

FreeDV plus Video User Guide

Ver. 1.0

March 2019

by Rick Peterson, WA6NUT

wa6nut@arri.net

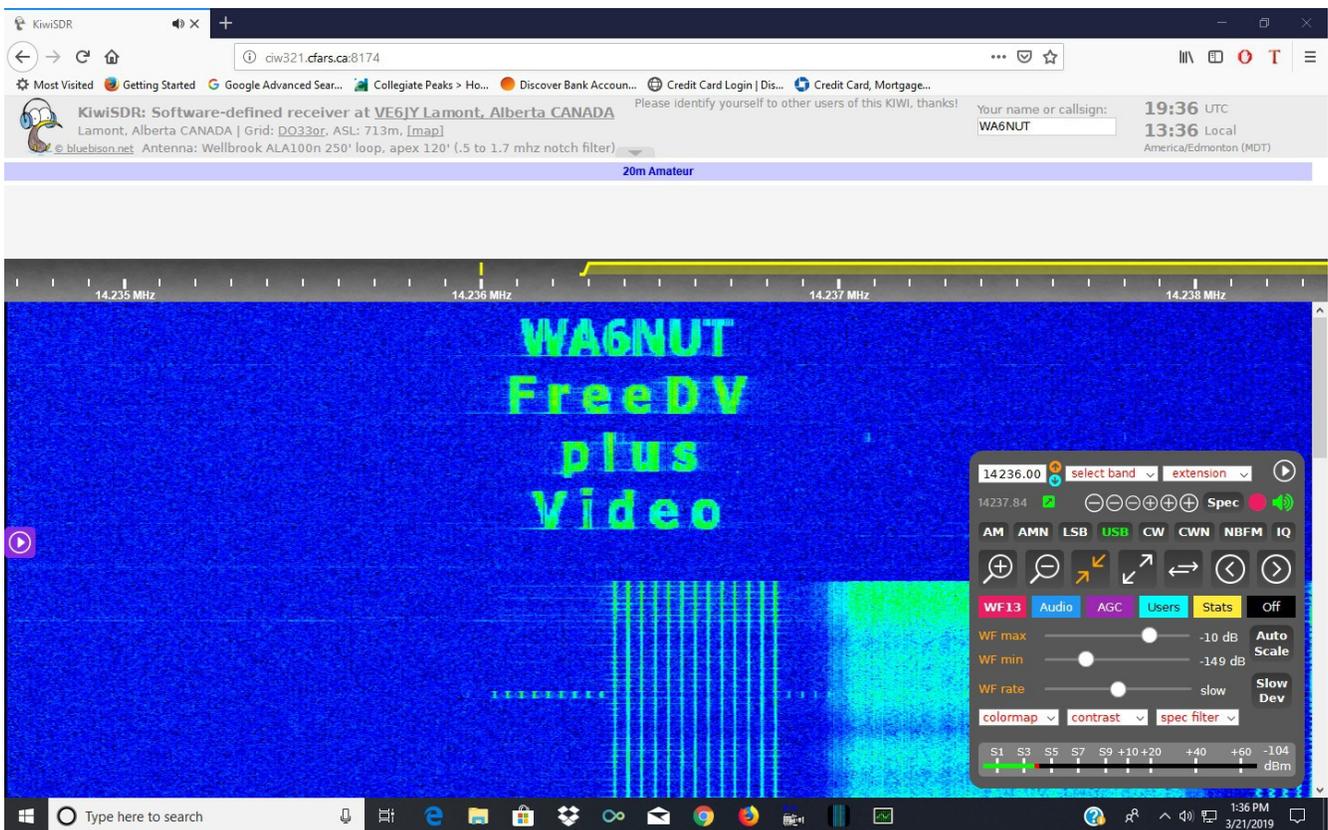
Table of Contents

1.	Getting Started	4
1.1	Introduction	4
1.2	System Requirements	6
1.3	Program Installation	6
1.4	Program Removal	6
1.5	Running FreeDV plus Video	7
2.	Software Required	7
2.1	Video TX/FreeDV Software	7
2.2	Video RX Software	10
2.3	Other.....	12
3.	Hardware Setup	12
3.1	Transceiver and Accessories	12
3.2	PC	15
3.3	USB sound card	15
3.4	USB camera	15
4.	Video TX/FreeDV Software Setup	15
4.1	FreeDV settings	16
4.2	Voicemeeter settings	18
4.3	Motherboard and USB sound card settings	19
4.4	Video TX Settings	21
5.	Video RX Software Setup	22
5.1	USB sound card settings	22
6.	Receiving the video component of the signal	24
6.1	Recording received video	25
6.2	Processing of recorded video	25
7.	Receiving the FreeDV component of the signal	26
8.	Transmitting Adjustments	26
8.1	Mic gain	26
8.2	Output power level	26
8.3	Adaptive predistortion	26
9.	Further References and Acknowledgments	27

Figures

1.	FreeDV plus Video Spectrum	5
2.	Screenshot: Receiving Video and Voice	8
3.	Video TX/FreeDV Software Configuration	9
4.	Video RX Software Configuration	11
5.	PC Connections	13

Below: Waterfall ID transmitted after a FreeDV+ QSO, as received on an SDR.hu receiver near Edmonton, Alberta, Canada. Note the 13 chroma subcarriers, with the FreeDV signal higher in frequency. The first four of the 36 luminance subcarriers are barely visible higher in frequency. Average power output at WA6NUT was 40 watts, with PureSignal.



