JPEG Encoder IP v1.2

JPEG Encoder IP User Guide

Introduction

Joint Photographic Experts Group (JPEG) is a commonly used method for image compression. JPEG Encoder is an intraframe compression method where each video frame is compressed by using the data of the same frame. The compression does not depend on past or future frames. The video frame is divided into multiple 8 x 8 blocks, which are called Macroblocks. A 2-dimensional Discrete Cosine Transform (DCT) is applied to each macroblock. The output of DCT represents frequency components in the horizontal and vertical directions. The DCT output is quantized using a quantization table that makes insignificant high-frequency components to zero, thereby reducing the number of bytes required to represent an 8 x 8 macroblock. The number of non-zero bytes in the quantization output depends on the high-frequency components in the image and on the Quality factor (Q factor) used to generate the quantization table. The degree of compression can be adjusted by the Q factor allowing a trade-off between size and image quality.

The output of quantization is passed through Huffman encoding, which reduces the number of bits used to represent the components of quantization output. A typical compression ratio of 20:1 can be achieved at a 50% Q factor. This user guide describes the JPEG encoder that encodes camera data given as input to JPEG Encoder IP in 4:2:2 (YCbCr) format in 8-bits per pixel mode. IP can provide compressed data for the selected quality factor (Quantization tables are programmable).

JPEG Encoder IP can include JPEG Header and Tables used for compression along with compressed data based on the input signal.

Key Features

The JPEG Encoder IP has the following key features:

- Samples input in 4:2:2 YCbCr format
- Implements compression in 4:2:2 format
- Support 8-bits for each component (Y, Cb, and Cr)
- Supports Programmable Quantization tables
- Minimal latency (nine horizontal lines)

Supported Families

The JPEG Encoder IP supports the following families:

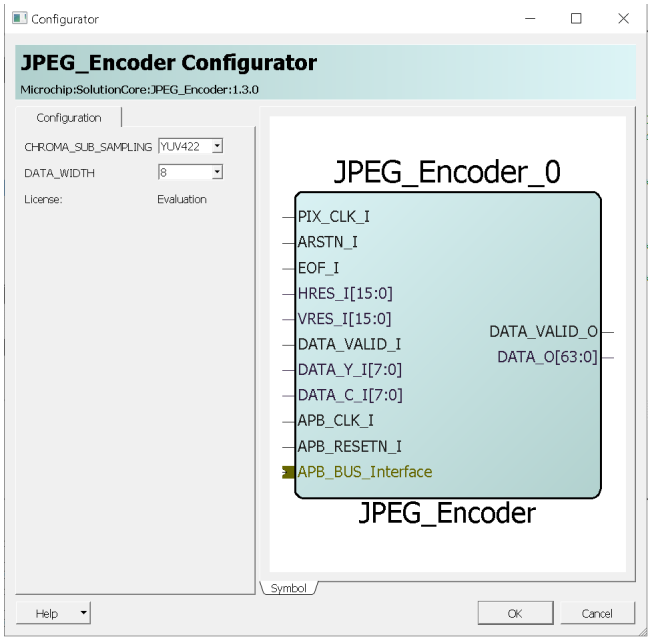
- PolarFire® SoC
- PolarFire

JPEG Encoder IP Configuration

The JPEG Encoder IP supports in 4:2:2 mode. It supports an 8-bit width for each component of Y, Cb, and Cr.

The following figure shows the JPEG Encoder Configurator.

Figure 1. JPEG Encoder Configurator in Compile Time Mode



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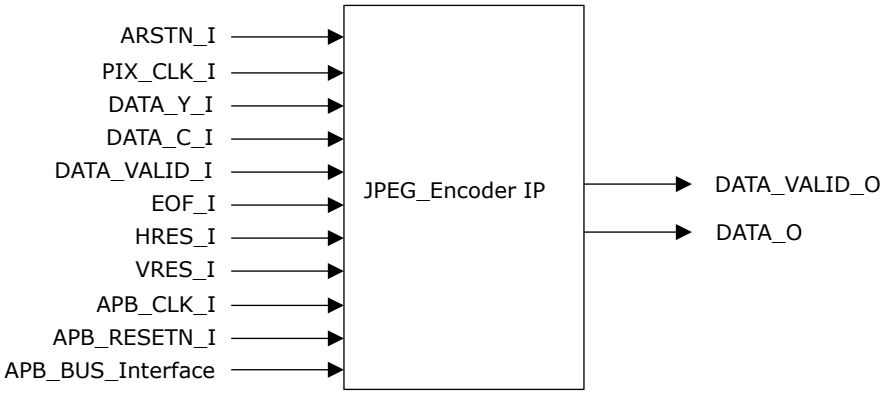
The following figure shows the JPEG Encoder IP block diagram.

