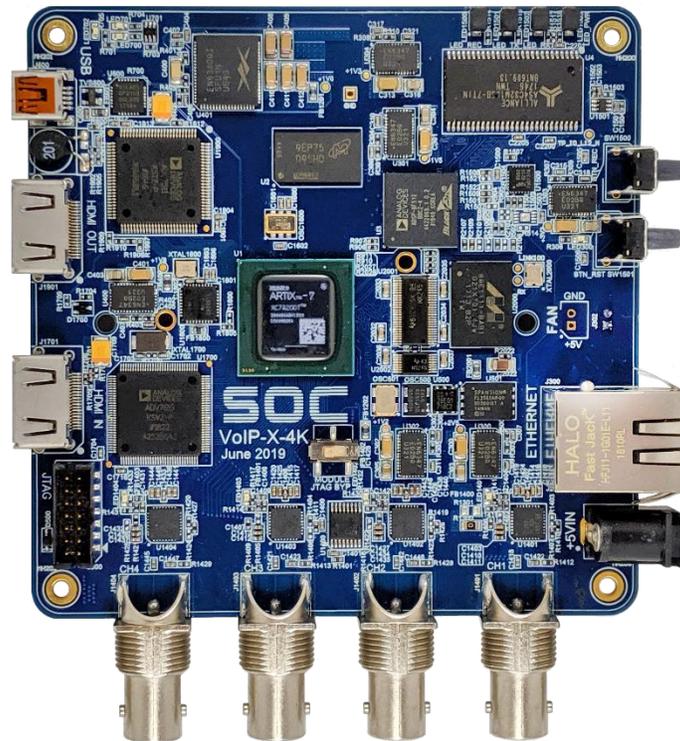


# VoIP-X-4K Board

## User Guide

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## *Preface*

### *About This User Guide*

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This User Guide describes the features and applications of the SOC VoIP-X-4K Product Details on the I/O interfaces and the corresponding components are provided. The User Guide also provide the application examples for the VoIP-X-4K.

### **Related Documents**

#### **Datasheets of IP Cores**

- [Datasheet - H.265 Encoder IP Cores](#)
- [Datasheet - H.265 Decoder IP Cores](#) • [Datasheet - H.264 Encoder IP Cores](#)
- [Datasheet - H.264 Decoder IP Cores](#)
- [Datasheet – MPEG-2 Encoder IP Cores](#)

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- [Datasheet – MPEG-2 Decoder IP Cores](#)
- [Datasheet – H.264-to-H.265 Transcoder IP Cores](#)
- [Datasheet – H.265-to-H.264 Transcoder IP Cores](#)
- [Datasheet - MPEG2-to-H.264 Transcoder IP Cores](#)
- [Datasheet - H.264-to-MPEG2 Transcoder IP Cores](#)

## Integration Sheets of IP Cores

- [Integration Sheet - H.265 Encoder IP Cores](#)
- [Integration Sheet - H.265 Decoder IP Cores](#) • [Integration Sheet - H.264 Encoder IP Cores](#)
- [Integration Sheet - H.264 Decoder IP Cores](#)
- [Integration Sheet - H.265 4K Encoder IP Cores](#)
- [Integration Sheet - H.265 4K Decoder IP Cores](#) • [Integration Sheet - H.264 4K Encoder IP Cores](#)
- [Integration Sheet - H.264 4K Decoder IP Cores](#)
- [Integration Sheet - MPEG-2 Encoder IP Cores](#)
- [Integration Sheet - MPEG-2 Decoder IP Cores](#)
- [Integration Sheet - H.264-to-MPEG2 Transcode IP Cores](#)
- [Integration Sheet - MPEG2-to-H264 Transcoder IP Cores](#)

## Datasheets of Codec Modules

- [Datasheet - MPEG Video-Audio Codec Modules - Standard Version](#)
- [Datasheet - MPEG Video-Audio Codec Modules - NET version](#)

## Datasheets of Codec Chipsets

- [Datasheet - H.264 Encoder Chipsets](#)
- [Datasheet - H.264 Decoder Chipsets](#)

## VoIP-X-4K Board

### 1. Overview

The SOC VoIP-X-4K is a versatile FPGA board designed for multiple functions/products. Customers can use the VoIP-X-4K for their products directly (OEM Product), or as a product development platform. SOC customizes the firmware based on customer requests to enable easy customer product development. SOC also ships preconfigured VoIP-X-4K as H.264/H.265/MPEG-2 video encoders/transmitters (over IP networks), receivers/decoders, and transcoders. The applications of the VoIP-X-4K are described in the next Section of this document.

The VoIP-X-4K has its own FPGA chip, the Xilinx Artix-7 XC7A200T, which controls the I/Os. The VoIP-X-4K also has a DDR3 SODIMM connector that is used to connect to the SOC SoM modules or MPEG codec modules.

The VoIP-X-4K with an encoder or decoder module is a fully functional H.264/265 (or MPEG-2) video/audio over the Internet (IP) transmitter or receiver that can be packaged into an enclosure box for end-user products. It provides HDMI input, HDMI output, four 3G/HD SDI ports, with each can be configured into either input or output. The 4 SDI ports together can be used for 4K@30/60 video input or 4K@30/60 output. Each of the 3G/HD SDI port can be used to one HD@30/60 input or output. The Ethernet port along with the firmware inside the FPGA provides the UDP/RTP/IP compatibilities. The VoIP-X-4K Board is shown in Figure 1 (top view) and Figure 2 (bottom view).