1. Getting Started

1.1. Introduction

FreeDV plus Video (FreeDV+) consists of add-on software for the FreeDV digital voice app providing simultaneous voice and low-resolution, low frame-rate video.

FreeDV is a popular HF digital voice mode using frequency division multiplex signals. FreeDV plus Video adds 36-line full-color video at 1 frame/sec to the voice signal (Figure 1 shows the FreeDV+ spectrum). Most FreeDV operation is on 14236 kHz, in the 20-meter amateur radio band.

NOTE: The video component of the FreeDV plus Video signal described in this document is compatible only with the FreeDV "1600" and "700D" modes (it is NOT compatible with the older "1400" mode).

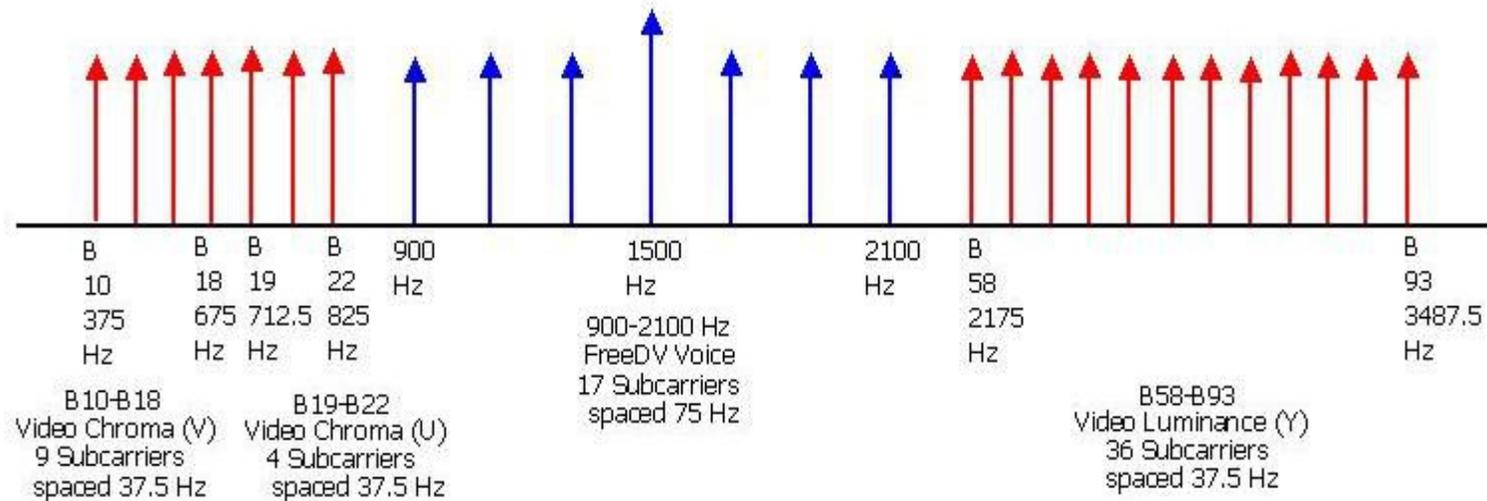
FreeDV+ adds a new dimension to amateur radio operation. Not only can you hear the other operator, you can see him or her as well. Now HF has a new multimedia mode!

FreeDV+ requires overall IMD₃ of -40 dB or better (including the external linear amplifier, if used). Either Class-A outputs can be used (some Yaesu transceivers, without an external amplifier), or adaptive predistortion (soon to be available with FlexRadio SDR transceivers, or using Apache Labs SDR transceivers with PureSignal). The author uses an Apache Labs ANAN-10E with PureSignal, and HF Packer and Ameritron AL-811 amplifiers.

FreeDV+ is described in more detail on the website at:

<https://www.qsl.net/wa6nut/FreeDVplusVideo>

FreeDV plus Video User Guide Ver. 1.0



FreeDV plus Video Baseband Spectrum

R. Peterson, WA6NUT
3/8/16

Figure 1. FreeDV plus Video Spectrum

1.2 System Requirements

Operating system: FreeDV+ has been tested with Windows Vista, 7 and 10

PC hardware: PC: FreeDV+ has been tested with an HP 8540w Elitebook laptop (also with older Dell C640 and C610 laptops; C640 for Video TX/FreeDV and C610 for Video RX)

Processor: FreeDV+ has been tested with an Intel I7-820QM quad-core processor (less powerful processors may require separate PCs for Video TX/FreeDV and Video RX functions)

Sound card: FreeDV+ requires an external USB sound card in addition to the PC's internal motherboard sound card.

