MIPI Input Video Capture /Conversion Board

[SVM-MIPI]

Hardware Specification

Rev.1.0

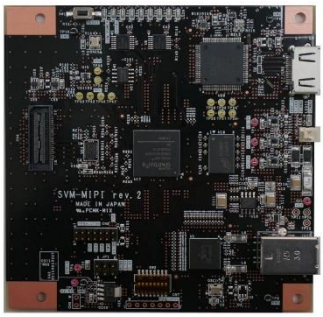
NetVision Co., Ltd.

Update History

Revision	Date	Note	
1.0	2018/04/24	New File (Equivalent to Japanese version 2.4)	

Index

1. Outline



This document is a hardware specification of the board "SVM-MIPI" to convert the MIPI standard video signal from an image sensor to an HDMI or USB 3.0 signal.

SVM-MIPI has two modes: HDMI output mode and USB output mode. This specification is called "SVM-03 mode" and "SVM-03U mode" respectively. You can switch between these modes in the DIP switch #8 (SW2) on the board. When Dip switch 8 off, act as SVM-03 mode. When Dip switch 8 on, act as SVM-03U mode. Both modes support uncompressed video up to 1920x1080 60fps.

In SVM-03 mode, you can connect to a target such as an image sensor, connect it to a PC monitor or TV with an HDMI port, and easily display and verify and evaluate the image data from the target in real time on the monitor.

SVM-03U mode allows you to capture from your PC as a device that complies with UVC (USB Video Class), so you can use Windows, Linux and other operating systems The image sensor can be evaluated and developed.

1.1. SVM-MIPI functions

SVM-03 ﾓｰﾄﾞ: MIPI Video Signal -> HDMI Conversion

SVM-03U ﾓｰﾄﾞ: MIPI Video Signal -> USB3.0 (UVC) Conversion

1.2. Specifications (SVM-03 Mode)

Power : USB Bus Supply (External Power Input Applicable) / +5V 0.7A typ.

Input standards : MIPI CSI-2 Video Signal (1 - 4 lane)

Data rate per lane : max. 1Gbps

Effective pixel data Rate : max. 2.4Gbps

MIPI Clock Rate: 100 - 500 MHz

Input Resolution: max. 4093 x 4093 pixel

Input Pixel Format : YUV4:2:2, Raw10, Raw12, RGB24

Output: HDMI Connector (HDMI Mode = YUV / DVI Mode = RGB)

Output Resolution : 1280x720 / 1920x1080 (Can be cut out in any area)

Output Frame Rate : 30FPS / 60FPS

Output Frame Format : YUV4:2:2 Uncompressed / RGB 4:4:4 Uncompressed

1.3. Specifications (SVM-03U Mode)

Power: USB USB Bus Supply (External Power Input Applicable) / +5V 0.5A typ.

Input standards : MIPI CSI-2 Video Signal (1 - 4 lane)

Data rate per lane : max. 1Gbps

Effective pixel data Rate : max. 2.4Gbps

MIPI Clock Rate: 100 - 500 MHz

Input Resolution: max. 4093 x 4093 pixel

Input Pixel Format : YUV4:2:2, Raw10, Raw12, RGB24

Output: USB 3.0 (USB 2.0 connection is possible if it is about VGA Size)

Device Class : USB Video Class (UVC)

Output Through Rate: max. 3.0 Gbps

Output Resolution : Same as input resolution （Can be cut out in any area）

Output Frame Rate : any

Output Pixel Format : Same as input Pixel Format

＊ In the case of Raw input, HDMI mode is output in monochrome images (pixel-by-pixel).

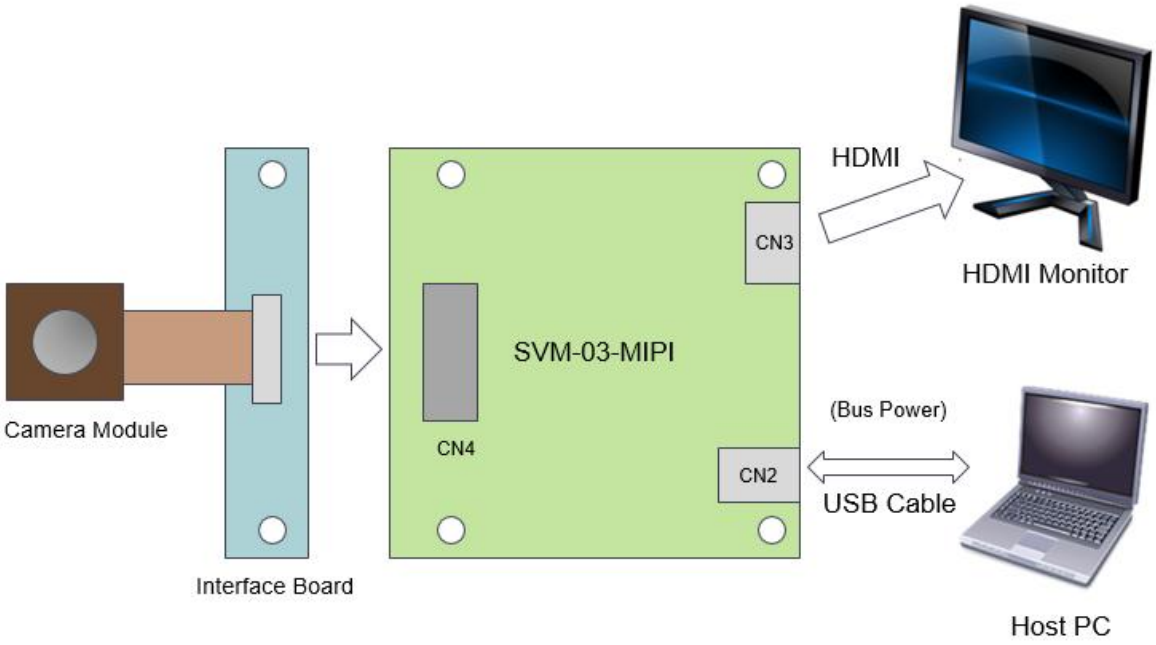
2. SVM-03 Mode operation details

This chapter describes the SVM-03 mode (MIPI input, HDMI output).