### **Key Features**

- Xilinx Artix-7 XC7A200T FPGA
- One DDR3 SODIMM connector for a SOC MPEG Codec Module or SOC SoM module
- One HDMI 1.4a input and one HDMI 1.4a output
- Four 3G/HD SDI ports (each can be configured into input or output independently)
- Tri-speed Ethernet (10/100/1000 Mbps), offers UDP/IP connectivity
- Mini USB as an URAT port
- Two Extension Connectors and LEDs
- SD memory Card
- Power rails for SOC MPEG Codec Modules or SOC SoM modules □ JTAG for on board FPGA and/or SoM configurations.

### **Dimension**

The dimension of the VoIP-X-4K is 100mm x 100mm x 20mm

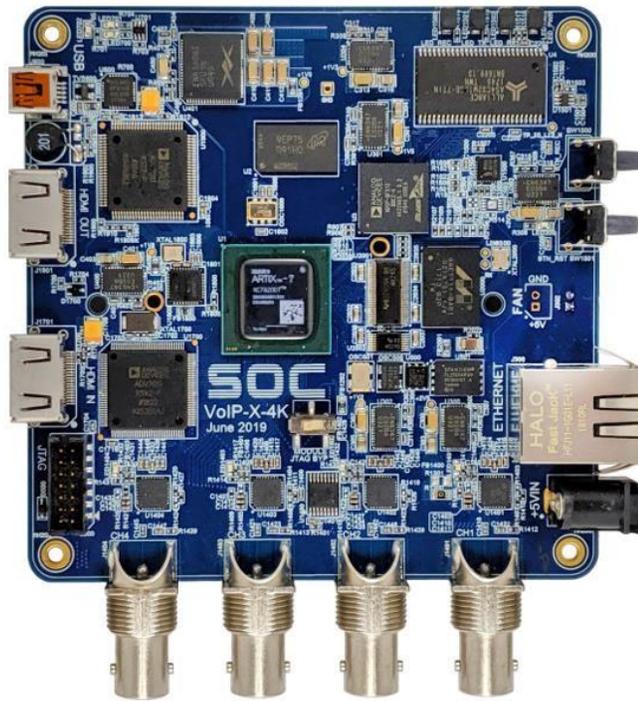


Fig.1 VoIP-X-4K Top View



Fig. 2 VoIP-X-4K bottom View

## 2. Applications of the VoIP-X-4K

### 2.1 OEM MPEG Video Codec Products

The VoIP-X-4K, with a SOC H.264 or H.265 (or MPEG-2) encoder or a decoder module, is a ready-to-use H.264 (or H.265 or MPEG-2) video/audio over the Internet (IP) or wireless (connected to a wireless transponder) 4K@30/60 transmitter or receiver which is offered as an OEM product by SOC. The VoIP-X-4K can also be configured into a bidirectional HD video transponder or multi-channel HD video/audio transmitters, receivers, or transponders. Standard products include:

1. Single-channel 4K@30/60 H.264 video encoder and transmitter (over IP networks)
2. Single-channel 4K@30/60 receiver (over IP networks) and H.264 video decoder.
3. Quad-channel HD@30/60 (1080p@30/60) H.264 video encoder and transmitter (over IP networks)
4. Quad-channel HD@30/60 (1080p@30/60) H.264 video receiver (from IP network) and decoder
5. Quad-channel HD@30/60 (1080p@30/60) H.264 video receiver (from IP network) and decoder
6. Due-channel HD@30/60 bidirectional encoder and decoder (Transponder)
7. The above devices for H.265 or MPEG-2 standard
8. The above products connecting to WIFI or radio transponders for wireless video communications.
9. The above devices with customizations based on customer requirements

Fig. 3 shows an example of two VoIP-X-4K boards for 4K video over IP application. In the example, one VoIP-X-4K is configured into a 4K transmitter and the second is configured into a 4K receiver. The 4K video input (on the transmitter side) and the 4K video output (on the receiver side) are going through 4 of the 3G SDI ports.

It is noted that the SOC offers VoIP-I-4K with 12G SDI I/O ports, which allows for one SDI port for 4K video I/Os. Please refer to the User Guide of VoIP-I-4K for details.

Fig. 4 shows an application of two VoIP-X-4K boards for bidirectional HD video communication over the Internet, such as video conference over the Internet applications. In this case, two SDI ports are

used on each side, with one SDI port as input and the second as output. The HDMI ports can be used as well, if it is more desirable. Refer to the green dotted lines for the HDMI connections.