USB ports: Three required (for the USB sound card, for the USB camera, and for the USB-to-Serial cable).

1.3 Program Installation

The FreeDV+ software consists of a suite of three apps, in addition to the FreeDV, WinWarbler and Voicemeeter apps (and the Windows Sound Playback and Record GUIs). The TXfftCO5L, RXfftDIFF7L, and RxReplay7A apps are manually installed by copy and paste from the Download folder to a subfolder in the Documents folder. The FreeDV, WinWarbler and Voicemeeter apps are installed using Windows Installer, and are accessed from the Windows list of programs.

1.4 Program Removal

The FreeDV+ apps do not change registry settings, so the TXfftCO5L, RXfftDIFF7L, and RxReplay7A apps are removed by simply going to their subfolder, right-clicking on the file, and selecting Delete. The FreeDV, WinWarbler and Voicemeeter apps are removed by selecting their Uninstall option.

1.5 *Running FreeDV plus Video*

Once the software is installed in your PC, a batch file can be made to open the apps simultaneously by clicking on a desktop icon (see details on the “Operating” page of the FreeDV+ website).

The PTT button on the FreeDV app is used to switch between receive and transmit.

WinWarbler is used for fine-tuning the received video. The WinWarbler AFC is locked to one of the FreeDV+ subcarriers (B58 in Figure 1), and the transceiver's receiver is tuned in 1 Hz steps until the AFC readout indicates 2.175 kHz (with the transceiver in “Split” mode). At that point the hues in the received image are optimized.

Figure 2 shows the WA6NUT FreeDV+ signal being received on 14236 kHz. Note the WinWarbler AFC readout indicating 2.177 kHz while locked to the B58 subcarrier (shown in yellow on the waterfall). For a video showing Figure 2 with audio and motion, see the YouTube video at:

<https://www.youtube.com/watch?v=ZQf2z9gbPZI>

FreeDV+ operation is described in more detail in this document and on the FreeDV+ website.

2. Software Required

2.1 *Video TX/FreeDV Software (See Figure 3)*

TXfftCO5L.exe	The application for transmitting the video component of the FreeDV plus Video signal
TESTPATT.ini	The text file used by TXfftCO5L.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.