Figure 1-1. JPEG Encoder IP Block Diagram



1.1 Inputs and Outputs

The following table lists the JPEG Encoder IP input and output ports.

Table 1-1. Input and Output Ports of JPEG Encoder IP

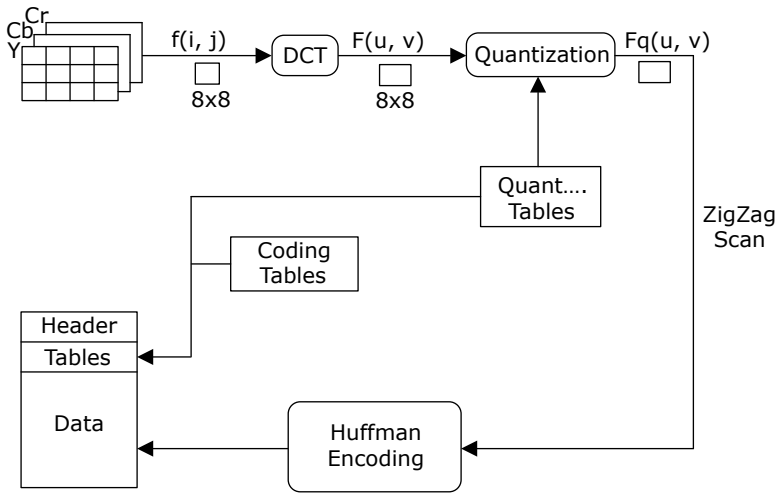
Signal Name	Direction	Width	Port Valid Under	Description
ARSTN_I	Input	1	—	Active-Low Asynchronous Reset signal to design
PIX_CLK_I	Input	1	—	Input clock with which incoming pixels are sampled
DATA_Y_I	Input	8	—	8-bit Luma (Y) input
DATA_C_I	Input	8	—	8-bit Chroma input
DATA_VALID_I	Input	1	—	Input pixel data valid signal
EOF__I	Input	1	—	End of Frame indication
HRES_I	Input	[15:0]	—	Horizontal resolution of input image
VRES_I	Input	[15:0]	—	Vertical resolution of input image
DATA_VALID_O	Output	1	—	Signal indicating valid compressed data on the compressed_data_o bus
DATA_O	Output	[63:0]	—	Compressed data
APB Bus Interface				
APB_PEN_I	Input	1	—	APB Interface write enable signal
APB_PWRITE_I	Input	1	—	APB Interface write signal
APB_PSEL_I	Input	1	—	APB Interface select signal

.....continued				
Signal Name	**Direction**	**Width**	**Port Valid Under**	**Description**
APB_PADDR_I	Input	[31:0]	—	APB Interface write address signal
APB_PWDATA_I	Input	[31:0]	—	APB Interface write data signal
APB_CLK_I	Input	1	—	APB Interface clock All APB interface signals are synchronous to this clock.
APB_RESETN_I	Input	1	—	APB Interface Active-Low Reset signal. This reset is synchronous to APB_CLK_I.

1.2 Hardware Implementation of JPEG Encoder IP

The following figure shows the JPEG Encoder IP block diagram.

Figure 1-2. JPEG Encoder IP Block Diagram



1.2.1 Design Description for JPEG Encoder IP

This section describes the different internal modules of the JPEG Encoder IP. Data input to the JPEG Encoder IP should be in the form of 8 x 8 blocks in YCbCr format.

1.2.1.1 DCT

This module processes the incoming data based on the selected Data format (4:2:2).

As a first step in computing the DCT of the 8×8 block, its values are shifted from a positive range to one centered on zero. For an 8-bit image, each entry in the original block falls in the range [0 255]. The midpoint of the range (in this case, value 128) is subtracted from each entry to produce a data range that is centered on zero, so that the modified range is [-128 127]. Every 8 x 8 block of each component (Y, Cb, Cr) is converted to a frequency domain representation, using a normalized, two-dimensional type-II DCT.

