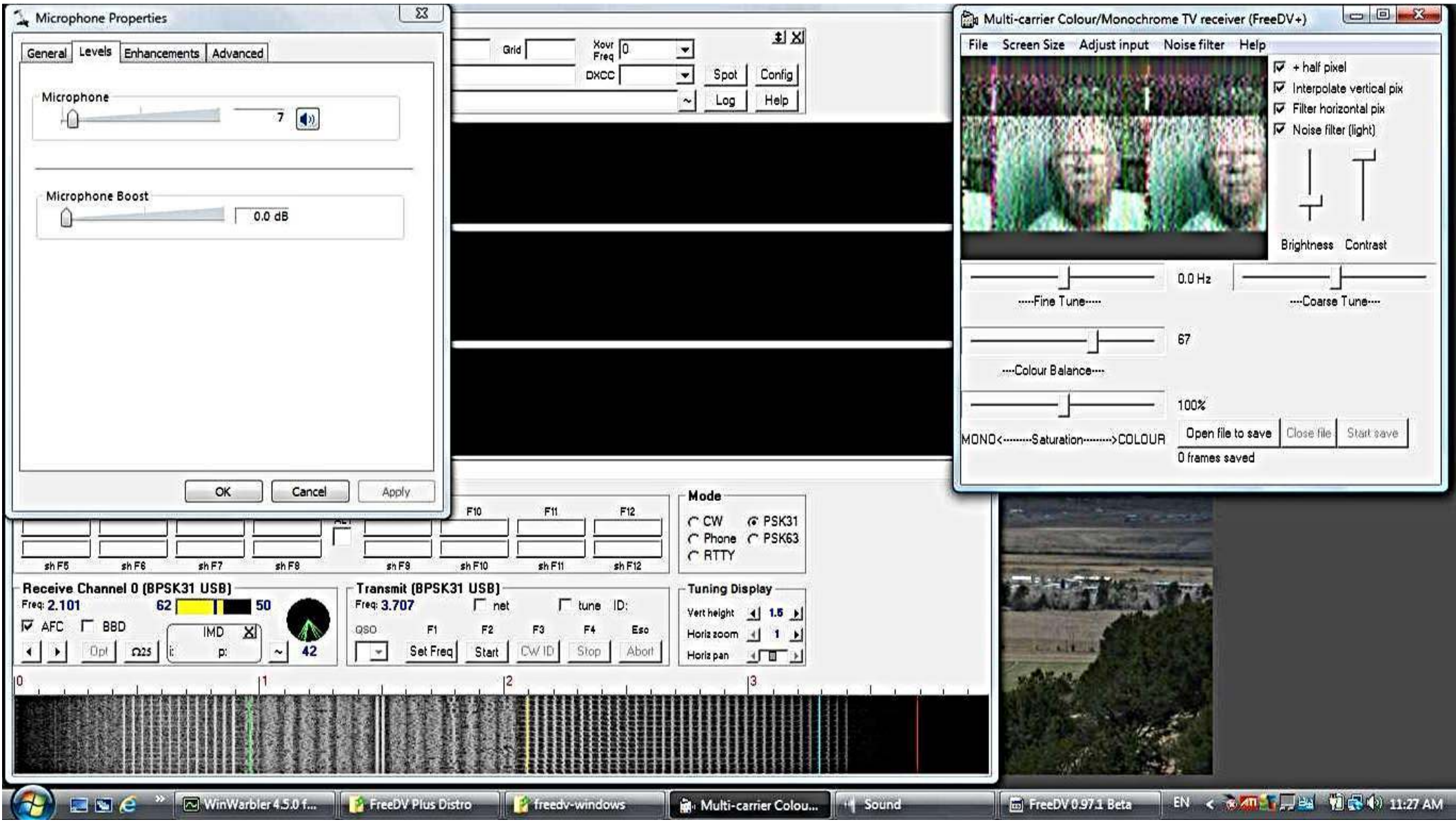
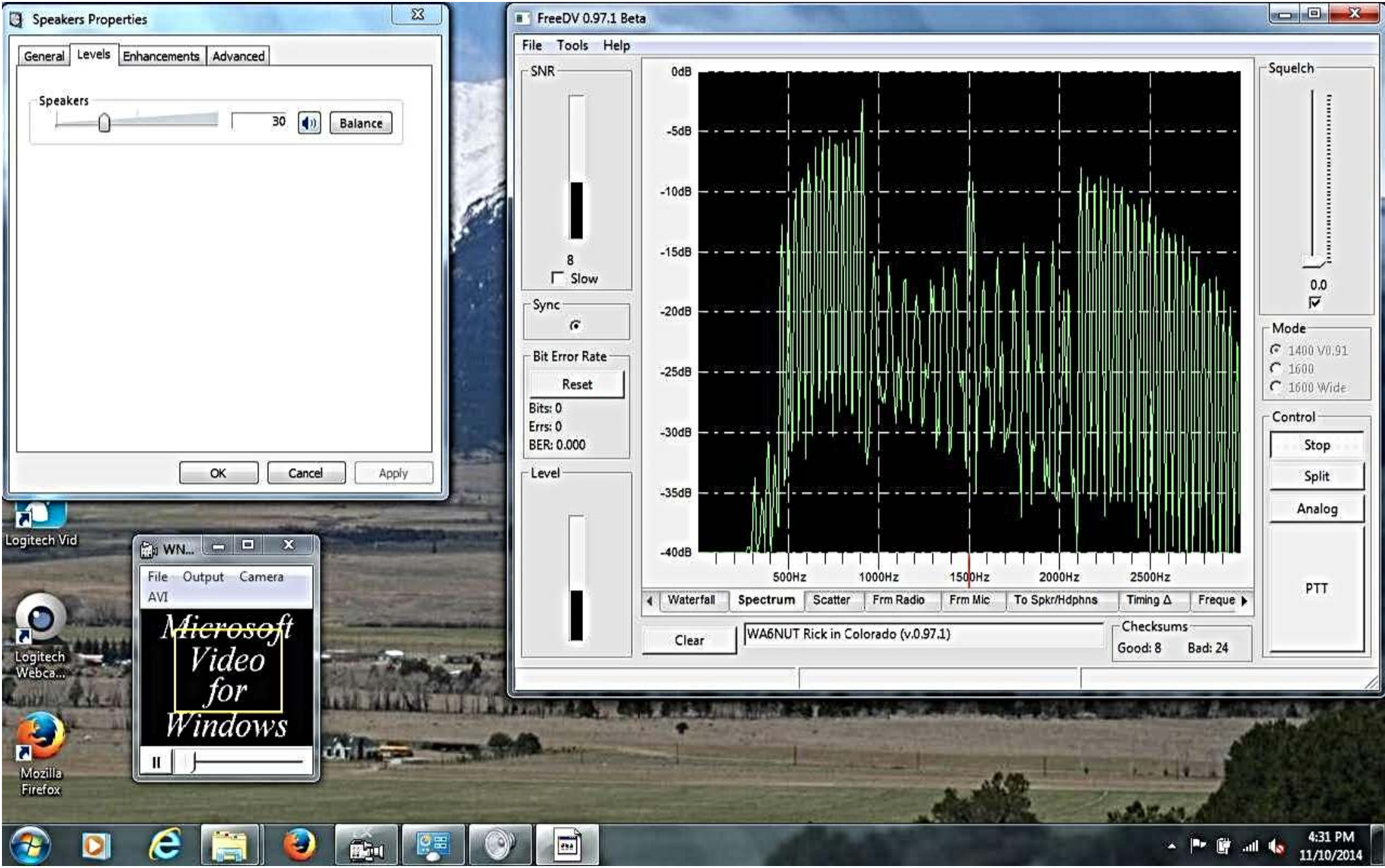

Microphone Properties
General
Levels
Enhancements
Advanced
Microphone
7
Microphone Boost
0.0 dB
OK
Cancel
Apply
Grid
Xovr Freq
0
DXCC
Spot
Config
Log
Help
Multi-carrier Colour/Monochrome TV receiver (FreeDV+)
File
Screen Size
Adjust input
Noise filter
Help
+ half pixel
Interpolate vertical pix
Filter horizontal pix
Noise filter (light)
Brightness
Contrast
0.0 Hz
----Fine Tune----
----Coarse Tune----
67
----Colour Balance----
100%
MONO<--------Saturation-------->COLOUR
Open file to save
Close file
Start save
0 frames saved
F10
F11
F12
sh F5
sh F6
sh F7
sh F8
sh F9
sh F10
sh F11
sh F12
Mode
CW
PSK31
Phone
PSK63
RTTY
Receive Channel 0 (BPSK31 USB)
Freq: 2.101
62
50
AFC
BBD
IMD
Opt
42
Transmit (BPSK31 USB)
Freq: 3.707
net
tune
ID:
QSO
F1
F2
F3
F4