FreeDV plus Video User Guide Ver. 1.0

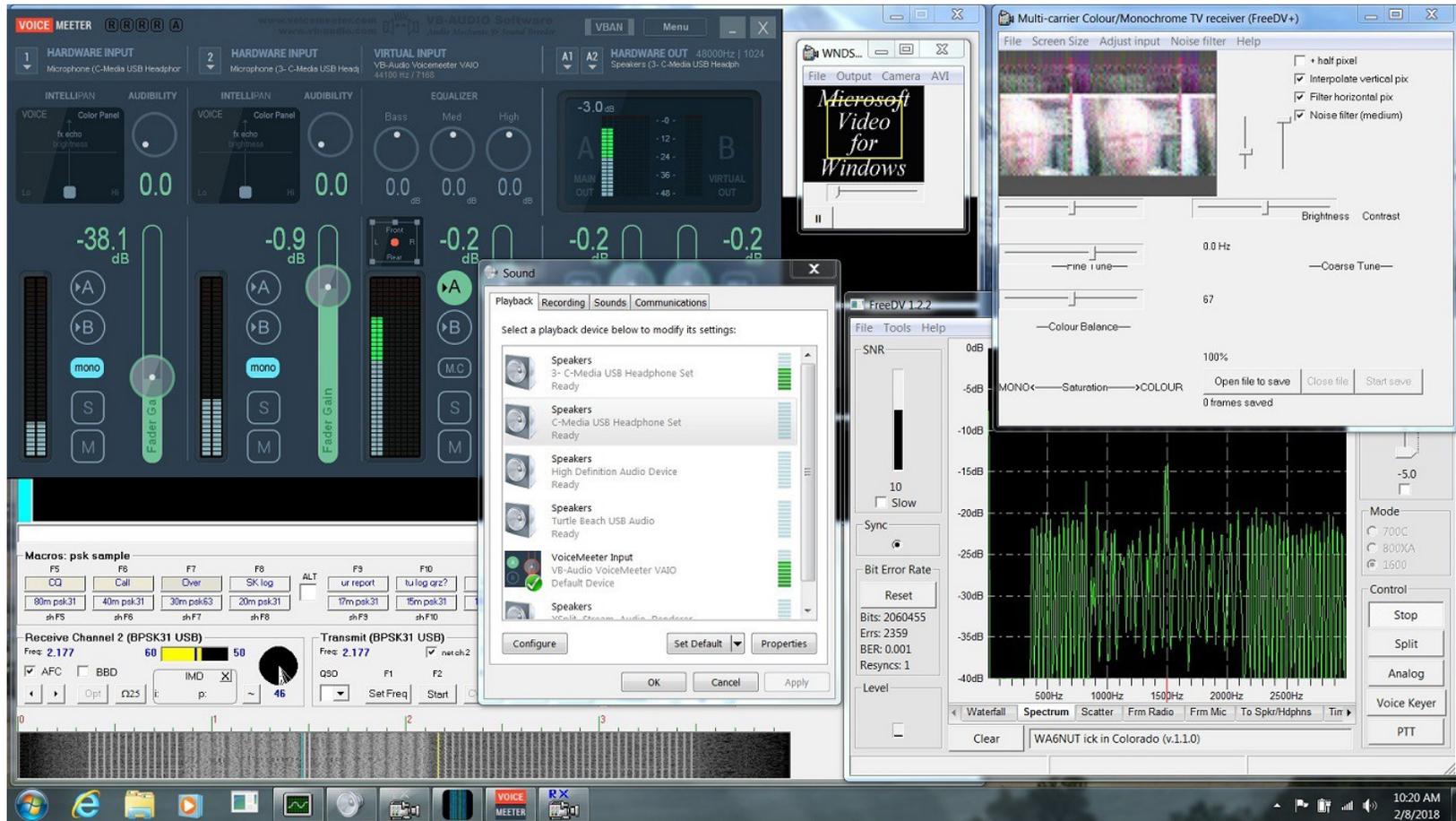


Figure 2. Screenshot: Receiving Video and Voice

FreeDV plus Video User Guide Ver. 1.0

*** 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 2 or more USB ports).

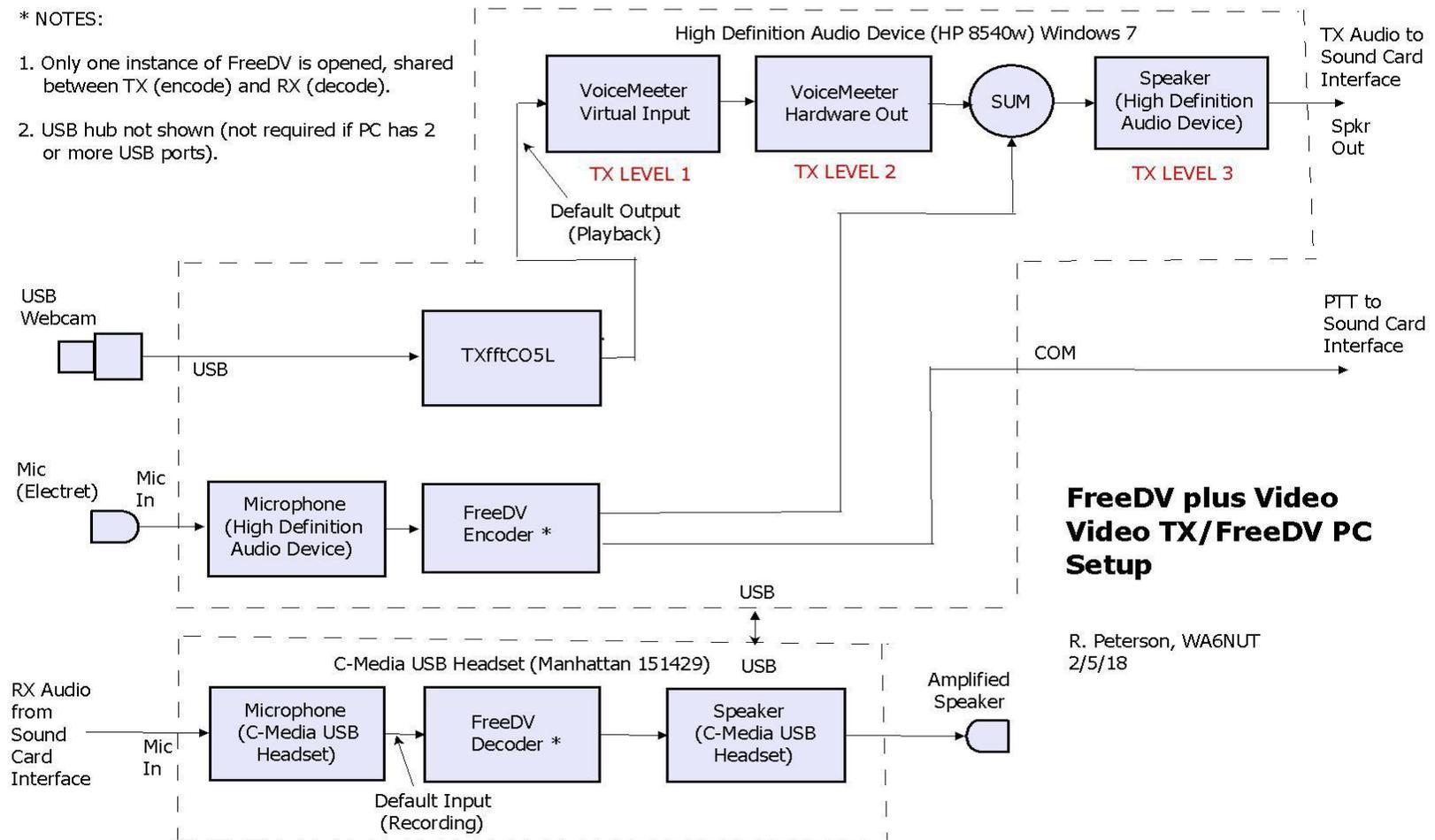


Figure 3. Video TX/FreeDV Software Configuration

- WNDSURF1.AVI** This Microsoft test video is useful for testing the TXfftCO5L.exe app.
- FreeDV** The application for receiving (decoding) and transmitting (encoding) the digital voice component of the FreeDV+ signal. This app is not part of the FreeDV+ software suite and must be downloaded from:

<https://freedv.org/>

A User Manual and “Quick Start Guide” for FreeDV are available at this website.

This app provides PTT for FreeDV+ via a COM port. Unless your PC has a serial port, you'll need a USB-to-Serial cable for PTT.

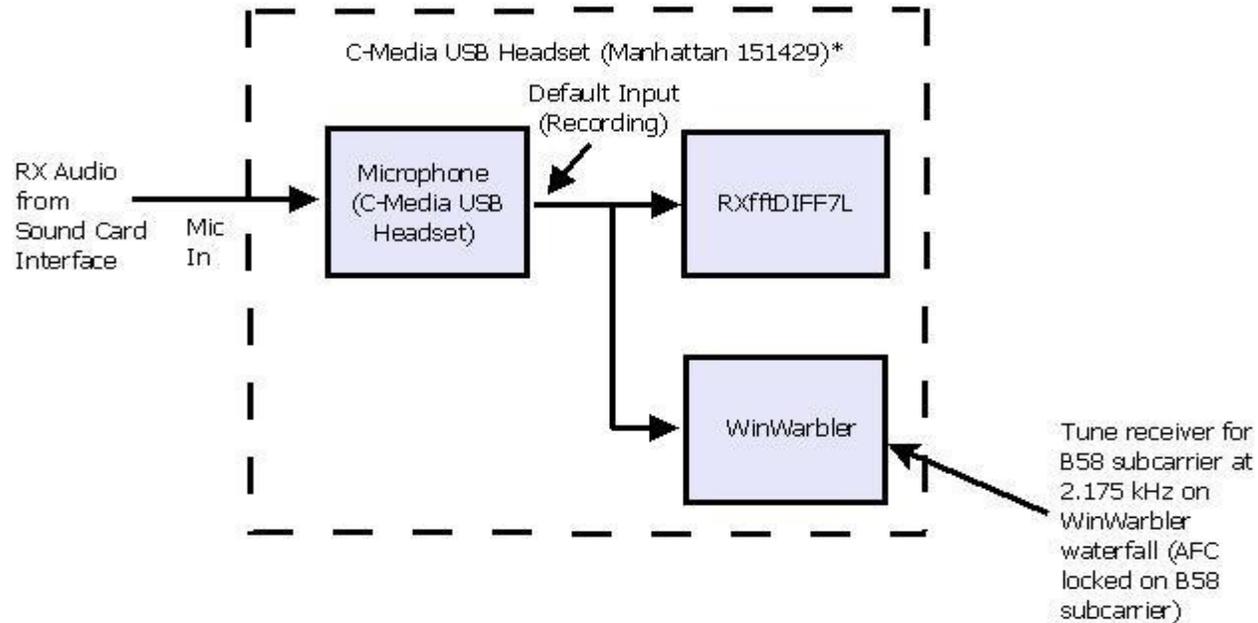
2.2 Video RX Software (see Figure 4)

- RXfftDIFF7L.exe** The application for receiving the video component of the FreeDV plus Video signal (used also for recording received video as a ".49" file)
- RxReplay7A.exe** The application for playing back recorded ".49" files. Video transmitted and received at 1 FPS can be played back at 10 FPS (useful for video clips).
- WinWarbler** This application is useful for fine-tuning the received video signal. This app is not part of the FreeDV+ software suite and must be downloaded from:

<http://www.dxlabsuite.com/winwarbler/>

Detailed online help for WinWarbler is available at this website.

FreeDV plus Video User Guide Ver. 1.0



* NOTE:

1. A single USB sound card is used for both the FreeDV RX (decode) and video RX functions.

FreeDV plus Video Video RX PC Setup

R. Peterson, WA6NUT
5/3/18

Figure 4. Video RX Software Configuration

2.3 Other

Voicemeeter This application provides bargraph displays for monitoring audio levels and slider controls for controlling levels. The slider controls permit the video level to be balanced with respect to the FreeDV level. This app is not part of the FreeDV+ software suite. It is “donationware” and must be downloaded from:

<https://www.vb-audio.com/Voicemeeter/index.htm>

A User Manual for Voicemeeter is available from this website.