1.2.1.2 Quantization

The human eye is good at seeing small differences in brightness over a relatively large area but not so good at distinguishing the exact strength of a high-frequency brightness variation. This allows one to reduce the amount of information in the high-frequency components. This is done by dividing each component in the frequency domain by a constant for that component and then rounding to the nearest integer. This rounding operation is the only lossy operation in the whole process (other than chroma subsampling) if the DCT computation is performed with sufficiently

high precision. As a result of this, many of the higher frequency components are rounded to zero, and the rest become small positive or negative numbers, which take fewer bits to represent.

Default Quantization table that is valid for Quality value of 50. The QP varies from **5** to **95**.

Luma Table:

Default Luma Table[0–63] -

[16 11 10 16 24 40 51 61 12 12 14 19 26 58 60 55 14 13 16 24 40 57 69 56 14 17 22 29 51 87 80 62 18 24 37 56 68 109 103 77 24 35 55 64 81 104 113 92 49 64 78 87 103 121 120 101 72 92 95 98 112 100 103 99]

Chroma Table

Default Chroma Table[0 - 63] -

[17 18 23 47 99 99 99 99 18 21 26 66 99 99 99 99 24 26 56 99 99 99 99 99 47 66 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99 99]

Quant value for Luma and Chroma gets calculated with following equation for 0 to 63:

If Quality value is < 50, then use the following equation:

```
quant_luma[i] = ((5000/Quality Value)*Default Luma Table[i])/100
quant_chroma[i] = ((5000/Quality Value)*Default Chroma Table[i])/100
```

If Quality value is >= 50, then use the following equation:

```
quant_luma[i] = (((200 - 2*Quality Value)*Default Luma Table[i])/100)
quant_chroma[i] = (((200 - 2*Quality Value)*Default Chroma Table[i])/100)
if(quant_luma[i]==0) quant_luma[i]=1;
if(quant_chroma[i]==0) quant_chroma[i]=1;
```

IQuant value for Luma and Chroma gets calculated with following equation for 0 to 63:

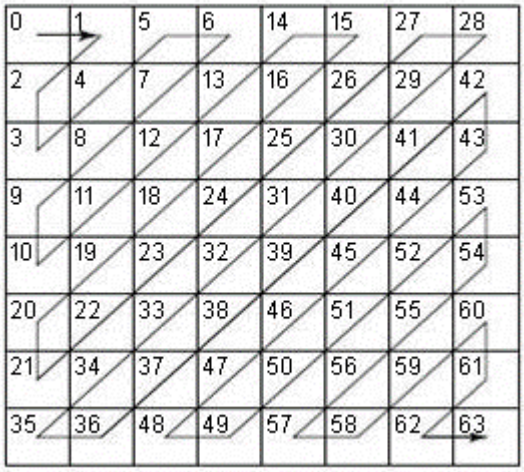
```
IQuant value for Luma :
iquant_luma[i] = (4096/quant_luma[i]) ;
IQuant value for Chroma :
iquant_chroma[i] = (4096/quant_chroma[i])
if(iquant_luma[i] > 4095) iquant_luma[i] = 4095;
if(iquant_chroma[i] > 4095) iquant_chroma[i] = 4095;
```

Note: IQuant = Inverse Quant

1.2.1.3 Zigzag Scan

Zigzag scanning is used to group low-frequency coefficients of the 8 x 8 quantized block to the top level of the vector and the high coefficient to the bottom. This is likely to result in the large number of zeros of the quantized matrix get grouped towards the end of the block. These large number of zeros at the end of the block can be encoded for better compression. The following figure shows the Zigzag scan order.

Figure 1-3. ZigZag Scan



1.2.1.4 Huffman Coding

Separate Huffman tables are used for DC and AC components of Luma and Chroma samples. Standard Huffman tables are used for encoding.

1.2.1.5 Data Packing

Data packing block combines the huffman output along with the header to create the encoded output as per the JPEG format.

2. Register Table

The following table lists the JPEG Encoder IP registers.