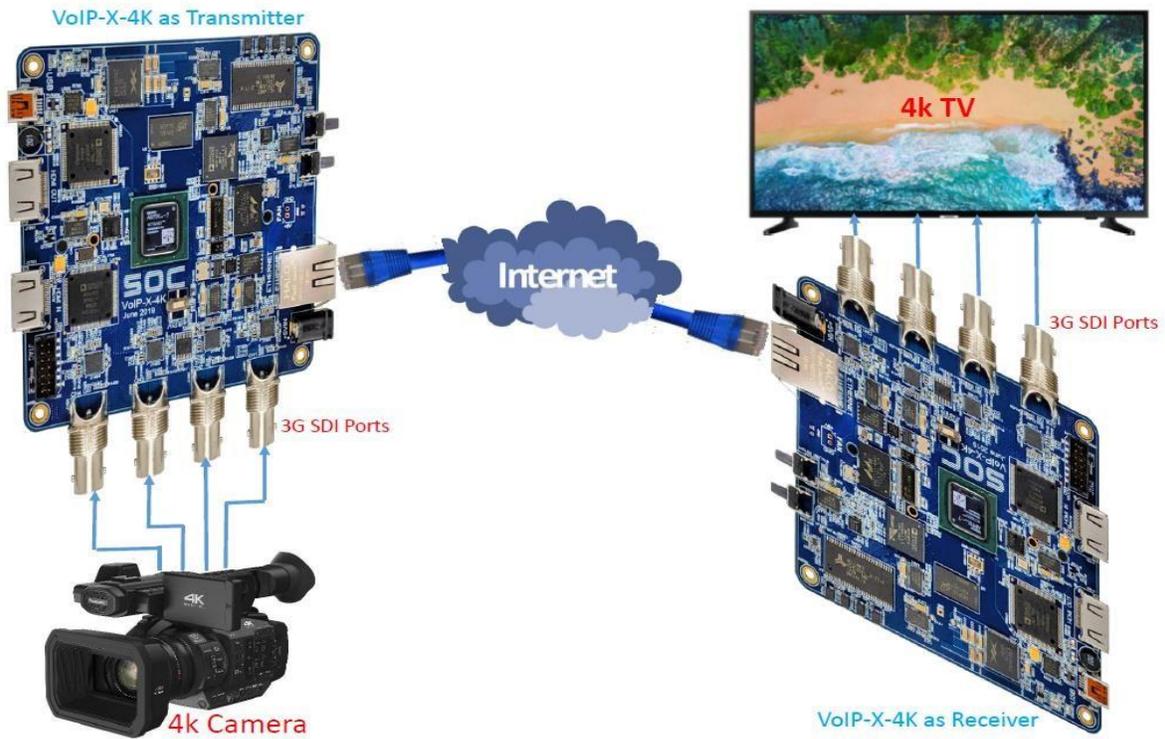


Fig. 3 The VoIP-X-4K is used for 4K video-over-IP applications

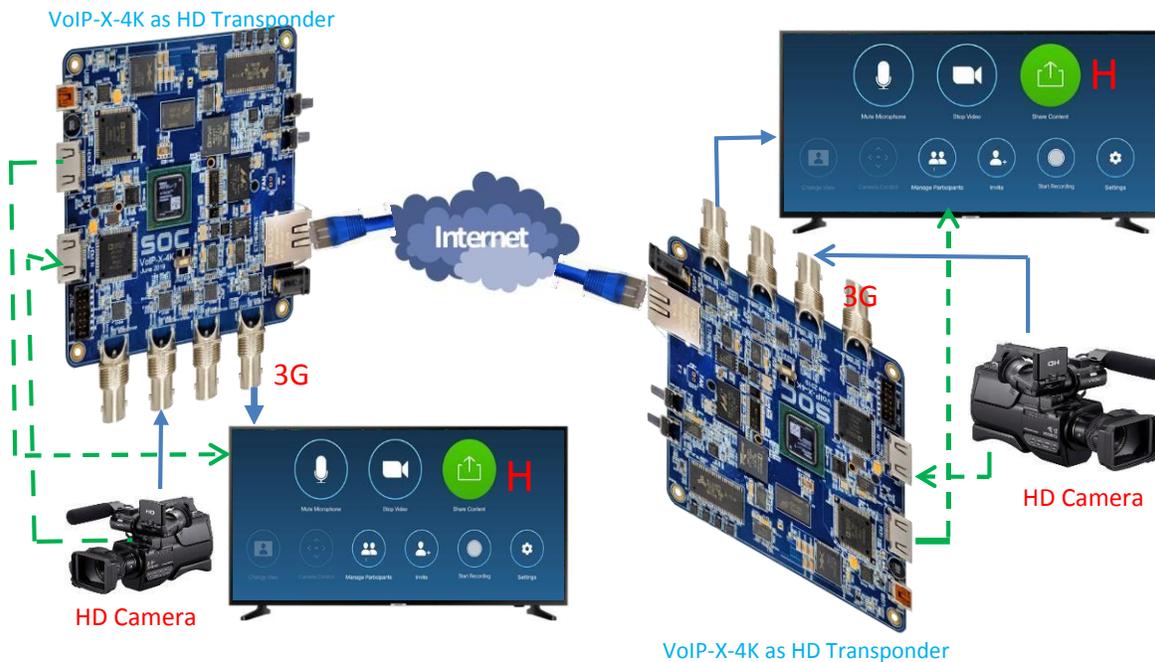


Fig. 4 The VoIP-X-4K is used for bidirectional HD video-over-IP applications (Video Conferencing)

## 2.2 Product Development Platform based on the SOC Codec Modules

The VoIP-X-4K is a versatile platform for product development, based on the SOC MPEG codec modules (or IP cores), for end-user product development. SOC supplies the MPEG codec modules, including H.264, H.265, or MPEG-2 encoder, decoder, or transcoder modules.

SOC provides (under licensing agreement) “netlist” IP cores for all the I/O ports, including the network (UDP/IP over Ethernet) stack for the VoIP-X-4K, so that the users can drop them into their own designs without having to implement the I/O drivers.

Design templates of the I/O drivers and the network stack IP cores are available for licensing. These can greatly speed up the development process.