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

3. Hardware Setup (see Figure 5)

This section lists the major hardware used for FreeDV+ at the WA6NUT station. Note that the ANAN-10E is no longer manufactured, but newer Apache Labs SDR transceivers are also suitable for FreeDV+.

3.1 Transceiver and Accessories

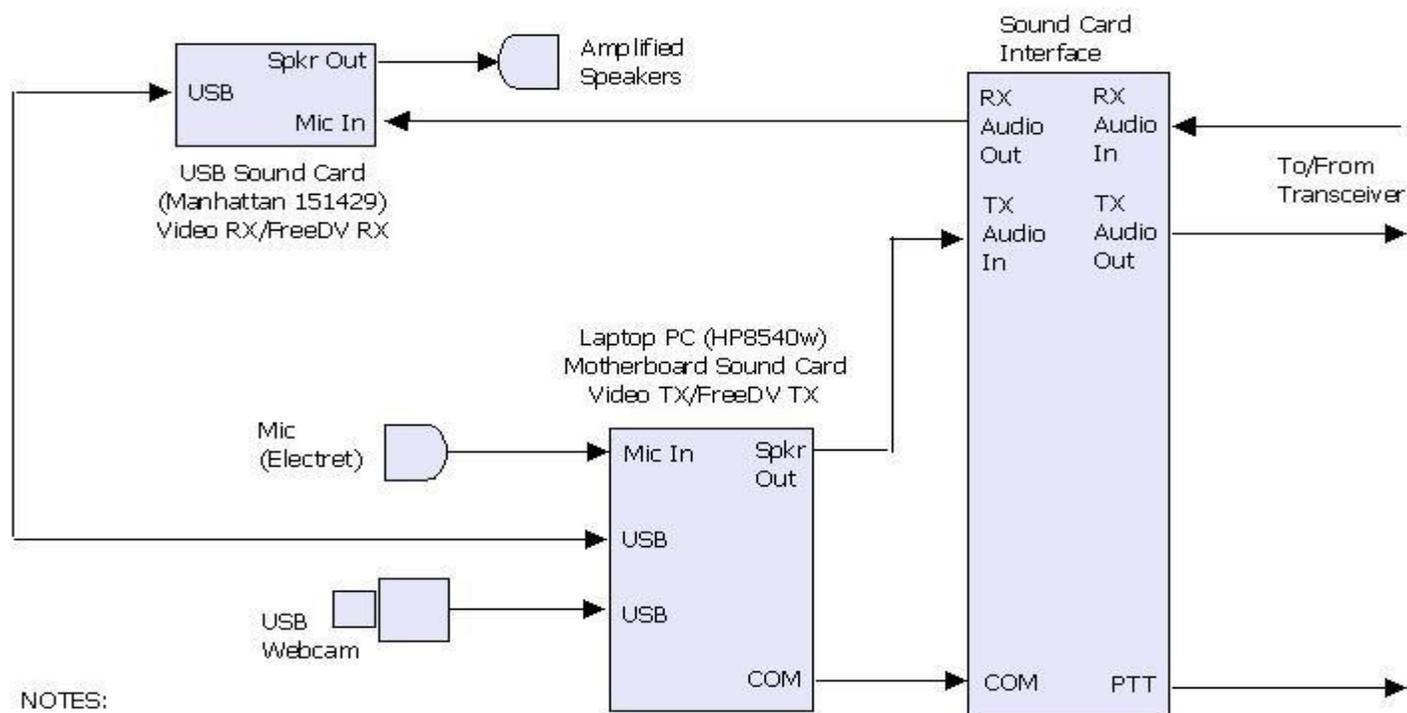
HF Transceiver Apache Labs ANAN-10E (with PowerSDR software including PureSignal adaptive predistortion). A useful accessory for the ANAN-10E is the J16 Break-out Board, available from TAPR:

https://www.tapr.org/kits_hermes_breakout.html

Amplifier HF Packer 2 with PSU-36V board for operation with 36 Vdc supply.