Table 2-1. Register Table

Address[12:0]	Data width	Description
0x0	12	Inverse quant table value for Luma [0]
0x4	12	Inverse quant table value for Luma [1]
0x8	12	Inverse quant table value for Luma [2]
0xc	12	Inverse quant table value for Luma [3]
0x10	12	Inverse quant table value for Luma [4]
0x14	12	Inverse quant table value for Luma [5]
0x18	12	Inverse quant table value for Luma [6]
0x1c	12	Inverse quant table value for Luma [7]
0x20	12	Inverse quant table value for Luma [8]
0x24	12	Inverse quant table value for Luma [9]
0x28	12	Inverse quant table value for Luma [10]
0x2c	12	Inverse quant table value for Luma [11]
0x30	12	Inverse quant table value for Luma [12]
0x34	12	Inverse quant table value for Luma [13]
0x38	12	Inverse quant table value for Luma [14]
0x3c	12	Inverse quant table value for Luma [15]
0x40	12	Inverse quant table value for Luma [16]
0x44	12	Inverse quant table value for Luma [17]
0x48	12	Inverse quant table value for Luma [18]
0x4c	12	Inverse quant table value for Luma [19]
0x50	12	Inverse quant table value for Luma [20]
0x54	12	Inverse quant table value for Luma [21]
0x58	12	Inverse quant table value for Luma [22]
0x5c	12	Inverse quant table value for Luma [23]
0x60	12	Inverse quant table value for Luma [24]
0x64	12	Inverse quant table value for Luma [25]
0x68	12	Inverse quant table value for Luma [26]
0x6c	12	Inverse quant table value for Luma [27]
0x70	12	Inverse quant table value for Luma [28]
0x74	12	Inverse quant table value for Luma [29]
0x78	12	Inverse quant table value for Luma [30]
0x7c	12	Inverse quant table value for Luma [31]

.....continued

Address[12:0]	Data width	Description
0x80	12	Inverse quant table value for Luma [32]
0x84	12	Inverse quant table value for Luma [33]
0x88	12	Inverse quant table value for Luma [34]
0x8c	12	Inverse quant table value for Luma [35]
0x90	12	Inverse quant table value for Luma [36]
0x94	12	Inverse quant table value for Luma [37]
0x98	12	Inverse quant table value for Luma [38]
0x9c	12	Inverse quant table value for Luma [39]
0xa0	12	Inverse quant table value for Luma [40]
0xa4	12	Inverse quant table value for Luma [41]
0xa8	12	Inverse quant table value for Luma [42]
0xac	12	Inverse quant table value for Luma [43]
0xb0	12	Inverse quant table value for Luma [44]
0xb4	12	Inverse quant table value for Luma [45]
0xb8	12	Inverse quant table value for Luma [46]
0xbc	12	Inverse quant table value for Luma [47]
0xc0	12	Inverse quant table value for Luma [48]
0xc4	12	Inverse quant table value for Luma [49]
0xc8	12	Inverse quant table value for Luma [50]
0xcc	12	Inverse quant table value for Luma [51]
0xd0	12	Inverse quant table value for Luma [52]
0xd4	12	Inverse quant table value for Luma [53]
0xd8	12	Inverse quant table value for Luma [54]
0xdc	12	Inverse quant table value for Luma [55]
0xe0	12	Inverse quant table value for Luma [56]
0xe4	12	Inverse quant table value for Luma [57]
0xe8	12	Inverse quant table value for Luma [58]
0xec	12	Inverse quant table value for Luma [59]
0xf0	12	Inverse quant table value for Luma [60]
0xf4	12	Inverse quant table value for Luma [61]
0xf8	12	Inverse quant table value for Luma [62]
0xfc	12	Inverse quant table value for Luma [63]
0x100	12	Inverse quant table value for Chroma [0]
0x104	12	Inverse quant table value for Chroma [1]
0x108	12	Inverse quant table value for Chroma [2]

.....continued

Address[12:0]	Data width	Description
0x10c	12	Inverse quant table value for Chroma [3]
0x110	12	Inverse quant table value for Chroma [4]
0x114	12	Inverse quant table value for Chroma [5]
0x118	12	Inverse quant table value for Chroma [6]
0x11c	12	Inverse quant table value for Chroma [7]
0x120	12	Inverse quant table value for Chroma [8]
0x124	12	Inverse quant table value for Chroma [9]
0x128	12	Inverse quant table value for Chroma [10]
0x12c	12	Inverse quant table value for Chroma [11]
0x130	12	Inverse quant table value for Chroma [12]
0x134	12	Inverse quant table value for Chroma [13]
0x138	12	Inverse quant table value for Chroma [14]
0x13c	12	Inverse quant table value for Chroma [15]
0x140	12	Inverse quant table value for Chroma [16]
0x144	12	Inverse quant table value for Chroma [17]
0x148	12	Inverse quant table value for Chroma [18]
0x14c	12	Inverse quant table value for Chroma [19]
0x150	12	Inverse quant table value for Chroma [20]
0x154	12	Inverse quant table value for Chroma [21]
0x158	12	Inverse quant table value for Chroma [22]
0x15c	12	Inverse quant table value for Chroma [23]
0x160	12	Inverse quant table value for Chroma [24]
0x164	12	Inverse quant table value for Chroma [25]
0x168	12	Inverse quant table value for Chroma [26]
0x16c	12	Inverse quant table value for Chroma [27]
0x170	12	Inverse quant table value for Chroma [28]
0x174	12	Inverse quant table value for Chroma [29]
0x178	12	Inverse quant table value for Chroma [30]
0x17c	12	Inverse quant table value for Chroma [31]
0x180	12	Inverse quant table value for Chroma [32]
0x184	12	Inverse quant table value for Chroma [33]
0x188	12	Inverse quant table value for Chroma [34]
0x18c	12	Inverse quant table value for Chroma [35]
0x190	12	Inverse quant table value for Chroma [36]
0x194	12	Inverse quant table value for Chroma [37]