2.1. Main Functions and Features of SVM-03 Mode

- In SVM-03 Mode, the board can work at stand-alone. Without complicated operation from PC, you can easily show input video from target at a HDMI monitor.
- We use the MIPI D-phy 1.1 compliant repeater (SN65DPHY440SS, TI Inc.).
- As the video output size to a HDMI monitor at 1080p (1920x1080) and 720p (1280x1080) are supported.
- The video output frame rate to a HDMI monitor can be Supported to 60fps and 30fps.
- The setting from the PC is basically unnecessary.
- The initial setting of the image sensor is easy because it comes with the utility software for the I2C transfer.
- Because it corresponds to the output in DVI mode in RGB444, it is possible to display it to the DVI monitor which does not conform to the HDMI standard.
- Due to DDR2-SDRAM (128MByte) as frame memory, the board supports various timing specification of most image sensors. Input picture can be displayed on a monitor without dropping lines, pixels or frames.
- Automatic detection of input video resolution. When input image size is larger than monitor output video resolution, according to output size, an input image is clipped out automatically.
- When the input image is smaller than the monitor output image size, the border is automatically added to the upper and lower sides according to the output size. And, the input image is displayed by Dot-by-dot in the center of the monitor screen.
- The target connection side is fully pin-compatible with the existing Netvision NV-006-B board, so you can immediately connect your target on the same board.
- The input image format corresponds to the YUV, Raw 10bit, Raw 12bit, RGB24 format.
- With USB connectors and device controllers, you can configure and control a variety of USB connections.
- Starts up as the SVM-03 mode by setting DIP SW #8 to OFF when power up.

2.2. Connection Example for SVM-03 Mode



2.3. Notification about Power Supply

SVM-MIPI board consumes about 600mA on 5V line when it outputs test pattern without target connection. When target sensor is connected the power consumption may be larger. Please use adequate AC adapter or USB cable.

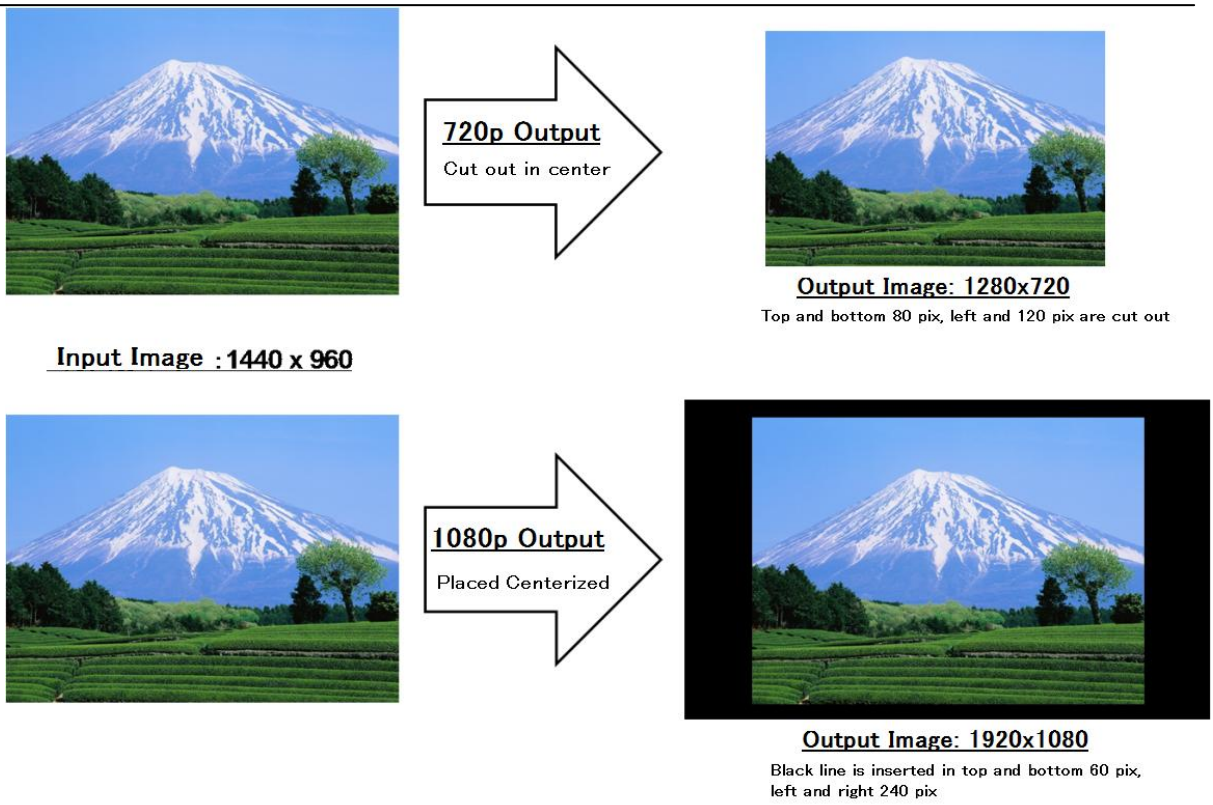
- When SVM-03U mode the power consumption is about 500mA.

2.4. Notification about USB Bus Power

SVM-MIPI board can be work on USB bus power from PC, but from the USB specification sheet USB 2.0 and USB 3.0 port should be limited at 500mA and 900mA, relatively. Thus, we don't offer a guarantee of operation when you use from USB bus power. Please use it at your own risk.

2.5. Automatic central cutting and automatic border addition center display

In SVM-03 Mode, the input resolution from target device is automatically detected. As the following figure, when the input resolution is larger than the monitor resolution, the input video will be cut out in center and output dot-by-dot. On the other hand, when the input is smaller than the monitor, the input will be put in center surrounded by black background.



2.6. Processing on RAW input

For RAW input formats, SVM-MIPI supports input in the RAW10/RAW12 format, but in SVM-03 mode it is output as a monochrome image of 1 pixel (dot-by-dot) per input pixel. The lower bits are truncated because only the upper 8 bits are output. The Raw development (de-mosaic) function is not currently installed.

