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# Jointwave H.264 Encoder Live Demo User Guide

Xilinx IVK by Avnet Edition

Document Number:  
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Creation Date: August 22, 2010  
Last Updated: October 20, 2010  
Last Saved By: Paul Qiu  
Version: 1.0  
Location:  
Keywords:



# Jointwave

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**Revision History:**

Version #	Author	Date	Description
0.9	Jerry Wang	August 22, 2010	Initial creation
1.0	Paul Qiu	September 10, 2010	Update demo diagram and trouble shooting, add setup example
1.1	Paul Qiu	October 20, 2010	Update the maximum bit rate for E440/E640 demo

**Distribution List:**

Version #	Who/Where	Date

**Reviewers:**

Version #	Name	Position	Date Accepted

**Approvals:**

Version #	Name	Position	Date	Signature

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## 1. INTRODUCTION

This Jointwave H.264 Encoder Live Demo provides an evaluation version of E240, E340, E440, E540, and E640 demo on Xilinx IVK by Avnet (Avnet Spartan-6 FPGA Industrial Video Processing Kit).

Demos on IVK:

Encoder Model	Profile	GOP	1920x1080p FPS	1280x720p FPS
E640	Main	I+P	0 to 30	0 to 72
E540	Baseline	I+P	0 to 30	0 to 72
E440	Main	I+P	0 to 30	0 to 72
E340	Main	I only	0 to 30	0 to 72
E240	Baseline	I only	0 to 30	0 to 72

There are several limitations of evaluation version comparing with formal version:

- Logo : The evaluation encoder added a “*Jointwave*” logo on right-bottom position of the encoded video
- Time Limitation: The evaluation encoder can work continuously for *three to five hours* after power up or reset, then the encoder might stop working or the output data might be corrupted, Pressing an user button on the FPGA board to reset would resume the encoding to work continuously for another four hours.
- Bitrate Limitation: The demo only provides 4 different settings of bitrate for each Encoder Model by two switches on the FPGA board. You can set any bitrate in valid range by formal version.
- Resolution Limitation: The demo supports only two resolutions 1920x1080 and 1280x720. The formal version supports resolution from 176x144 to 4000x4000 or even larger.
- GOP Size: evaluation version is limited to 60 for I+P or 1 for I-only, formal version can be any value in valid range.
- Error Recovery: The demo doesn't provide automatic resume on subsequent errors:
  - Input Video Signal Interrupt, such as disconnect and reconnecting input HDMI cable
  - Entropy FIFO overflow
 The formal version provides tools to resume from those errors.

## 2. REQUIREMENTS

1. Avnet Spartan-6 FPGA Industrial Video Processing Kit  
  
<http://www.xilinx.com/products/devkits/AES-S6IVK-LX150T-G.htm>
2. A video source able to output HDMI/DVI signal at 1920x1080p (30, 25 or 24Hz) or 1280x720p (60, 30, 25 or 24Hz).
3. A HDMI cable which complies with HDMI 1.3 standard.
4. A PC or laptop with subsequent configuration:
  - CPU frequency should be at least 1.6GHz
  - A Gigabit Ethernet adapter
  - Windows XP or Windows Vista
  - Optional, a high resolution display (1920x1200 or 1920x1080). It can be either laptop built-in screen or external monitor/TV with resolution with compatible video card on PC

Thinkpad laptop T60, T61, T400, T500, X60, X61 are tested in Jointwave laboratory, all work well.
5. A 1 to 3 meter long CAT6 Ethernet cable to connect the FPGA board and the PC. The quality of cable and its RJ45 head is important, because the Demo doesn't have error correcting mechanism such as TCP in Ethernet transmission. A high quality cable is essential to guarantee that 100% Ethernet packets are transmitted and received successfully.

### 3. SETUP AND RUN PROCEDURE

1. Contact Jointwave to get the demo suite, which comprises of:
  - A. A FPGA image file, in Xilinx BIT format.
  - B. Demo Supporting Package  
Following files are included in Jointwave demo supporting package:

win\_pcap\_XXXX.exe  
vcredit\_x86.exe  
etherdump.exe  
mplayer.exe

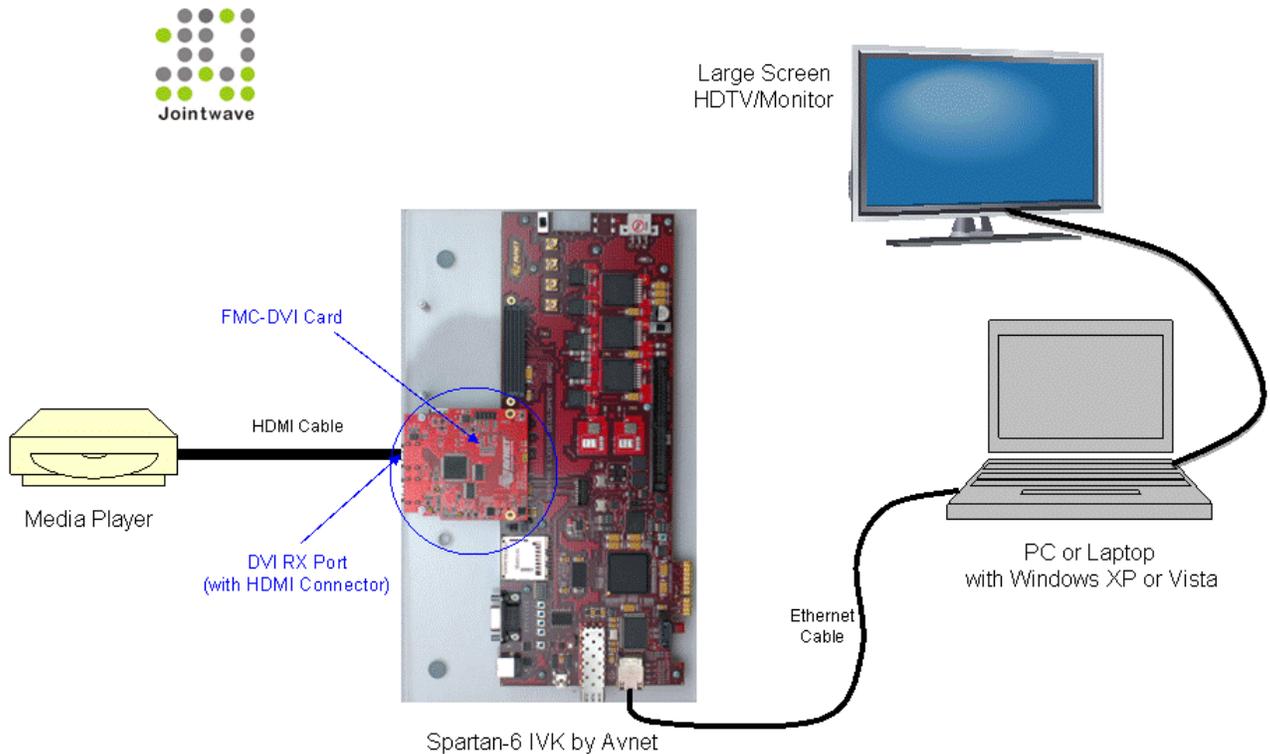
2. Install winpcap\_XXXX.exe in Jointwave demo supporting package onto your PC
3. Install vcredist\_x86.exe in Jointwave demo supporting package onto your PC
4. Install the FMC-DVI daughter board on the Spartan6 board's FMC port JX1 as following picture:



5. Connect video source, FPGA board and PC together as following picture.

# Jointwave H.264 Encoder Demo Setup

(Xilinx Spartan-6, Avnet IVK)



6. Set *DIP Switch SW6* on FPGA board according to your resolution, bitrate and other parameters. Refer to Chapter 4 for details.
7. Power up the FPGA board and program the BIT file you want to run by using *Xilinx iMPACT* software. There are 3 devices on the board, you need to program only the one name "xc6slx150t" and bypass the other two. After programming is done, press the SW2 to reset.
8. Power up your video source – which could be a blue-ray player or hard disk HD player. It's better to be powered up the player after the FPGA board is on, because some players require correct EDID information from the HDMI daughter board to set the HDMI output in appropriate mode.
9. Open a command prompt window and run etherdump.exe in Jointwave demo supporting package, it will list all the network cards and prompt you to select the correct device, as shown in following example (Note: If your operating system is Windows Vista, you need to run a command prompt windows "as Administrator" even you are the administrator, then run etherdump.exe in it):

No adapter selected: printing the device list:

1. \Device\NPF\_{9ADFE0B9-683F-446A-A962-EAEB5A2062D8}  
(MS Tunnel Interface Driver)
2. \Device\NPF\_{115E1410-4E51-4B9C-B62D-566359FCF6A5}  
(Intel(R) PRO/1000 PL Network Connection)

3. \Device\NPF\_{CAA92102-B1D4-4C95-AE49-ECBEC31B2B4A}  
(Microsoft)  
Enter the interface number (1-3): 2

Select the correct device, in the example it's 2.