.....continued

Address[12:0]	Data width	Description
0x198	12	Inverse quant table value for Chroma [38]
0x19c	12	Inverse quant table value for Chroma [39]
0x1a0	12	Inverse quant table value for Chroma [40]
0x1a4	12	Inverse quant table value for Chroma [41]
0x1a8	12	Inverse quant table value for Chroma [42]
0x1ac	12	Inverse quant table value for Chroma [43]
0x1b0	12	Inverse quant table value for Chroma [44]
0x1b4	12	Inverse quant table value for Chroma [45]
0x1b8	12	Inverse quant table value for Chroma [46]
0x1bc	12	Inverse quant table value for Chroma [47]
0x1c0	12	Inverse quant table value for Chroma [48]
0x1c4	12	Inverse quant table value for Chroma [49]
0x1c8	12	Inverse quant table value for Chroma [50]
0x1cc	12	Inverse quant table value for Chroma [51]
0x1d0	12	Inverse quant table value for Chroma [52]
0x1d4	12	Inverse quant table value for Chroma [53]
0x1d8	12	Inverse quant table value for Chroma [54]
0x1dc	12	Inverse quant table value for Chroma [55]
0x1e0	12	Inverse quant table value for Chroma [56]
0x1e4	12	Inverse quant table value for Chroma [57]
0x1e8	12	Inverse quant table value for Chroma [58]
0x1ec	12	Inverse quant table value for Chroma [59]
0x1f0	12	Inverse quant table value for Chroma [60]
0x1f4	12	Inverse quant table value for Chroma [61]
0x1f8	12	Inverse quant table value for Chroma [62]
0x1fc	12	Inverse quant table value for Chroma [63]
0x200	8	Quant value for Luma [0]
0x204	8	Quant value for Luma [1]
0x208	8	Quant value for Luma [2]
0x20c	8	Quant value for Luma [3]
0x210	8	Quant value for Luma [4]
0x214	8	Quant value for Luma [5]
0x218	8	Quant value for Luma [6]
0x21c	8	Quant value for Luma [7]
0x220	8	Quant value for Luma [8]

.....continued

Address[12:0]	Data width	Description
0x224	8	Quant value for Luma [9]
0x228	8	Quant value for Luma [10]
0x22c	8	Quant value for Luma [11]
0x230	8	Quant value for Luma [12]
0x234	8	Quant value for Luma [13]
0x238	8	Quant value for Luma [14]
0x23c	8	Quant value for Luma [15]
0x240	8	Quant value for Luma [16]
0x244	8	Quant value for Luma [17]
0x248	8	Quant value for Luma [18]
0x24c	8	Quant value for Luma [19]
0x250	8	Quant value for Luma [20]
0x254	8	Quant value for Luma [21]
0x258	8	Quant value for Luma [22]
0x25c	8	Quant value for Luma [23]
0x260	8	Quant value for Luma [24]
0x264	8	Quant value for Luma [25]
0x268	8	Quant value for Luma [26]
0x26c	8	Quant value for Luma [27]
0x270	8	Quant value for Luma [28]
0x274	8	Quant value for Luma [29]
0x278	8	Quant value for Luma [30]
0x27c	8	Quant value for Luma [31]
0x280	8	Quant value for Luma [32]
0x284	8	Quant value for Luma [33]
0x288	8	Quant value for Luma [34]
0x28c	8	Quant value for Luma [35]
0x290	8	Quant value for Luma [36]
0x294	8	Quant value for Luma [37]
0x298	8	Quant value for Luma [38]
0x29c	8	Quant value for Luma [39]
0x2a0	8	Quant value for Luma [40]
0x2a4	8	Quant value for Luma [41]
0x2a8	8	Quant value for Luma [42]
0x2ac	8	Quant value for Luma [43]