<https://groups.io/g/hfprojects>

FreeDV plus Video User Guide Ver. 1.0



NOTES:

1. USB hub will be required if PC has only 1 USB port.
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
5/3/18

Figure 5. PC Connections

Amplifier	Ameritron AL-811
Directional Coupler	Required for use with adaptive predistortion, kit available from Elecraft (assembled for -30 dB coupling). ftp://ftp.elecraft.com/Mini%20Modules/Manuals%20Downloads/E740090%20-%20CP1%20manual%20rev%20B.pdf
Adjustable RF Attenuator	Required for use with adaptive predistortion, kit available from Elecraft. ftp://ftp.elecraft.com/Mini%20Modules/Manuals%20Downloads/E740101%20AT1%20Step%20Attenuator%20Rev%20A1.pdf
TX/RX Switching Unit	Required for use with adaptive predistortion (for the ANAN-10E only). “TR-Plus” kit available from TAPR. https://www.tapr.org/kits_trplus.html https://www.febo.com/pages/hpsdr/TR-Plus/
USB-to-Serial Cable	Required for PTT control from the FreeDV app (Note that a USB Sound Card Interface may provide the USB-to-Serial function required for PTT keying). Gigaware cable (Radio Shack P/N 26-949) or equivalent
Sound Card Interface	Homebrew: Note that a VOX-operated sound card interface cannot be used with FreeDV+, unless the VOX feature is disabled or bypassed (the TXfftCO5L application provides an output from the sound card regardless of PTT status)

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/May07.pdf>

Substitute Triad TY-145P (Jameco P/N 630459) for Radio
Shack transformers.

<http://jameco.com>

3.2 PC

PC HP 8540w Elitebook laptop (or equivalent: see "System Requirements," section 1.2 of this Guide).

3.3 USB Sound Card

USB Sound Card Manhattan 151429 (or equivalent)

3.4 USB Camera

USB Webcam Logitech E3560 (or equivalent). The laptop webcam can also be used.

4. Video TX/FreeDV Software Setup

"High Definition Audio Device" = Motherboard sound card

"C-Media USB Headset" = USB sound card (the same USB sound card is used for both FreeDV RX and Video RX)

4.1 FreeDV Settings

See Figures 2 and 3

FreeDV v.1.3 The PTT button on the FreeDV Graphic User Interface (GUI) will be used to control the transceiver transmit/receive function.

Tools --> Audio Config

Receive

From Radio: Device	Sample Rate
--------------------	-------------

Microphone (C-Media USB Headset) WDM	48000*
--------------------------------------	--------

To Speaker/Headphones	Sample Rate
-----------------------	-------------

Speakers (C-Media USB Headset) WDM	48000*
------------------------------------	--------

Transmit

From Microphone	Sample Rate
------------------------	--------------------

Microphone (High Definition Audio Device) WDM	48000*
--	---------------

To Radio	Sample Rate
-----------------	--------------------

Speakers (High Definition Audio Device) WDM	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 "1600" or "700D" 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 Component of the Signal" (Section 7) 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.

4.2 *Voicemeeter Settings*

Voicemeeter
"TX LEVEL 1" and
"TX LEVEL 2" on
Figure 3

Voicemeeter Menu --> System Settings/
"TX Options --> Preferred Main Sample Rate

Change from: 44100 Hz
to: 48000 Hz

Exit Menu.

Hardware Input 1 Setting:
Select WDM: Microphone (C-Media USB Headset).
Allows Hardware Input 1 bargraph display to
monitor RX level to FreeDV decoder.

Hardware Input 2 Setting:
Select WDM: Microphone (High Definition Audio
Device). Allows Hardware Input 2 bargraph display
to monitor mic level to FreeDV encoder.

Hardware Out Setting:
Select MME: Speakers (High Definition Audio
Device). Allows Hardware Out to sum the video
signal with the FreeDV signal to form the composite
FreeDV+ signal.

Levels: The level of the video component with
respect to (w.r.t.) the fixed FreeDV level is
controlled by the Virtual Input and Hardware Out
"Fader Gain" slider controls.

Control Panel --> Sound --> Playback

Highlight "Voicemeeter Input"

Click on "Set Default" (this directs the TXfftCO5L video output to the Virtual Input)

Control Panel --> Sound --> Recording

Highlight "Voicemeeter Output"

Click "Properties" button

Listen: Click "Listen to this device" checkbox

Select "Speakers High Definition Audio Device"

(This allows the Voicemeeter Hardware Out to sum the video signal with the FreeDV signal).

4.3 Motherboard and USB Sound Card Settings

Sound Playback
(TX Power Level)
"TX LEVEL 3"
on Figure 3

Control Panel --> Sound --> Playback

Highlight "Speakers (High Definition Audio Device)"

Click "Properties" button.

Levels: Speakers slider sets TX power level of composite TX signal.**

See "Transmitting Adjustments" (Section 8) below.

**Recording Control
(FreeDV TX mic
level)**

Control Panel --> Sound --> Recording

Highlight "Microphone (High Definition Audio Device)"

Click "Properties" button.

Levels: Microphone slider sets mic level to FreeDV encoder.

See "Transmitting Adjustments" (Section 8) below.

**Recording
Control (FreeDV
RX input level)**

Control Panel --> Sound --> Recording

Highlight "Microphone (C-Media USB Headset)."

Click on "Set Default"

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 (C-Media USB Headset)"

Click "Properties" button.

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

- * The TX LEVEL 1 and TX LEVEL 2 slider controls are used to set the level of the video subcarriers with respect to the the level of the FreeDV sub-carriers (the video subcarrier level should be set to the same level as the FreeDV subcarriers).