3. SVM-03U Mode operation details

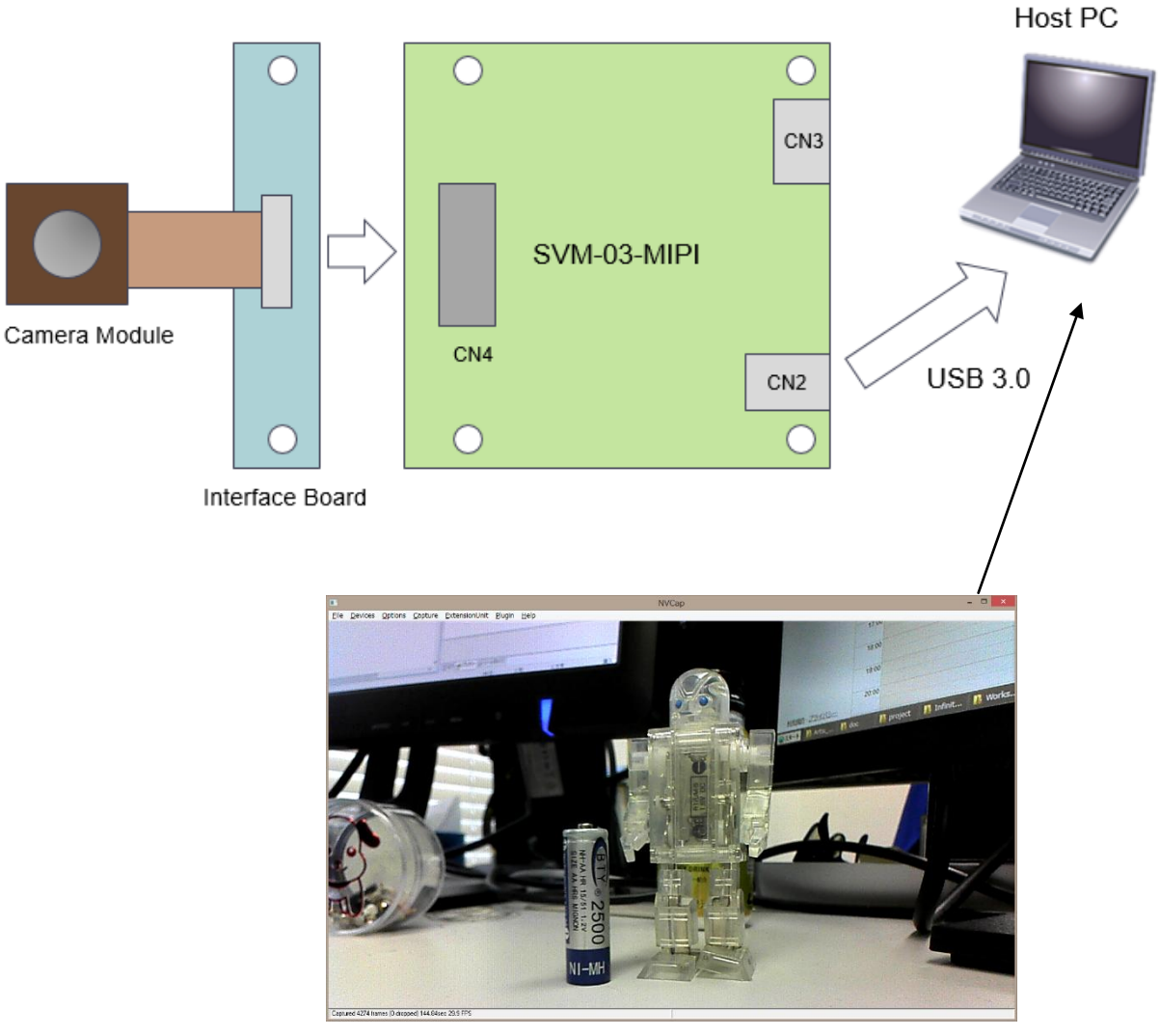
This chapter describes the SVM-03U mode (MIPI input, USB output).

3.1. Main Functions and Features of SVM-03U Mode

- In the SVM-03U Mode, the MIPI input video signal from a target device is converted and output to PC through USB 3.0 connection.
- We use the MIPI D-phy 1.1 compliant repeater (SN65DPHY440SS, TI Inc.).
- USB Video Class (UVC) compatible feature brings good portability and usability with various libraries, such as DirectShow, OpenCV, and ROS.
- Uncompressed capture; The image quality of a camera is not spoiled and it is ideal also for an evaluation test or algorithm development.
- Supports Windows and Linux (Ubuntu) OS.
- The initial setting of the image sensor is easy because it comes with the utility software for the I2C transfer.
- Multi channel capture and the I2C transmission by Extension Unit interface is supported.

- Dedicated DirectShow capture Software (NVCAP) is included in the accompanying CD.
- The high-speed transmission of USB 3.0 allows uncompressed video data capture up to 3.2 Gbps (theoretical values).
- Initial setting such as signal polarity and pixel format is configured from PC. Since initial setting data is stored at internal SPI-ROM, the setup process after the 2nd times is unnecessary.
- The target connection side is fully pin-compatible with the existing Netvision NV-006-B board, so you can immediately connect your target on the same board.
- Standard input image formats correspond to YUV, RAW, and RGB formats. It is possible to correspond to other formats, but it is necessary to consult.
- The USB 3.0 chip is loaded with Cypress EZ-USB FX3.
- Starts up as the SVM-03U mode by setting DIP SW #8 to ON when power up.

3.2. Connection Example for SVM-03U Mode



DirectShow Capture Software

3.3. Initial Setting Procedure in SVM-03U Mode

In the SVM-03U mode, initial setting with the specification of image sensor is needed at the time of first time use. When this setup differs from the specification of the image sensor, it could not be captured normally.

1. Setting Target Power Voltage (VDDIO)

The VDDIO must match the IO voltage of the target device before the target device is connected. VDDIO can be switched by jumpers (JP1) on the board. In default, VDDIO is set to 3.3 v.

2. Setting DIP SW

DIP SW must be set according to the number of MIPI lanes on the target device. For the detail setting of DIP SW, please refer section 7.2. By default, it is set to four lanes.

3. Initial Setting from PC

Initial setting such as input resolution and pixel format must be configured from PC before capturing. This configuration is applied by using the utility software "SVMCtl" that included in CD-ROM. For detail operation of SVMCtl, please refer to "SVMCtl Software Manual".