.....continued

Address[12:0]	Data width	Description
0x2b0	8	Quant value for Luma [44]
0x2b4	8	Quant value for Luma [45]
0x2b8	8	Quant value for Luma [46]
0x2bc	8	Quant value for Luma [47]
0x2c0	8	Quant value for Luma [48]
0x2c4	8	Quant value for Luma [49]
0x2c8	8	Quant value for Luma [50]
0x2cc	8	Quant value for Luma [51]
0x2d0	8	Quant value for Luma [52]
0x2d4	8	Quant value for Luma [53]
0x2d8	8	Quant value for Luma [54]
0x2dc	8	Quant value for Luma [55]
0x2e0	8	Quant value for Luma [56]
0x2e4	8	Quant value for Luma [57]
0x2e8	8	Quant value for Luma [58]
0x2ec	8	Quant value for Luma [59]
0x2f0	8	Quant value for Luma [60]
0x2f4	8	Quant value for Luma [61]
0x2f8	8	Quant value for Luma [62]
0x2fc	8	Quant value for Luma [63]
0x300	8	Quant value for Chroma [0]
0x304	8	Quant value for Chroma [1]
0x308	8	Quant value for Chroma [2]
0x30c	8	Quant value for Chroma [3]
0x310	8	Quant value for Chroma [4]
0x314	8	Quant value for Chroma [5]
0x318	8	Quant value for Chroma [6]
0x31c	8	Quant value for Chroma [7]
0x320	8	Quant value for Chroma [8]
0x324	8	Quant value for Chroma [9]
0x328	8	Quant value for Chroma [10]
0x32c	8	Quant value for Chroma [11]
0x330	8	Quant value for Chroma [12]
0x334	8	Quant value for Chroma [13]
0x338	8	Quant value for Chroma [14]

.....continued

Address[12:0]	Data width	Description
0x33c	8	Quant value for Chroma [15]
0x340	8	Quant value for Chroma [16]
0x344	8	Quant value for Chroma [17]
0x348	8	Quant value for Chroma [18]
0x34c	8	Quant value for Chroma [19]
0x350	8	Quant value for Chroma [20]
0x354	8	Quant value for Chroma [21]
0x358	8	Quant value for Chroma [22]
0x35c	8	Quant value for Chroma [23]
0x360	8	Quant value for Chroma [24]
0x364	8	Quant value for Chroma [25]
0x368	8	Quant value for Chroma [26]
0x36c	8	Quant value for Chroma [27]
0x370	8	Quant value for Chroma [28]
0x374	8	Quant value for Chroma [29]
0x378	8	Quant value for Chroma [30]
0x37c	8	Quant value for Chroma [31]
0x380	8	Quant value for Chroma [32]
0x384	8	Quant value for Chroma [33]
0x388	8	Quant value for Chroma [34]
0x38c	8	Quant value for Chroma [35]
0x390	8	Quant value for Chroma [36]
0x394	8	Quant value for Chroma [37]
0x398	8	Quant value for Chroma [38]
0x39c	8	Quant value for Chroma [39]
0x3a0	8	Quant value for Chroma [40]
0x3a4	8	Quant value for Chroma [41]
0x3a8	8	Quant value for Chroma [42]
0x3ac	8	Quant value for Chroma [43]
0x3b0	8	Quant value for Chroma [44]
0x3b4	8	Quant value for Chroma [45]
0x3b8	8	Quant value for Chroma [46]
0x3bc	8	Quant value for Chroma [47]
0x3c0	8	Quant value for Chroma [48]
0x3c4	8	Quant value for Chroma [49]

.....continued		
Address[12:0]	**Data width**	**Description**
0x3c8	8	Quant value for Chroma [50]
0x3cc	8	Quant value for Chroma [51]
0x3d0	8	Quant value for Chroma [52]
0x3d4	8	Quant value for Chroma [53]
0x3d8	8	Quant value for Chroma [54]
0x3dc	8	Quant value for Chroma [55]
0x3e0	8	Quant value for Chroma [56]
0x3e4	8	Quant value for Chroma [57]
0x3e8	8	Quant value for Chroma [58]
0x3ec	8	Quant value for Chroma [59]
0x3f0	8	Quant value for Chroma [60]
0x3f4	8	Quant value for Chroma [61]
0x3f8	8	Quant value for Chroma [62]
0x3fc	8	Quant value for Chroma [63]

3. License

JPEG Encoder is provided in encrypted form only under license.