The PDF schematics design of the VoIP-X-4K is available under licensing programs, which provides the details information for using the board for product development. Users can also purchase the PCB

design files (Altium) from SOC, which can be used as a reference for the user PCB once the product is developed. Contact SOC sales ([sales@soctechnologies.com](mailto:sales@soctechnologies.com)) for details.

## 2.3 Product Development Kit based on the SOC SoM Modules

The SOC SoM modules can be used as a generic System-on-Module (SoM) platform for user designs. There are a number of modules can be used on the VoIP-X-4K board. The SoM-X-Z7045 (Xilinx Zynq7045 FPGA) and SoM-I-SX660 (Intel Arria-10 SX660 FPGA) are commonly used.

Fig. 5 shows the SOC SoM-X-Z7045 module. The module is equipped with one Zynq-7045 FPGA which has 218K LUTs of logics and 2 ARM processors. The SOM-X-Z7045 module has 8Gbits of DDR3 memories, with 4Gb for the logic and 4Gb for the ARMs. There are also two oscillators on the module. The flash memory on the module allows the user to store their firmware after the development. Once configured with the user developed firmware, the module can be used as a SoM module for user applications. Using the SOC SoMs can accelerate product development and reduce hardware design costs. Users can use the VoIP-X-4K to develop any firmware for the SoM-X-Z7045 to make the SoM-X-Z7045 as a product. As discussed in Section 2.1, SOC configures the SoM-XZ7045 for MPEG Codec applications.

Fig. 6 shows the SOC SoM-I-SX660 module. The module is equipped with one Arria-10 SX660 FPGA which has 250K ALMs of logics and two ARM processors. The SOM-I-SX660 module has 8Gbits of DDR3 memories, with 4Gb for the logic and 4Gb for the ARMs. There are also two oscillators on the module. The flash memory on the module allows the user to store their firmware after the

development. Once configured with the user developed firmware, the module can be used as SoM module for user applications. This accelerates product development and reduces hardware design costs. Users can use the VoIP-X-4K to develop any firmware for the SoM-I-SX660 to make the SoMI-SX660 as a product. As discussed in Section 2.1, SOC configure the SoM-I-SX660 (or the SoM-XZ7045) for MPEG Codec applications.

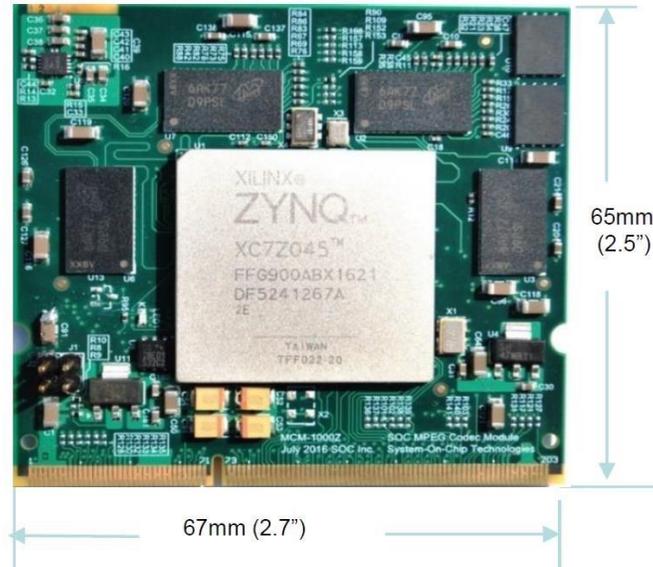


Fig.5 The SOC SoM-X-Z7045 Module



Fig. 6 The SOC SoM-I-SX660 Module

SOC also supplies modules with other FPGAs, which can be used on the VoIP-X-4K carrier board as well. Table-1 list the current available modules.

Table-1 SOC SOMs – Product Code and the FPGA chip on the module

| Item # | SOM Product Code | FPGA Chip on the Module |
|--------|------------------|-------------------------|
| 1      | SOM-X-SLX150     | Spartan-6 XC6SLX150     |
| 2      | SOM-X-A200T      | Artix-7 XC7A200T        |
| 3      | SOM-X-Z7035      | Zynq-7 XC7Z035          |
| 4      | SOM-X-Z7045      | Zynq-7 XC7Z045          |
| 5      | SOM-I-SX660      | Arria-10 SX066          |

SOC provides reference SoM designs and SoM configuration instructions and examples. Once the SoM is developed, it can be copied using the VoIP-X-4K board. The SoM module along with the VoIP-X-4K can be a final product. Alternatively, a carrier board can be designed based on the VoIP-X-4K PCB.

## 2.4 Evaluation Kit for SOC 4K and HD Codec Modules, IP cores, and Chipsets

The VoIP-X-4K is preloaded with firmware for evaluating the SOC 4K@30/60 or HD@30/60 MPEG codec modules or IP cores. It is a plug-and-play system that allows the user to insert the module (encoder, decoder, or transcoder) to be evaluated, and connect the I/O devices to start the evaluation.

When evaluating the SOC IP cores, the IP cores to be evaluated will be pre-loaded into the modules shipped with the evaluation kit. Since the SOC codec chipsets use SOC IP cores, chipsets are evaluated based on IP cores which are preloaded into the modules.