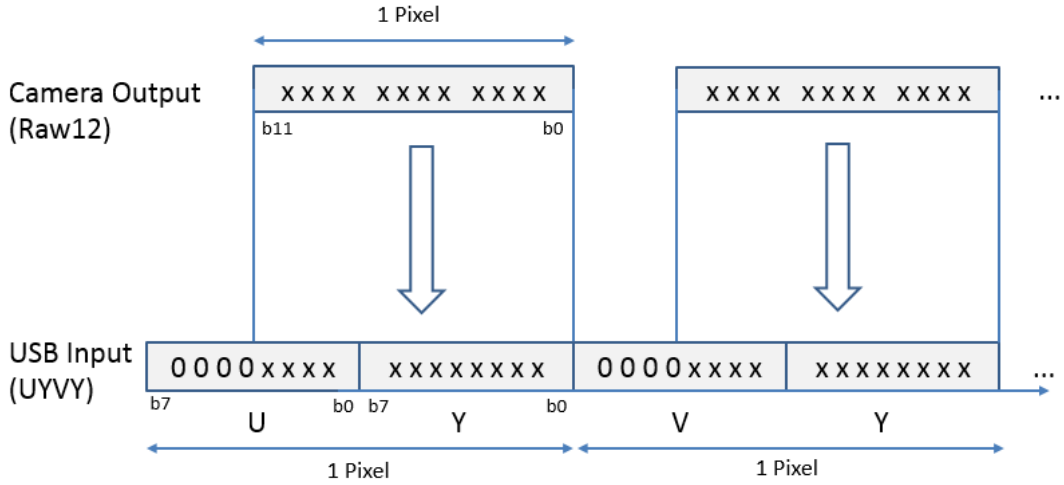
The factory setting will follow the UVC Setting factory settings described in the shipment report. The standard settings are as follows:

Resolution: 1280x800
Frame Rate: 30 FPS
Color Space: UYVY

- SVMCtl may be updated accordingly. Latest version of SVMCtl application could be downloaded from our web page.
- The PC recognizes it as a device named "SVM-03U-MIPI".
- If the device name is allocate by SVMCtl, the ID number will be appended with parentheses after the device name.

3.4. Processing on RAW input

For RAW input formats, SVM-MIPI supports input in the RAW10/RAW12 format. Because the UVC standard does not support Raw format, in SVM-03U mode, the raw input data is considered to be 16bit wide, and the Upper bit is set to 0 to output to the PC. Therefore, if you want to capture raw format, you can pack it into 16bit/pixel by specifying UYVY in the pixel format setting, and the software on the host PC will do the raw image processing.

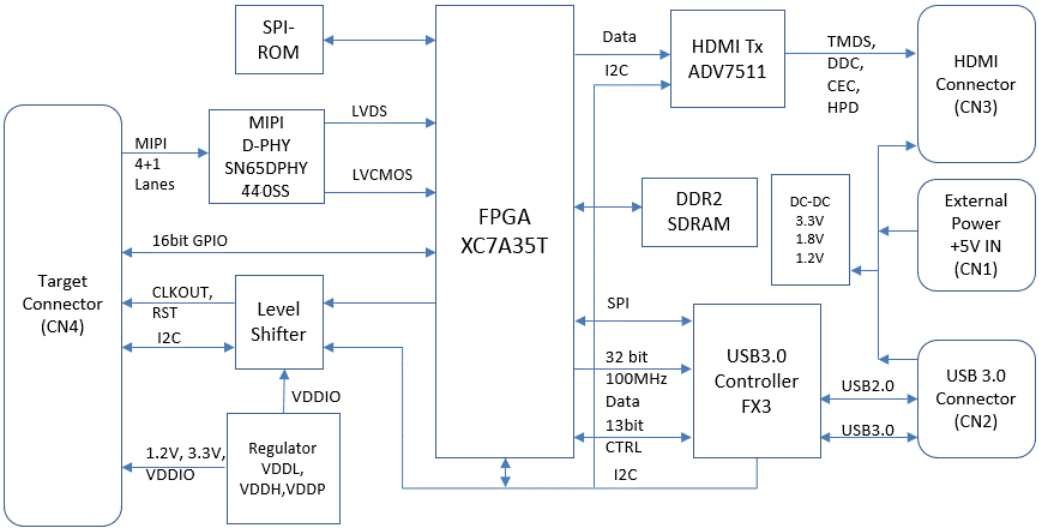


4. Block Diagram of SVM-MIPI Board

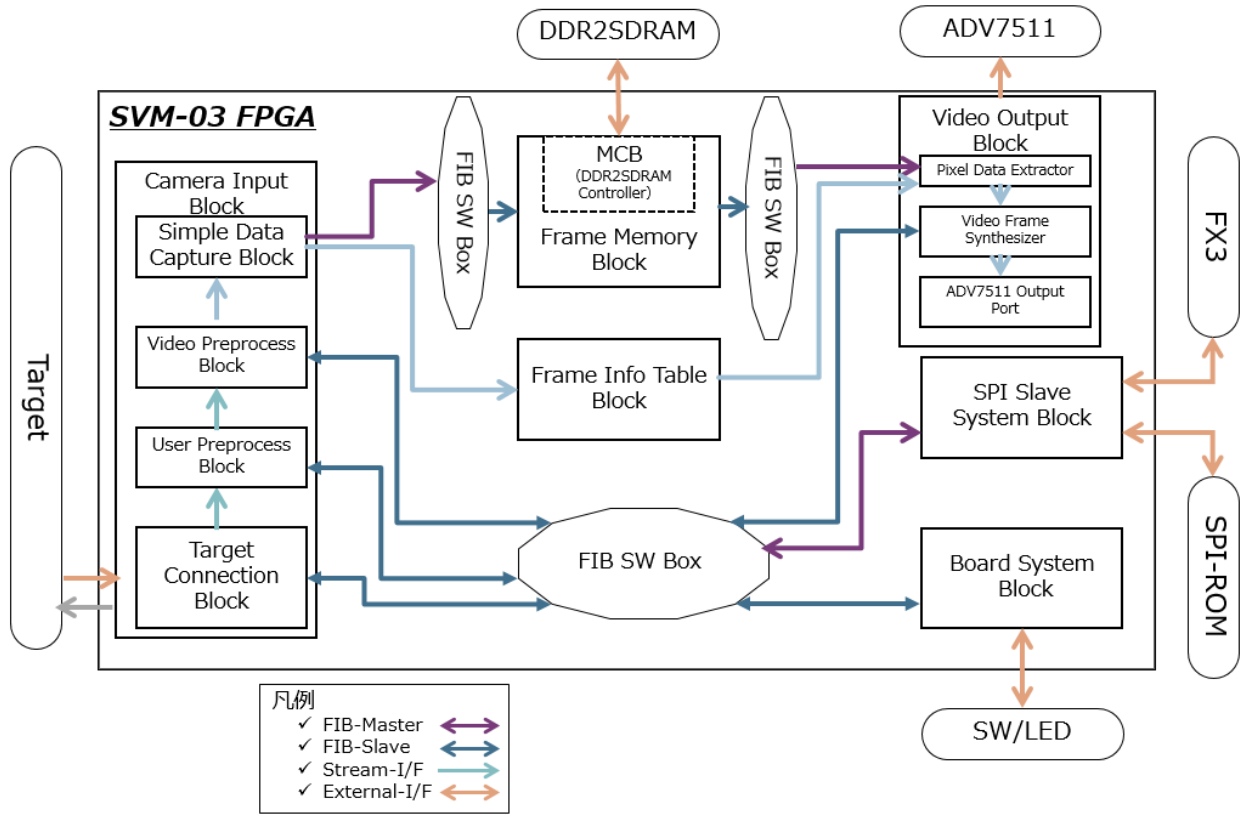
A schematic block diagram of the SVM-MIPI board is shown below.