Encrypted RTL source code is license-locked and must be purchased separately. You can perform simulation, synthesis, layout, and program the Field Programmable Gate Array (FPGA) silicon using the Libero design suite.

Evaluation license is provided for free to check the JPEG Encoder features. The evaluation license expires after an hour’s use on the hardware.

4. Installation Instructions

The IP core must be installed to the IP Catalog of Libero SoC software automatically through the IP Catalog update function in Libero SoC software, or it can be manually downloaded from the catalog. Once the IP core is installed in Libero SoC software IP Catalog, it can be configured, generated, and instantiated within SmartDesign for inclusion in the Libero project.

5. Testbench

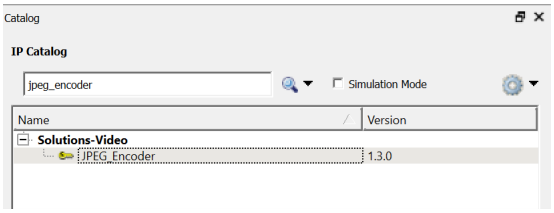
Testbench is provided to check the functionality of the JPEG_Encoder IP.

5.1 Simulation

The simulation uses a 512 × 512 image in the YCbCr422 format, which is represented by two files each for Y and C as input and generates a compressed HEX file format containing one frame. The following steps describe how to simulate the core using the testbench.

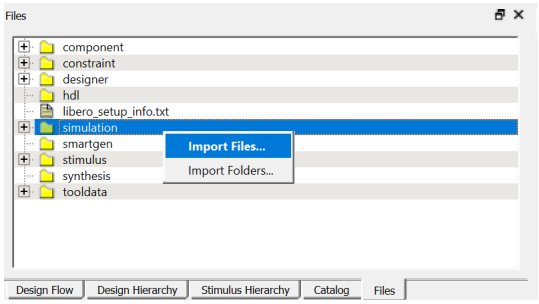
1. Go to Libero SoC **Catalog** > **View** > **Windows** > **Catalog**, and then expand **Solutions-Video**. Double click **JPEG_Encoder**, and then click **OK**.

   Figure 5-1. JPEG_Encoder IP Core in Libero SoC Catalog



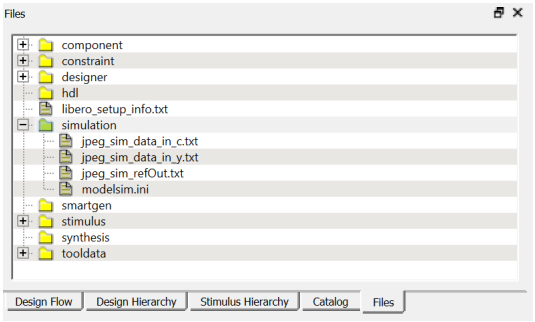
2. On the **Files** tab, right click **simulation** > **Import Files**.

   Figure 5-2. Import Files



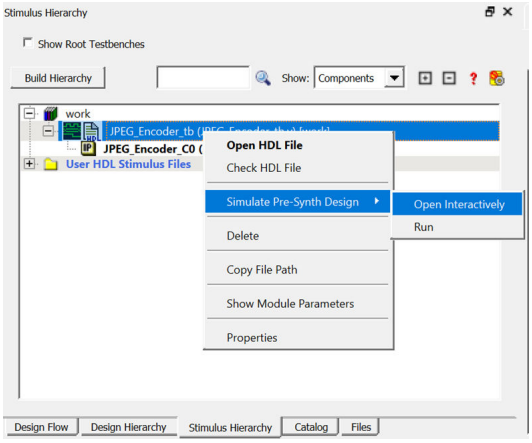
3. Import the `jpeg_sim_data_in_y.txt, jpeg_sim_data_in_c.txt` and `jpeg_sim_refOut.txt` file from the following path: `...\<Project_name>\component\Microchip\SolutionCore\JPEG_Encoder\<JPEG Encoder IP version>\Stimulus`.
4. To import a different file, browse the folder that contains the required file, and click **Open**. The imported file is listed under simulation, see the following figure.