For 4K encoder evaluation, the 4K@30/60 input video source is sent to the VoIP-X-4K via the four 3G SDI ports (configured to input); the encoded stream is sent to a computer through the Ethernet port. Users can decode the encoded streams by using standard software decoders, such as VLC. Fig. 7 shows the setup for 4K encoder evaluation. It should be noted that the setup shown in Fig. 7 requires a video source device that output 4K video via 4 of the 3G SDI ports. SOC offers a 12G SDI I/O board for customers who want to use 12G SDI for video I/Os. The Product code for the 12G SDI board is VoIP-I-4K. Please refer to the User Guide of VoIP-I-4K for details.

Fig. 8 show the setup for HD encoder evaluation. Only one 3G SDI port is used for the video input. The HDMI input port can be used for video input as well, if it is more desirable. Refer to the green dotted lines in Fig. 8 for the connections.

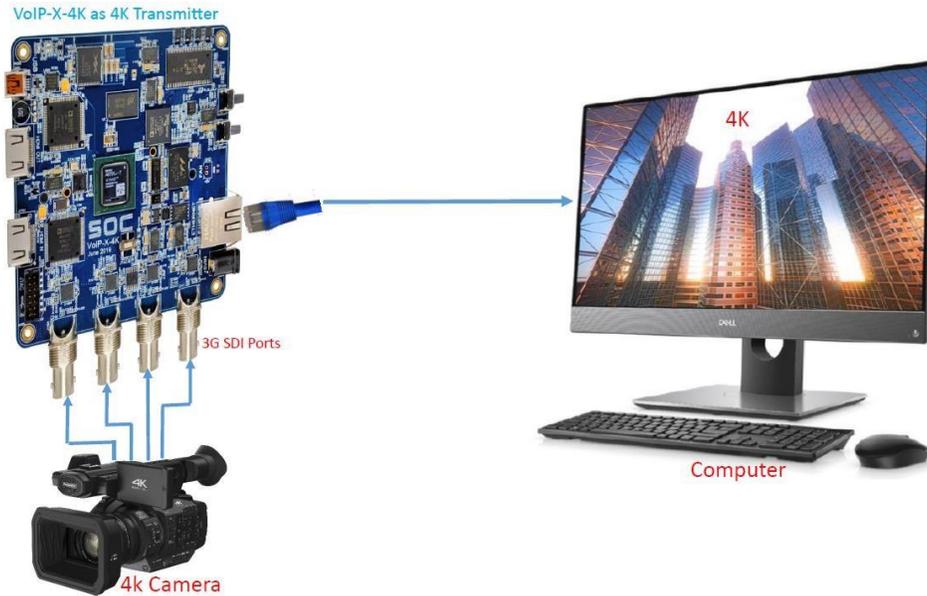


Fig. 7 Setup for the SOC 4K video encoder evaluation using the VoIP-X-4K kit

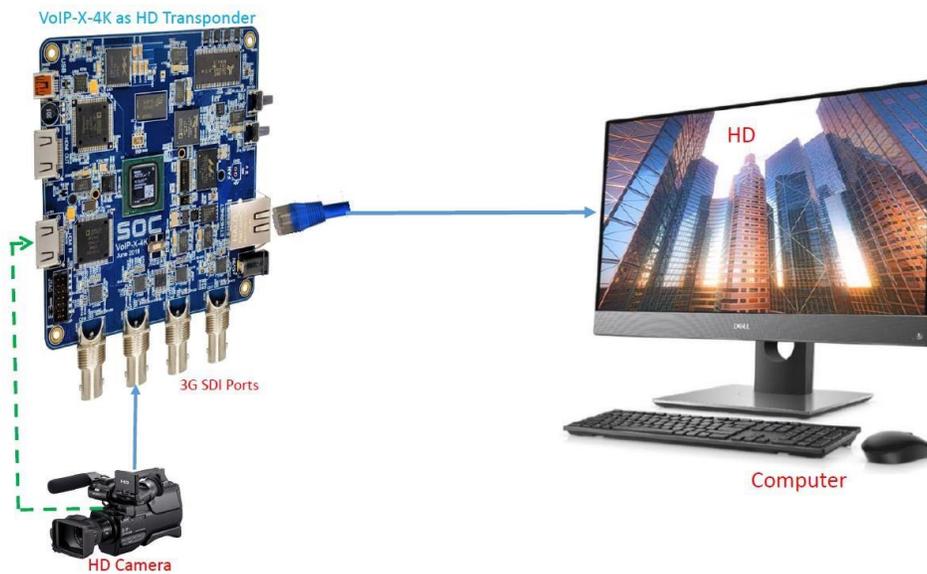


Fig. 8 Setup for the SOC HD video encoder evaluation using the VoIP-X-4K kit

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For decoder evaluation, the compressed streams are sent to the VoIP-X-4K through the Ethernet from a computer. The software for sending the streams is provided as part of the VoIP-X-4K package. The decoded video and audio streams are sent to display via the four SDI ports.

Fig. 9 shows the setup for 4K decoder IP cores (modules or chipsets) evaluations. Again, the 4K video is sent to the display device via 4 of the 3G SDI port. The SOC VoIP-I-4K board provides 12G SDI ports. Please refer to the User Guide of VoIP-I-4K for details.

Fig, 10 shows the setup for HD decoder IP cores (modules or chipsets) evaluations. In the HD situation, either the 3G SDI or the HDMI I/Os can be used for the video input or output.