Next the program will prompt "Enter the dump-file-path:". Just input the file name to dump the h.264 stream, such as "a.264". (Note: If the BIT file name contains "ts" string which means it's an h264+ts demo, the suffix of the stream name should be ".ts").

Then the program will prompt "Enter how many Ethernet packets per dump (valid range 1 to 16384):". Refer to following table to input an appropriate value.

Target Bitrate (Mbps)	Suggested Packets Per Dump value
4 and lower	512
8	1024
16	2048
32	4096
64	8192
128 and larger	16384

Tip: After first running, you can combine the inputted answers to create a .bat file, for example:

File *myetherdump.bat*:  
etherdump \Device\NPF\_{115E1410-4E51-4B9C-B62D-566359FCF6A5} a.264 1024

Then you just type the command "myetherdump" to run it.

10. After a few seconds, you can see following text is printing and scrolling on the command windows:

```
0 * 1048576 S00 PktErr= 0
1 * 1048576 S01 PktErr= 0
2 * 1048576 S02 PktErr= 0
.....
```

Every time, the program etherdump.exe dumps "PacketPerDump" number of 1024bytes Ethernet packets onto the hard disk and prints one line text on command window.

Now you can play the dumped file by using mplayer.exe in Jointwave demo supporting package. If your file name is a.264 and the video source's frame rate is 30, the mplayer.exe command line will be:

```
mplayer a.264 -fps 30
```

Or if the BIT name contains "ts", it's a h264+ts demo, the command line will be:

```
mplayer -demuxer lavf a.ts
```

*Note: If PktErr doesn't equal to 0, it means some Ethernet packets are already lost, thus mplayer will report error and some video frames might be partially corrupted too. The Demo doesn't have error correcting mechanism such as TCP in Ethernet transmission, but we designed etherdump.exe to make the possibility of packet loss infinitesimal.*

*Disabling SpeedStep of CPU on laptop helps to reduce packet loss further. It can be done in BIOS or by some software, e.g. RightMark CPU.*

11. Refer to Chapter 4 for changing encoding parameters and observing status and error of the encoder by switches and LEDs on the FPGA board.

12. You can observe the live bitrate chart by Windows Task Manger.

Setup 1. Open Windows Task Manger, then switch to page "Networking".

Setup 2. Menu View → Network Adapter History → Bytes Received (Yellow).

## 4. FPGA BOARD CONFIGURATIONS

### 4.1. Reset

On the Spartan6 board, button **SW2** resets the Demo.

### 4.2. Configuring the Encoder with DIP Switch

On the Spartan6 board, the DIP Switch **SW6** is used to configure the parameters of the Encoder. Sliding to switch to “ON” means “1”, and the opposite side means “0”.

#### SW6-1

1	Activate the encoder
0	Deactivate the encoder

#### SW6-2

1	Video source is 1920x1080p
0	Video source is 1280x720p

#### SW6-3

1	Constant Bitrate Mode rate control (CBR)
0	Const QP Mode rate control (CQR)

**SW6-4** is not used.

**SW6-6, SW6-5** in CBR Mode (when SW6-2 == 1), Bitrate Configuration (Mbps)

The following table shows the output bitrate (in Mbps) for each board with different inputs.

Note 1: The encoder will adapt to the input frame rate if it's within the maximum limit, and the bitrate is proportional to the FPS. For example, SW6-6,SW6-5=1,0 on IVK running E640 with 720p@60fps input, the output is 16Mbps; when the input changes to 720p@30fps, the output will be 8Mbps.

Note 2: These tables show the bitrate for standard demo. If you get a customized demo BIT, please refer to the email or readme file come with it for bit rate setting.