This adjustment can be made with the output of the PC motherboard sound card connected to the input of the USB sound card. WinWarbler should be set to display the signal spectrum. Set the signal amplitude using the TX LEVEL 3 slider control (Windows Control Panel Sound Playback) and set the level of the video sub-carriers w.r.t. the FreeDV sub-carriers using the TX LEVEL 1 and 2 "Fader Gain" slider controls (Voicemeeter). The amplitude of the video subcarriers should be adjusted to be the same as the FreeDV subcarrier amplitude.

- ** 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.

4.4 Video TX Settings

TXfftCO5L.exe

Select Camera input, or File --> Open

Select AVI file and click Open button (AVI file must be located in the same folder as TxfftCO5L.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 TXfftCO5L GUI down so that the Pause/Play button is visible.

5. Video RX Software Setup

5.1 *USB Sound Card Settings*

"C-Media USB Headset" = USB sound card (the same USB sound card is used for both Video RX and FreeDV RX)

See Figures 2 and 4

Recording (RX
input level)

Control Panel --> Sound --> Recording

Right-click on "Microphone (C-Media USB Headset)."

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

Highlight "Microphone (C-Media USB Headset)."

Click "Properties" button.

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

See "Receiving the Video Component of the Signal" (Section 6) below.

**WinWarbler
(winwarbler.exe)**

AFC checkbox = checked

Click Config button --> Soundcard

Set PSK soundcard = "C-Media USB Headset"

Set Phone soundcard = "C-Media USB Headset"

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 Component of the Signal" (Section 6) 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 "Recording Received Video" and "Processing of Recorded Video" (Sections 6.1 and 6.2) below.

6. Receiving the Video Component of the Signal

See the “Video RX Software Setup” (Section 5 of this document) above. Also see Figures 2 and 4 (note the yellow B58 video subcarrier on the WinWarbler waterfall and the AFC Freq readout = 2.177 kHz)

The FreeDV component 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.

Use the "Colour Balance" slider control to fine-tune hues in the received video image.

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.

6.1 Recording Received Video

RXfftDIFF7L.exe can be used to record the video component 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.

6.2 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://web.archive.org/web/20190119041451/http://www.aviconstructor.com/>

<https://web.archive.org/web/20131206001038/http://www.goodervideo.com/products/MP.html>

7. Receiving the FreeDV Component of the Signal

See “Video TX/FreeDV Software Setup” (Section 4) above. Also see Figures 2 and 3.

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.

8. Transmitting Adjustments

See “Video TX/FreeDV Software Setup” (Section 4) above. Also see Figures 2 and 3. This discussion assumes that the TX LEVEL 1 and TX LEVEL 2 slider controls have correctly set the video subcarrier levels with respect to the FreeDV subcarriers.

8.1 Mic Gain

Set the motherboard sound card Mic gain slider control (High Definition Audio Device in the author's setup) so that, while transmitting, the peaks of the audio waveform on the FreeDV GUI are about $\pm 60\%$ of full scale.

8.2 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 PC, open the Windows Sound Playback GUI.

Set the motherboard sound card ("High Definition Audio Device" in the author's setup) speaker level slider (TX LEVEL 3) control to 0% (left). Click the FreeDV PTT 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.

8.3 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 predistortion, 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).

WARNING: If adaptive predistortion (PureSignal) is not used with FreeDV+, an unacceptable level of splatter will occur on adjacent frequencies!

9. Further References and Acknowledgments

The FreeDV+ website has numerous links and additional information on FreeDV+. Go to:

<https://www.qsl.net/wa6nut/FreeDVplusVideo>

FreeDV plus Video User Guide Ver. 1.0

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, Gerry Helder, N4DV, and Ray Knighton, W4BCX, for their patient on-the-air help to improve my FreeDV+ signal.

Last revised: 11/30/20

Below: FreeDV+ DX received by the W3PIE/WA3MJY KiwiSDR, a distance of over 1,400 miles. WA6NUT is transmitting a “twirling license plate” video clip with voice. Average power output at WA6NUT was 40 watts, with PureSignal.

The screenshot displays a Windows desktop environment. The primary window is the FreeDV 1.3 interface, which includes a waterfall plot on the left showing a signal at 2.176 MHz. The main display area shows a video window with a license plate that reads "WA6NUT". Overlaid on the right side of the FreeDV interface is a "Multi-carrier Colour/Monochrome TV receiver" window, which has a "Help" menu and options for "half pixel", "Interpolate vertical pix", "Filter horizontal pix", and "Noise filter (light)". Below this is a "Colour Balance" window with sliders for "Fine Tune" and "Coarse Tune". In the bottom right corner, there is a software control panel for the receiver, showing a frequency of 14236.00 kHz and various mode and power settings. The Windows taskbar at the bottom shows the time as 4:31 PM on 3/7/2019.