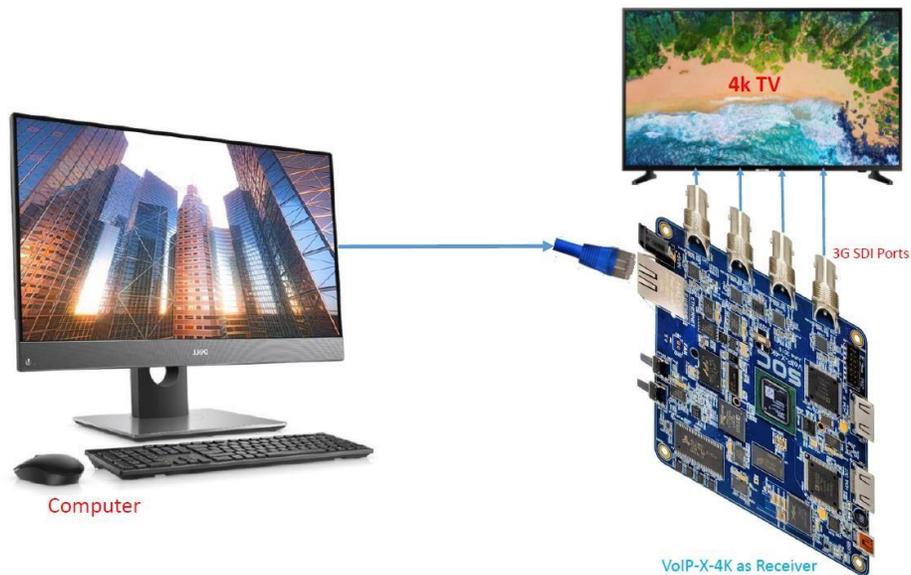


Fig. 9 Setup for the SOC 4K video decoder evaluation using the VoIP-X-4K kit

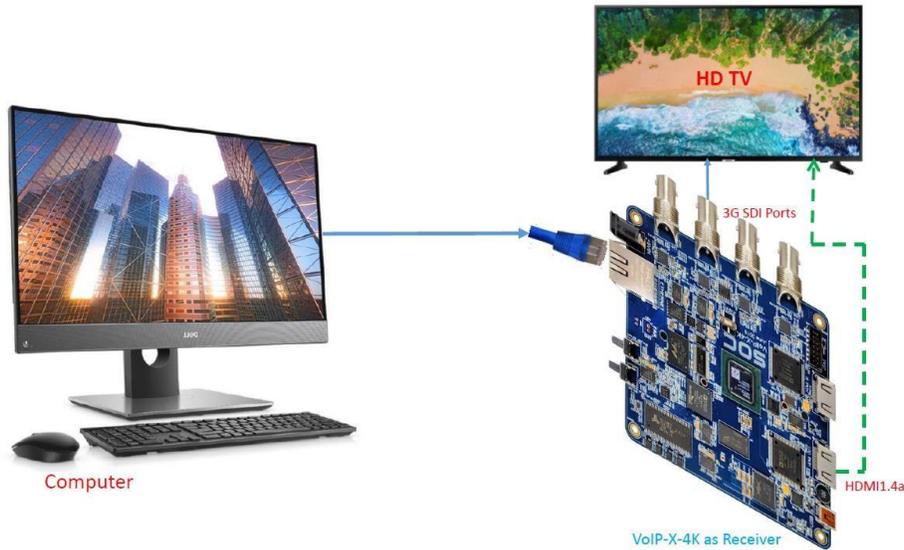


Fig. 10 Setup for the SOC HD video decoder evaluation using the VoIP-X-4K kit

It is noted that the setups of Fig. 7 to Fig. 10 cannot be used to test the latency of the SOC encoder or decoder, due to the large latency of the computer. To evaluate the latency, a pair of the VoIP-X-4K is used, which is shown in Fig.11.

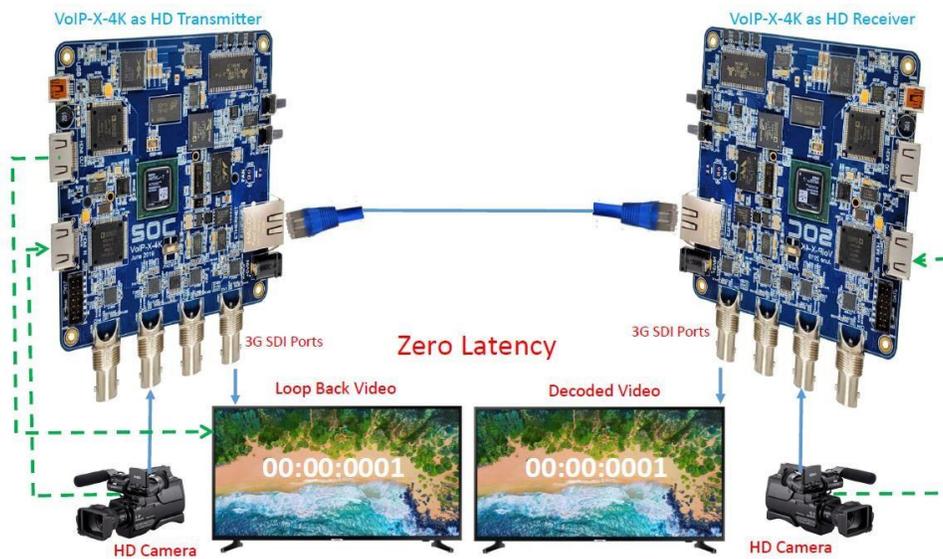


Fig. 11 Setup for the SOC HD video encoder-decoder evaluation and latency evaluation using the VoIP-X-4K kit

For transcoder evaluation, both the input stream and transcoded stream are sent through the Ethernet port.