4.1. Block Diagram

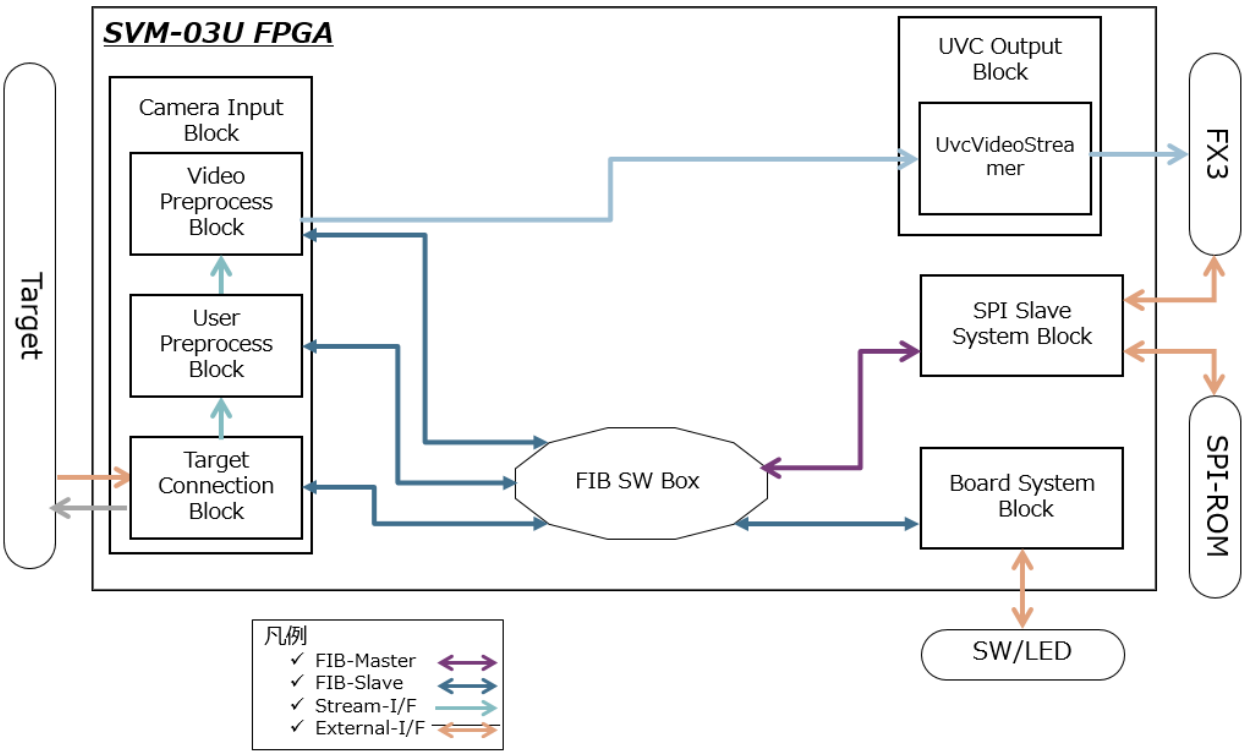
SVM-MIPI Block Diagram



4.2. FPGA internal block diagram in SVM-03 mode



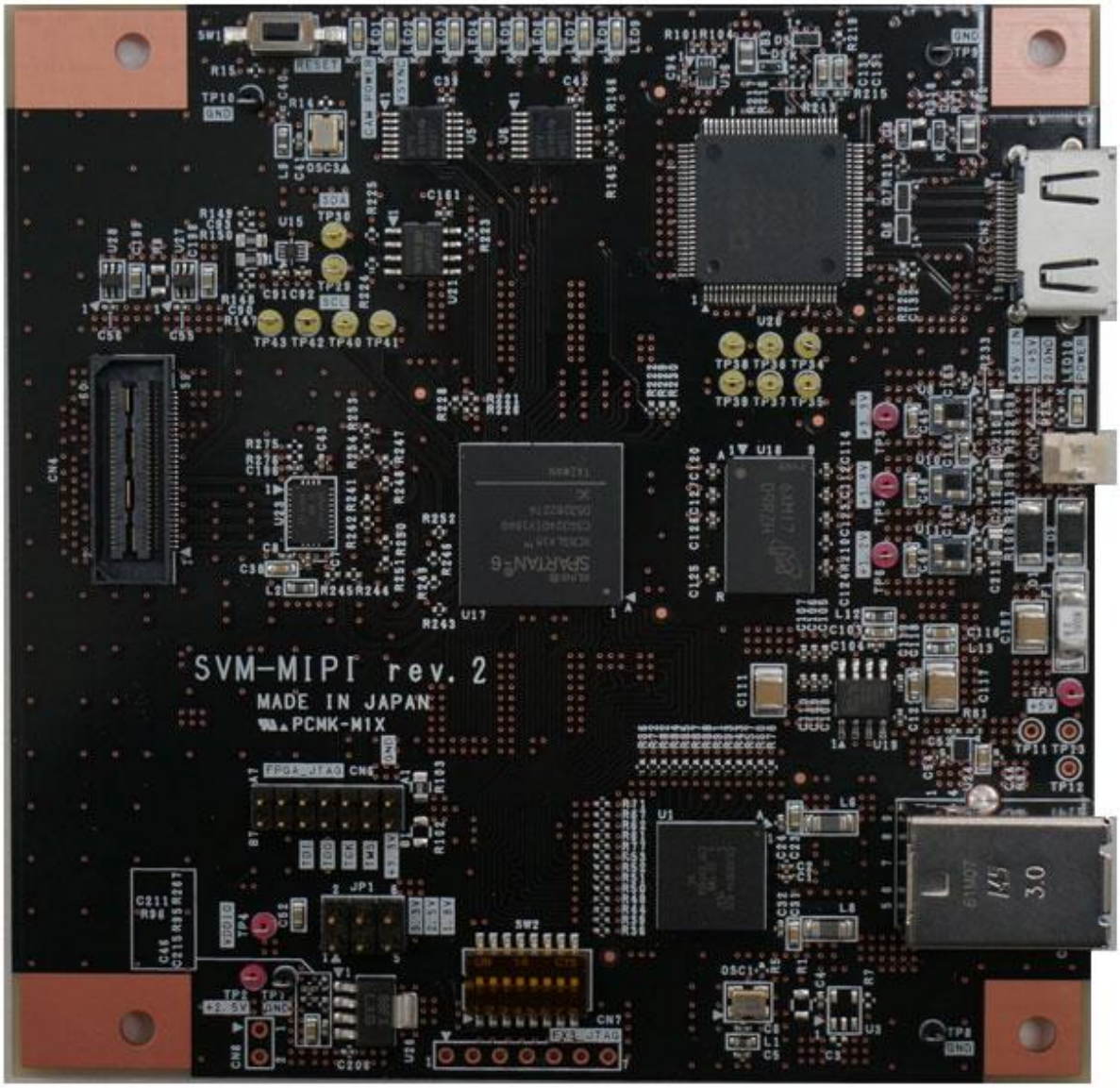
4.3. FPGA internal block diagram in SVM-03U mode