   Figure 5-3. Imported Files



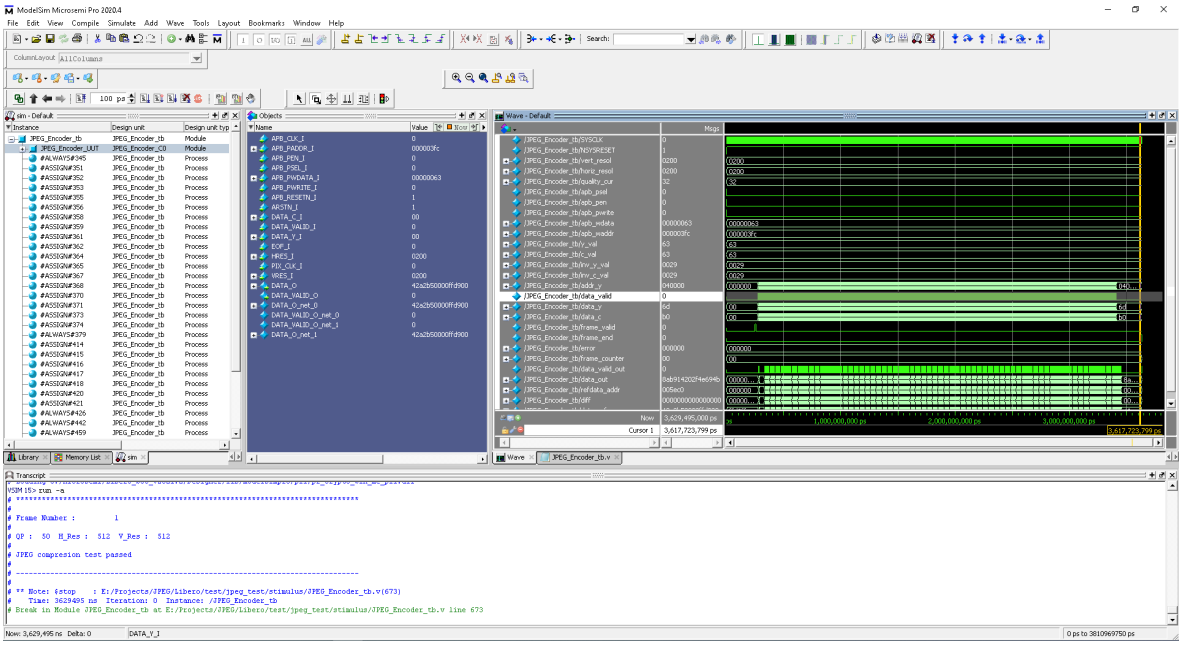
5. On the **Stimulus Hierarchy** tab, click **JPEG_Encoder_tb (JPEG_Encoder_tb. v)** > **Simulate Pre-Synth Design** > **Open Interactively**. The IP is simulated for two frames.

Figure 5-4. Simulating Pre-Synthesis Design



ModelSim opens with the testbench file, as shown in the following figure.

Figure 5-5. Simulation



Important:

- If the simulation is interrupted due to the run time limit specified in the `DO` file, use the `run -all` command to complete the simulation.
- The testbench generates `jpeg_compresed_hex.txt`, any HEX to JPEG converter tool can be used to view JPEG image.

6. Resource Utilization

The following table lists the resource utilization of a sample JPEG Encoder IP design made for PolarFire® SoC FPGA (MPFS250TS-1FCG1152I package) and generation of compressed data by using 4:2:2 sampling of input data.

Table 6-1. Resource Utilization of JPEG Encoder IP that Compresses Data Sampled in 4:2:2 Format

Element	Usage
DFFs	3388
4-input LUTs	6131
Interface DFFs	3672
Interface 4LUTs	3672
LSRAM	66
µSRAM	6
Math Blocks	34

7. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Description
B	01/2023	The following is the list of changes in revision B of the document: • Updated Figure 1. • Updated Figure 1-1. • Updated Table 1-1. • Updated Quant value equation for luma and chroma in 1.2.1.2. Quantization. • Added a new section 5. Testbench. • Updated the device family name and updated Table 6-1. • Renamed the JPEG with JPEG Encoder throughout the document.
A	04/2022	The following is the list of changes in revision A of the document: • The document was migrated to the Microchip template. • The document number was updated to DS50003301A from 50200952. • Added Evaluation License option.
1.0	08/2021	Initial Revision.

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