Detailed instructions for evaluating the SOC encoders and decoders using the VoIP-X-4K are provided in “Instruction Sheet of Using the VoIP-X-4K to Evaluate SOC Codec Modules and IP cores”.

### 3. Hardware Descriptions

#### 3.1 Block Diagram

Fig. 12 shows a block diagram of the VoIP-X-4K board.

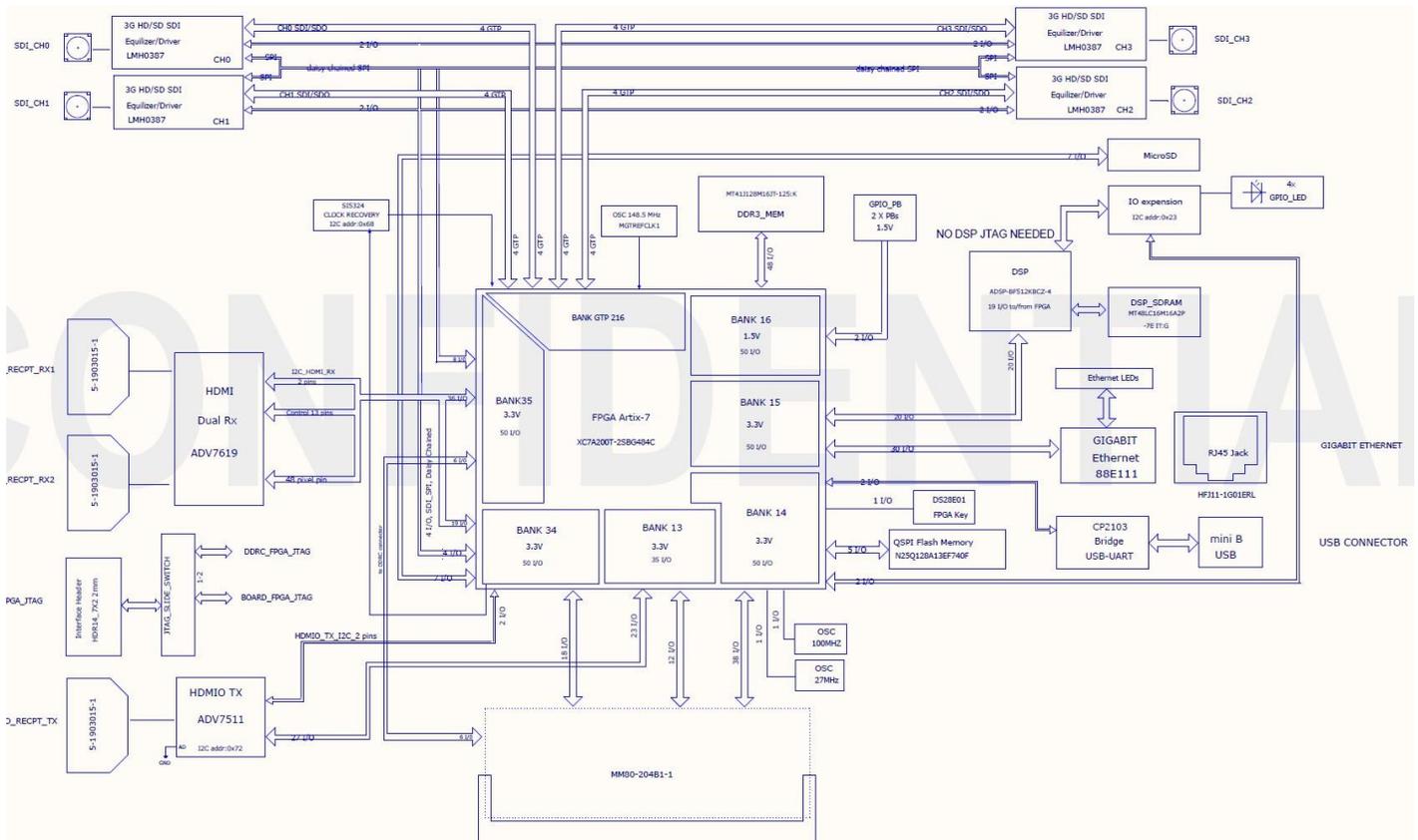


Fig. 12 Block diagram of VoIP-X-4K board

## 3.2 Key Components

Table-2 lists the components on the VoIP-X-4K that are important to users. Refer to the schematics of the VoIP-X-4K for the circuit design and the auxiliary components, if needed. The PCB schematics can be licensed from SOC.

The following Sections describe the components listed in Table-2. Refer to the datasheets of the components for further details.