5. Exterior of SVM-MIPI Board

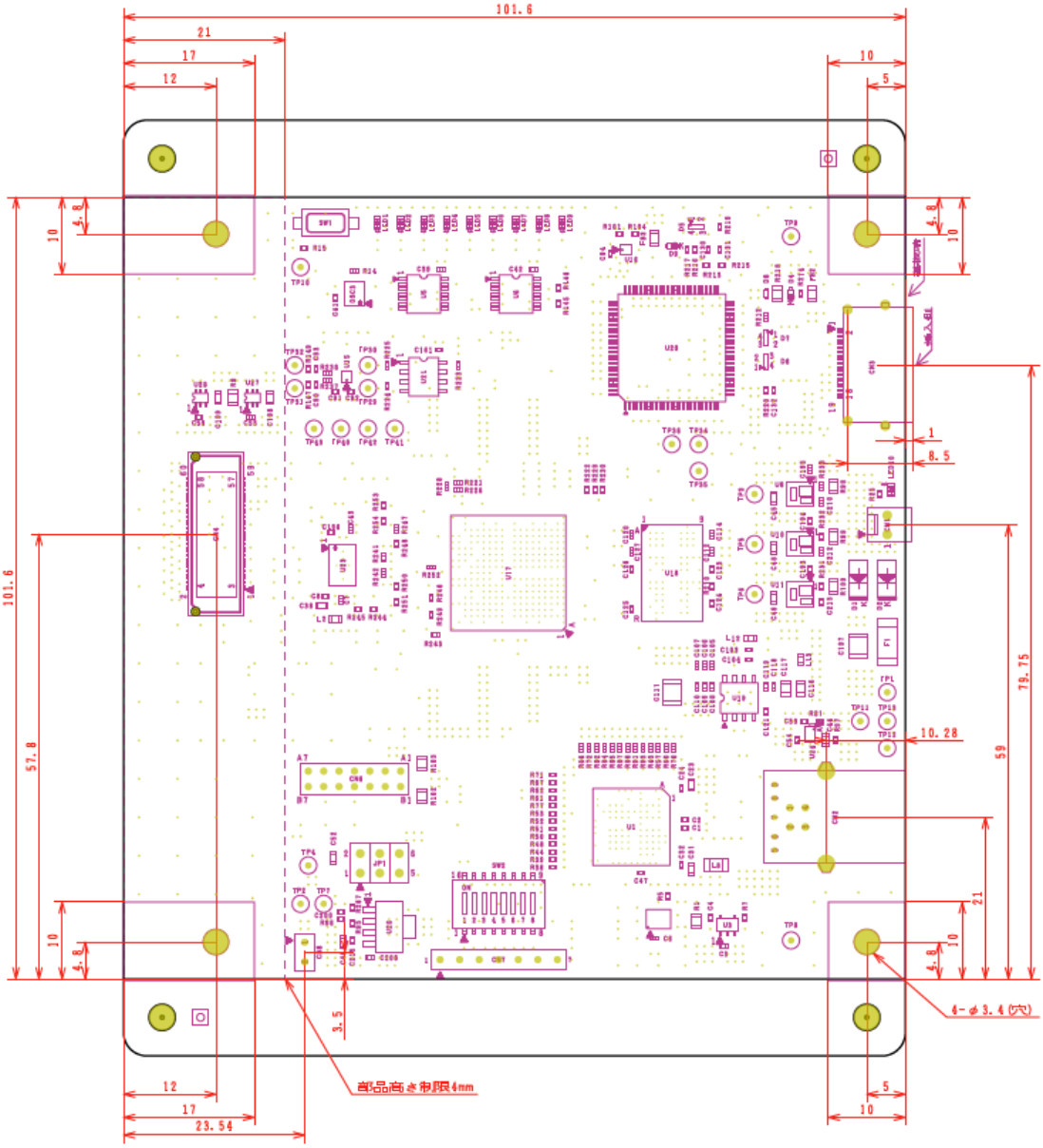
A photo and a picture of the outline of the SVM-MIPI board is shown below.

5.1. Picture of SVM-MIPI Board



5.2. Drawing

The dimensions of the SVM-MIPI board are listed below. The actual board does not include 10mm parts up to vcut at the top and bottom, and the vertical size is 101.6 [mm] in the same way as other SV series substrates.



6. Connector Specification

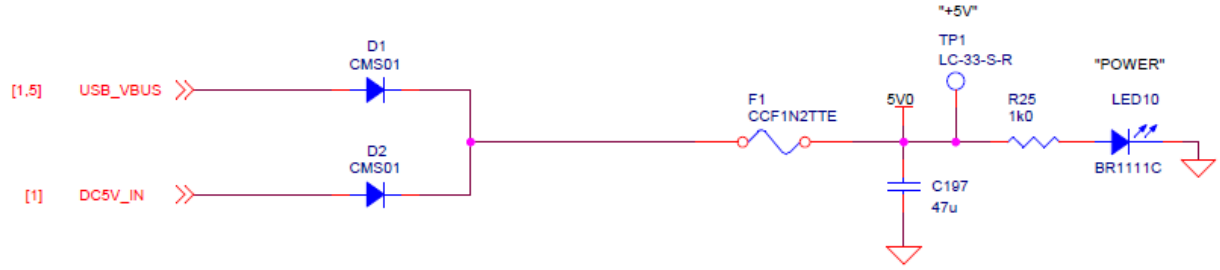
In this section, we are going to describe about the specification of connectors that are used to connect image sensor and SVM-03 board. In the Appendix section there are some specification about other connectors.