a) **1080p@30fps** input

SW6-6	SW6-5	E240/E340/E540	E440/E640
0	0	64	32
0	1	32	16
1	0	16	8
1	1	8	4

b) **720p@60fps** input

SW6-6	SW6-5	E240/E340/E540	E440/E640
-------	-------	----------------	-----------

0	0	128	Invalid
0	1	64	32
1	0	32	16
1	1	16	8

**SW6-6, SW6-5** in CQR Mode (SW6-2 == 0)

SW6-6	SW6-5	QP
0	0	16
0	1	24
1	0	32
1	1	40

**SW6-7**

1	Invert DVI V-sync signal's polarity
0	Keep DVI V-sync signal's polarity

**SW6-8 (E540/E640 Only)**

1	Invalid (For internal debugging only)
0	Normal demo

### 4.3. LED

LED ID	Component Name on Board	Description
LED0	D7	On: DDR2 controller is initialized successfully Off: DDR2 controller doesn't work
LED1	D8	On: ERROR, Entropy FIFO overflows Off: good state
LED2	D9	On: ERROR, Sensor's data rate is higher than the Encoder's encoding capacity Off: good state
LED3	D10	Blinking: Encoder is sending output byte stream Off: No output from Encoder
LED4	D11	connect to V-sync signal of video inputting interface
LED5	D12	connect to Data Enable (or Href) signal of video inputting interface
LED6	D13	connect to All Data signals' OR of video inputting interface
LED7	D14	<i>Note: For H.264+TS demo only, If the BIT file name contains "ts" string, it's a H.264+TS demo file.</i>  On: TS Mux is working Off: TS Mux is not working  Button SW3 is used to switch on/off TS Mux.
TX	transmit LED	On to indicate encoded H.264 stream is outputting from the Gigabit

(Ethernet)	of the RJ45 Jack	Ethernet chip
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#### 4.4. Example of Setup and LEDs

Here is an example where you can start the demo with.

For E440, when the input is 1080p 30fps video, and you want the output to be 4Mbps, set the SW6 as following (1 means On):

SW6-1	SW6-2	SW6-3	SW6-4	SW6-5	SW6-6	SW6-7	SW6-8
1	1	1	1	1	1	0	0

After programming the BIT file and connected video input, the LEDs status should be like this:

D7	D8	D9	D10	D11	D12	D13	D14
On	Off	Off	Flashing	Dim	On	On	Off

Near the RJ45 connector:

D1(10)	D2(100)	D5(1000)	D6(DUP)
Off	Off	On	On

On the RJ45 connector:

Left	Right
Flashing	On

On the FMC DVI card:

LED1
On

## 5. TROUBLE SHOOTING

Problem	Possible Cause(s)	Solution(s)
D7 is off	The board is not programmed correctly.	<ol style="list-style-type: none"> <li>1. Check the program cable</li> <li>2. Double check if the correct BIT file is used.</li> </ol>
LED1 on FMC DVI card is off	No DVI video signal	<ol style="list-style-type: none"> <li>1. Check the DVI/HDMI cable connection.</li> <li>2. Check if the video source (video player) is on and playing</li> </ol>
D11 is total off (It shall be dimly lit)	No DVI V-Sync	<ol style="list-style-type: none"> <li>1. Check if the FMC DVI card is firmly installed</li> <li>2. Check if the video source is on and playing</li> </ol>
D11 is fully on	DVI V-Sync polarity is wrong	<ol style="list-style-type: none"> <li>1. Change setting of SW6-7. (From 1 to 0 or from 0 to 1)</li> </ol>
D12 is steadily and fully on	<ol style="list-style-type: none"> <li>1. The resolution setting doesn't match</li> <li>2. V-Sync polarity is wrong.</li> <li>3. FMC DVI card connection problem</li> </ol>	<ol style="list-style-type: none"> <li>1. Check if SW6-2 setting match the video source resolution</li> <li>2. Change setting of SW6-7. (From 1 to 0 or from 0 to 1)</li> <li>3. Check if the FMC DVI card is firmly installed</li> </ol>
D5(1000) and D6(DUP) are off	<ol style="list-style-type: none"> <li>4. The board is not programmed correctly.</li> <li>5. The PC Ethernet port is not GE.</li> <li>6. Ethernet cable connection is broken.</li> <li>7. Ethernet PHY is damaged.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check if the correct BIT file is used.</li> <li>2. Make sure the PC Ethernet port is Gigabit Ethernet, not 10/100Base-T</li> <li>3. Replace the Ethernet cable</li> <li>4. Contact IVK vendor for RMA</li> </ol>
LEDs on RJ45 Jack are totally off	Problem in Ethernet cable connection	<ol style="list-style-type: none"> <li>1. Replace the Ethernet cable</li> </ol>
LEDs on PC Ethernet port are off	Problem in Ethernet cable connection	<ol style="list-style-type: none"> <li>1. Replace the Ethernet cable</li> </ol>
D10 is not flashing	Encoder is not activated	<ol style="list-style-type: none"> <li>1. Check if SW6-1 is set to "1" (On).</li> </ol>