Esc
Set Freq
Start
CW ID
Stop
Abort
Tuning Display
Vert height
1.5
Horiz zoom
1
Horiz pan
0
1
2
3
WinWarbler 4.5.0 f...
FreeDV Plus Distro
freedv-windows
Multi-carrier Colou...
Sound
FreeDV 0.97.1 Beta
EN
11:27 AM


Speakers Properties
General
Levels
Enhancements
Advanced
Speakers
30
Balance
OK
Cancel
Apply
FreeDV 0.97.1 Beta
File
Tools
Help
SNR
8
Slow
Sync
Bit Error Rate
Reset
Bits: 0
Errs: 0
BER: 0.000
Level
0dB
-5dB
-10dB
-15dB
-20dB
-25dB
-30dB
-35dB
-40dB
500Hz
1000Hz
1500Hz
2000Hz
2500Hz
Waterfall
Spectrum
Scatter
Frm Radio
Frm Mic
To Spkr/Hdphns
Timing Δ
Freque
Clear
WA6NUT Rick in Colorado (v.0.97.1)
Checksums
Good: 8
Bad: 24
Squelch
0.0
Mode
1400 V0.91
1600
1600 Wide
Control
Stop
Split
Analog
PTT
WN...
File
Output
Camera
AVI
Microsoft Video for Windows
Logitech Vid
Logitech Webca...
Mozilla Firefox
4:31 PM
11/10/2014