6.1. CN1 : External Power Input Connector

This is a power connector that should be used when USB bus power is not sufficient or when bus power should not be used.

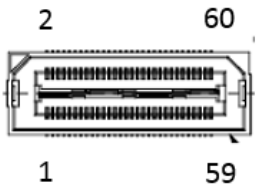
Connector		22-04-1021: Molex					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	+5V	IN	DC5V Input	2	GND	-	GND

+5V input signals from CN1 and USB connector are connected as the following circuit.



6.2. CN4 : Target Connector

This connector is used to connect the target image sensor.



Connector		QSH-030-01-L-D-A: SAMTEC					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	D1_N	IN	MIPI Lane 1 Input -	2	GPIO0	IO	GPIO 0 (Reserved)
3	D1_P	IN	MIPI Lane 1 Input +	4	GPIO1	IO	GPIO 1 (Reserved)
5	GND	-		6	GND	-	
7	D3_N	IN	MIPI Lane 3 Input -	8	GPIO2	IO	
9	D3_P	IN	MIPI Lane 3 Input +	10	GPIO3	IO	
11	GND	-		12	GND	-	
13	CLK_N	IN	MIPI Clock Input -	14	GPIO4	IO	
15	CLK_P	IN	MIPI Clock Input +	16	GPIO5	IO	
17	GND	-		18	GND	-	
19	D2_N	IN	MIPI Lane 2 Input -	20	GPIO6	IO	
21	D2_P	IN	MIPI Lane 2 Input +	22	GPIO7	IO	
23	GND	-		24	GND	-	

25	D4_N	IN	MIPI Lane 4 Input -	26	GPIO8	IO	
27	D4_P	IN	MIPI Lane 4 Input +	28	GPIO9	IO	
29	GND	-		30	GND	-	
31	SCL	OUT	I2C SCL Signal Line	32	GPIO10	IO	
33	SDA	IO	I2C SDA Signal Line	34	GPIO11	IO	
35	GND	-		36	GND	-	
37	GND	-		38	GND	-	
39	GND	-		40	GND	-	
41	GND	-		42	GND	-	
43	VSYNC	IN	VSYNC Input (Reserved)	44	GPIO12	IO	
45	HSYNC	IN	HSYNC Input (Reserved)	46	GPIO13	IO	
47	GND	-		48	GND	-	
49	CK	OUT	Clock Output	50	GPIO14	IO	
51	RST	OUT	Reset Output (L : Reset)	52	GPIO15	IO	
53	GND	-		54	GND	-	
55	VDDIO	POW	IO Power Output	56	1V2	POW	1.2V Power Output
57	3V3	POW	3.3V Power Output	58	3V3	POW	3.3V Power Output
59	GND	-		60	GND	-	

- HSYNC, VSYNC, and GPIO pins are reserved for use during customization. There is no function in the standard version. (Hi-Z)
- SubLVDS input (Customization function) is entered using the GPIO0-15 pin. Please inquire about the pin assignment etc. when Sub-LVDS.
- The clock output frequency is set by the PC-side utility software "SVMCtl".
- 1.2 V and 3.3 V can be output to about 150mA.

7. Detail of each part

7.1. **SW1:** Push Switch

While the SW1 is being pressed, the video transfer inside the FPGA is interrupted as soon as the RST signal line assigned to the CN4 is asserted(output : Low). SW1 functions can also be unassigned by SVMCtl.

7.2. **SW2:** DIP Switch

This is a 8-bit switch for setting the various modes of operation of SVM-MIPI. The following settings can be set by the switch.

Number	Name	Turns OFF	Turns ON
1	(Reserved)		
2	Test Pattern Output	Normal mode	Color Pattern Output
3	Input Lane setting	The number of input lanes is specified by SW [4:3]. #4=OFF, #3=OFF: 4 Lanes #4=OFF, #3=ON: 1 Lane #4=ON, #3=OFF: 2 Lanes #4=ON, #3=ON: 3 Lanes	
4	Input Lane setting		
5	Monitor Output Mode (SVM-03 Mode Only)	HDMI Mode (YUV4:2:2)	DVI Mode (RGB4:4:4)
6	Monitor Output Resolution (SVM-03 Mode Only)	1080p(1920 x 1080)	720p(1280 x 720)
7	Monitor Output Frame Rate (SVM-03 Mode Only)	60 [fps]	30 [fps]
8	Working Mode (effective when power up)	SVM-03 Mode	SVM-03U Mode

- UVC, etc setting are performed by SVM-03 control application "SVMCtl.exe".
- **When it works as SVM-03U Mode, only DIP SW 1, 3 ,4 are effective.**

7.3. LED1-9: Working State Indicator

This LED displays the operating status of the board or FPGA.

LED#	Description
1	This is a silk-labeled red LED with "CAM power". Indicates that the VDDIO power supply to the target are being supplied when lit.
2	This is a silk-labeled LED with "Vsync". This LED is switched ON/OFF in the V-sync synchronization signal from the target at a cycle of three-minute laps. When input video signal is 30 FPS, this LED blinks 5 times in 1 second.
3	The input image from the target indicates that the width and height can be automatically detected and the image size is stable.
4	(SVM-03 mode) Indicates that an overflow error occurred during writing input frame in the frame memory. (SVM-03U mode) Indicates the behavior of the block for frame synchronization.
5	(SVM-03 mode) Indicates that a problem occurred while adjusting the alignment of the input image from the target in accordance with the pixel format. (SVM-03U mode) Indicates the cycle of the three-minute lap of the V-sync synchronous signal to the USB output.