**Table-2 Major components on the VoIP-X-4K**

| Item | Part Name              | Description   | Manufacturer        |
|------|------------------------|---|---------------------|
| 1    | XC7A200T-2SBG484C      | FPGA, Artix-7, A200T  | Xilinx              |
| 2    | MT411256M16HA-125:E    | DDR3 Memory   | MICRON              |
| 3    | ADV7511KSTZ-P          | HDMI Transmitter  | Analog Devices Inc  |
| 4    | ADV7619KSVZ-P          | HDMI receiver (up to 4k@30 resolution)                                    | Analog Devices Inc  |
| 5    | LMH0387SLE/NOPB        | 3 Gbps HD/SD SDI Configurable I/O Adaptive Cable Equalizer / Cable Driver | TI                  |
| 6    | 88E1111_BAB1C000       | Gigabit Ethernet Transceiver, 10/100/1000                                 | Marvell             |
| 7    | CP2103                 | SINGLE-CHIP USB TO UART BRIDGE  | Silicon Labs        |
| 8    | N25Q128A13EF740F       | 128Mb, Serial Flash Memory  | MICRON              |
| 9    | ASFL1-27.000MHZ-L-T    | OSCILLATOR 27.000 MHZ 3.3V  | ABRACON             |
| 10   | ABM8-166-114.285MHZ-T2 | Crystal 114.2850MHz 20ppm 18pF 80 Ohm                                     | Abracon Corporation |
| 11   | ABM3-28.6363MHZ-B2-T   | CRYSTAL 28.6363MHZ 18PF   | Abracon Corporation |
| 12   | ABM8-25.000MHZ-B2-T    | CRYSTAL 25.000MHZ 18PF  | Abracon Corporation |
| 13   | MM80-204B1             | CONN 204POS DDR3 SDRAM SODIMM   | JAE Electronics     |
| 14   | DS28E01P-100+          | 1Kb PROTECTED 1-WIRE EEPROM   | MAXIM               |

### 3.2.1 FPGA

The FPGA on the VoIP-X-4K is Xilinx Artix-7 XC7A200T-2SBG484C. Refer to the Data Sheet of the FPGA for further details.

### 3.2.2 DDR3 Memory

The VoIP-X-4K is equipment with 4Gbits of DDR3 memory for the FPGA. The part number of the memory chip is MT411256M16HA-125:E

### 3.2.3 HDMI Receiver

The HDMI Receiver interface chip is the ADV7619KSVZ-P by Analog Devices. Refer to the Datasheet of ADV7619KSVZ-P for details.

The ADV7619KSVZ-P supports two channels of HD or 4k@30 video inputs. SOC provides the configuration file for ADV7619KSVZ-P which is a part of the I/O driver package. For evaluations, the ADV7619KSVZ-P is preconfigured for plug-and-play.

### 3.2.4 HDMI Transmitter

The HDMI transmitter interface chip is the ADV7511KSTZ-P by Analog Devices. Refer to the Datasheet of ADV7511KSTZ-P for details.

SOC provides the configuration file for ADV7511KSTZ-P which is a part of the I/O driver package. For evaluations, the ADV7511KSTZ-P is preconfigured for plug-and-play.

### 3.2.5 Bidirectional SDI Transmitter/ Receiver

The SOC VoIP-X-4K has four SDI ports, each is connected to a 3G HD/SD SDI Configurable I/O Adaptive Cable Equalizer/Cable Driver (LMH0387). These four SDI ports can be configured into all inputs, or all outputs, or some inputs and some outputs. Refer to the LMH0387 data sheet for details.

SOC provides the configuration file for LMH0387 which is a part of the I/O driver package. For evaluations, the LMH0387 is preconfigured for plug-and-play.

The SDI ports require a SDI IP core inside the FPGA, which is available for developers from SOC. For OEM products and evaluation kits, the SDI core is pre-installed.

### 3.2.6 Gigabit Ethernet

The Ethernet PHY is the 88E1111\_BAB1C000 by Marvel. It can be used for 10Mbps/100Mbps/1000Mbps. The configuration file is included in the I/O package. An Ethernet MAC core is a part of the Ethernet/UDP/IP network stack which can be licensed. For evaluations, the networks stack is preloaded to allow a plug-and-play system.

### 3.2.7 Mini USB

The VoIP-X-4K has a mini USB connector which is used as UART port. The CP2103, singlechip USB to UART bridge, is used as the interface chip.

### 3.2.8 Serial Flash Memory

The serial flash memory, N25Q128A13EF740F(EOL), is used to store the firmware of the FPGA. For evaluation, the I/O drivers and the Ethernet/UDP/IP network stack are pre-stored in the N25Q128A13EF740F(EOL). When the VoIP-X-4K is booted, the firmware stored in the N25Q128A13EF740F9EOL) will configure the FPGA and make the board a plug-and-play device to facilitate the evaluations of the SOC MPEG codec modules.

After the evaluation, users can store their own firmware into the N25Q128A13EF740F(EOL) for product development. For product development purposes, the I/O driver and the Ethernet/UDP/IP network stack IP core in “netlist” format are available for licensing. The method of downloading the firmware into the N25Q128A13EF740F(EOL) is detailed in Evaluation Instruction Manual.

## 4. The Enclosure

To be added

## 5. Ordering Information

The VoIP-X-4K can be ordered from SOC directly or through the distributors of SOC. Refer to the SOC web site, [www.soctechnologies.com](http://www.soctechnologies.com) , for distributor locations and contact information.

**SOC contacts:**

E-mail: [sales@soctechnologies.com](mailto:sales@soctechnologies.com)

Telephone: 1-519-880-8609

## Revision History

The following table shows the revision history for this document.

| Date       | Version             | Revision       |
|------------|---------------------|----------------|
| 08/08/2018 | SOC initial Release | 1.0            |
| 05/08/2019 | 2.0                 | Major Revision |
|            |                     |                |

**Note:**

**The PCB Schematics of the VoIP-X-4K can be licensed from SOC. Contact:**  
[sales@soctechnologies.com](mailto:sales@soctechnologies.com)