6	(SVM-03 mode) Indicates that writing block into frame memory inside the FPGA is in idle state. (SVM-03U mode) LED is always turned off.
7	(SVM-03 mode) Indicates that the frame information table block inside the FPGA cannot write new frame into the memory. When this LED is ON and there are input frames, the frame will be abandoned. (SVM-03U mode) LED is always turned off.
8	(SVM-03 mode) Indicates that the frame information table block in FPGA cannot receive read-out of a new frame from a memory. When this LED is ON and there is frame read-out of a HDMI monitor output, an output frame is reading and displaying re-from a memory about the last thing, and the same frame is displayed repeatedly. (SVM-03U mode) LED lights up during capture from the host PC.
9	(SVM-03 mode) Indicates the cycle of the three-minute lap of the V-sync synchronous signal to the HDMI Monitor output. When output video signal is 60 FPS, this LED blinks 10 times in 1 second. (SVM-03U mode) Indicates the cycle of the three-minute lap of the V-sync synchronous signal to the USB output.

7.4. **JP1**: VDDIO selection jumper

A jumper for selecting the IO Power (VDDIO) of the target device to be generated by the SVM-MIPI board. It can be selected from 1.8 V, 2.5 V, 3.3 V, and can output a current of about 150mA.

VDDIO is intended to be used as an IO supply voltage for image sensors and target devices. In addition, GPIO0-15, CLK, RST, and SCL, and SDA signal lines are input and output of the VDDIO power level.

In default, VDDIO is set to 3.3V.

8. Check Terminal

8.1. **TP4:** VDDIO check terminal (red)

This is the check terminal used to adjust the VDDIO.

8.2. **TP1, 3, 5, 6:** Voltage check terminal (red)

This is check terminal for each supply voltage required by the SVM-MIPI board operation. In normal use, there is no need to check. Also, please stop extract the power from this check terminal to supply power to external modules.

8.3. TP7-10: GND check terminal (black)

Please use it as a GND terminal.

8.4. TP11-33: Signal check terminal (yellow)

This is the check terminal of the target signal. The silk of each signal is stamped. Use it to connect the measuring instrument.

9. Applicable version

Mode	FX3 Version	FPGA Version
SVM-03U Mode	63 or later	2.00 or later
SVM-03 Mode	123 or later	2.00 or later

10. Notes

For proper use of this board, be sure to follow the following precautions.

1. Use SVM-03 control software from host PC to update firmware / FPGA of the board.
2. When you connect or take off the target, make the power supply of the SVM-03 board state of "OFF" by all means.
3. It isn't guaranteed that all HDMI monitor can display by each output image size and frame rate setting. Capable of outputting setting is differs from among monitors, nothing may be displayed in the output form that is not supported.
4. About power supply for this board, please read chapter 2.3 and chapter 2.4 carefully and use the power supply which has enough current capacity. Please supply power supply from PC under the self-responsibility of the customer. If you broke PC by any chance, we can't take any responsibility.
5. We don't verify 5V power supply to monitor through HDMI cable. Operation is not guaranteed.
6. The contents of this document may be changed in the future without notice.
7. Reprinting of part or the whole of the contents of this document is strictly forbidden.
8. Through extreme care has been taken in preparing this document, if you find any ambiguous points or errors, or if you would like to make any comments on the document itself or its content, please contact to sv-support@net-vision.co.jp
9. Be sure to use the newer SVMCtl utility software than the version that came with the CD-ROM. If you rewrite the SPI-ROM using a previous version of this board, it may not work due to false detection of the board.

11. Appendix

11.1. CN2: USB3.0 Connector

USB 3.0 connector to connect to the host PC. A commercially available USB 3.0 cable is available. This connector is used for power supply of SVM-03.

Connector		USB30B-09K-PC: JC Electronics Corporation					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	VBUS	IN	+ 5v Bus Power	2	D-	I/O	USB 2.0 Differential Pair-
3	D+	I/O	USB 2.0 Differential Pair+	4	GND	-	GND (Power)
5	SSRX-	IN	USB 3.0 receiver Differential	6	SSRX+	IN	USB 3.0 receiver Differential
7	GND DRAIN	-	GND (Signal)	8	SSTX-	OUT	USB 3.0 Transmission Differential pair -
9	SSTX+	OUT	USB 3.0 Transmission				

11.2. CN3: HDMI Connector

This connector is used to connect the HDMI monitor and the like through an HDMI cable.

Connector		5-1903015-1: TE Connectivity					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	D2+	OUT	TMDS Data 2+	2	D2 shield	OUT	TMDS Data 2 shield
3	D2-	OUT	TMDS Data 2-	4	D1+	OUT	TMDS Data 1+
5	D1 shield	OUT	TMDS Data 1 shield	6	D1-	OUT	TMDS Data 1-
7	D0+	OUT	TMDS Data 0+	8	D0 shield	OUT	TMDS Data 0 shield
9	D0-	OUT	TMDS Data 0-	10	CLK+	OUT	TMDS CLK +
11	CLK shield	OUT	TMDS CLK shield	12	CLK-	OUT	TMDS CLK -
13	CEC	I/O	CEC Data	14	Utility	IN	Utility
15	DDCSCL	(I)/O	DDC CLK	16	DDCSDA	I/O	DDC Data
17	GND	-	-	18	+5V	OUT	+5V Power
19	HPD	IN	Hot Plug Detection				

11.3. **CN6:** FPGA-JTAG Connector

The JTAG port used to write to the SPI-ROM of the FPGA bit stream or to debug a running FPGA. You do not need to use it in normal operation.

※The direction is seen from the FPGA.

Connector		A3B-14PA-2DSA(71): HRS					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	GND	-		2	VREF	OUT	Reference Voltage (3.3V)
3	GND	-		4	TMS	IN	JTAG-TMS
5	GND	-		6	TCK	IN	JTAG-TCK
7	GND	-		8	TDO	OUT	JTAG-TDO
9	GND	-		10	TDI	IN	JTAG-TDI
11	GND	-		12	NC	-	Disconnected
13	GND	-		14	NC	-	Disconnected

- **We do not guarantee the operation when you use it.**

11.4. **CN7:** FX3- JTAG Connector

The JTAG port used to debug the FX3 firmware. You do not need to use it in normal operation.

※The direction is seen from the FX3.

Connector		A2-7PA-2.54DSA(71): HRS					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	+3.3V	OUT	Reference Voltage (3.3V)	2	TMS	IN	JTAG-TMS
3	TCK	IN	JTAG-TCK	4	TDO	OUT	JTAG-TDO
5	TDI	IN	JTAG-TDI	6	TRST	OUT	Reset
7	GND	-					

- CN7 is optional. The PIN header is not implemented.
- **We do not guarantee the operation when you use it.**