Parallel to HDMI / USB Video Output Board

[SVM-03]

Hardware Specification

Rev.4.2

NetVision Co., Ltd.

Update History

Revision	Date	Note	
4.0	2016/06/27	All Renewal	H. Yamada
4.0en	2016/06/27	Translated from Japanese to English (Based on Rev. 4.0)	H. Yamada
4.1	2016/07/13	Revised translation	H. Yamada
4.2	2018/04/05	Revised translation (Equivalent to Japanese version 4.6)	S. Usuba

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1. Outline

SVM-03 is a video output board that converts video signal from camera or image sensor into HDMI or USB 3.0. SVM-03 has two kinds of mode: **SVM-03 Mode** (HDMI output mode) and **SVM-03U Mode** (USB output mode). These modes can be switched by setting of DIP switch on the board. Both modes support to capture uncompressed video up to 1920x1080 / 60 FPS.

In SVM-03 Mode, the board can be connected to PC monitor or television that has HDMI port and display real-time video in high resolution. You can easily test, evaluate and demonstrate your image sensors without complicated operation from PC.

In SVM-03U Mode, the board is recognized by host PC as UVC (USB Video Class) compliant device. Using your library on Windows and Linux, you can evaluate image sensor and develop algorithm of image processing, and so on.

1.1. Function of SVM-03 Board

SVM-03 Mode: Conversion from Parallel Video Signal to HDMI

SVM-03U Mode: Conversion from Parallel Video Signal to USB3.0 (USB Video Class)

1.2. Specification (SVM-03 Mode)

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

Input: Digital Parallel Video Signal（PCLK/VSYNC/HSYNC; embedded Sync (BT.656) optional）

Input Resolution: Any size / max.100MHz PCLK

Input Bit Width: 8bit / 16bit / 32bit (YUV4:2:2) / 24bit (RGB24)

Input Pixel Format: YUV4:2:2 (UYVY / YUY2) / RGB24

I2C Frequency: 100kHz / 200kHz / 400kHz

Output: HDMI Connector (HDMI Mode / DVI Mode)

Output Resolution: Custom (640x480 / 800x480 / 800x600 / 1024x768) / 1280x720 / 1920x1080

Output Frame Rate: 30FPS (1280x720, 1920x1080) / 60FPS

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

1.3. Specification (SVM-03U Mode)

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

Input: Digital Parallel Video Signal（PCLK/VSYNC/HSYNC; embedded Sync (BT.656) optional）

Input Resolution: Any size / max.100MHz PCLK

Input Bit Width: 8bit / 16bit / 32bit (YUV4:2:2) / 24bit (RGB24)

Input Pixel Format: YUV4:2:2 (UYVY / YUY2) / RGB24 (Applicable with other kinds of format)

I2C Frequency: 100kHz / 200kHz / 400kHz

Output: USB 3.0 (USB 2.0 connection is also supported)

Device Class: USB Video Class (UVC)

Output Through Rate: max. 3.0 Gbps

Output Resolution: Any size

Output Frame Rate: No restriction

Output Pixel Format: UYVY / YUY2 / RGB24 (Same as input pixel format)

2. Detail of SVM-03 Mode

In this section, we are going to describe about **SVM-03 Mode (Parallel-in, 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 at a HDMI monitor.

- As the video output size to a HDMI monitor 1080p (1920x1080) and 720p (1280x1080) and custom Resolution (640x480/800x480/800x600/1024x768 Select one type) are supported.

- The video output frame rate to a HDMI monitor can be changed to 60fps and 30fps. For custom resolutions, 30fps is fixed.

- Initial setting such as signal polarity from a camera and pixel data format is configured from PC.

Since initial setting data is stored at internal SPI-ROM, the setup process after the 2nd times is unnecessary.

- Since it supports to the output in the DVI mode (RGB4:4:4 output), a display on the DVI monitor which is not based on HDMI standard practice is also possible.

- 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.

- The target connection side is 50/60 pin of a two-row 2.54-mm pitch. Since it is completely pin compatible with our SVI series, any devices currently used in SVI series are easily connected with SVM board.

- The input hardware specification by the side of target connection supports to 8bit – 32bit / 100MHz data in CMOS parallel. Moreover, the data input in 32 bits is also possible by combining with 16 bit-GPIO port.

- In default YUV 4:2:2 input is supported.

- The input image format corresponds to the YUV 4:2:2 and RGB24 format. The input/output color space conversion is performed by the HDMI transmitter IC.

- 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
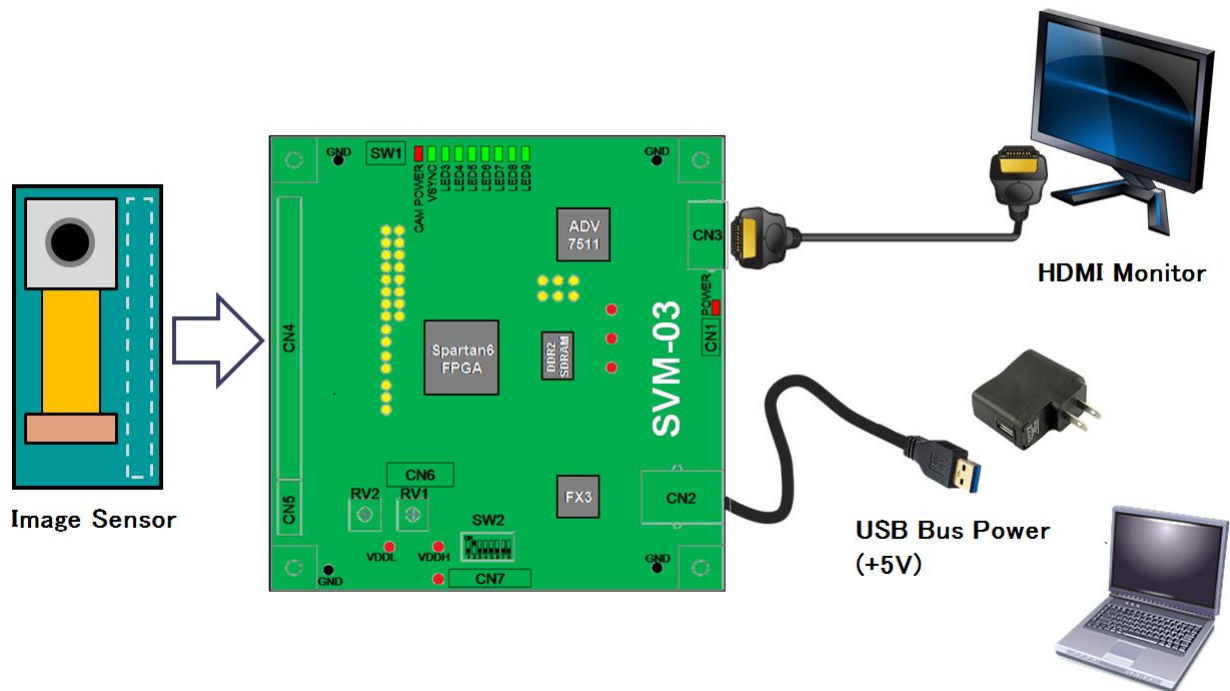
2.3.   Notification about Power Supply

SVM-03 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-03 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.

2.5.   HDMI Display for Non-Standard Resolution

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.

720p Output
Cut out in center

Input Image : 1440 x 960

Output Image: 1280x720
Top and bottom 80 pix, left and 120 pix are cut out

1080p Output
Placed Centerized

Output Image: 1920x1080
Black line is inserted in top and bottom 60 pix,
left and right 240 pix
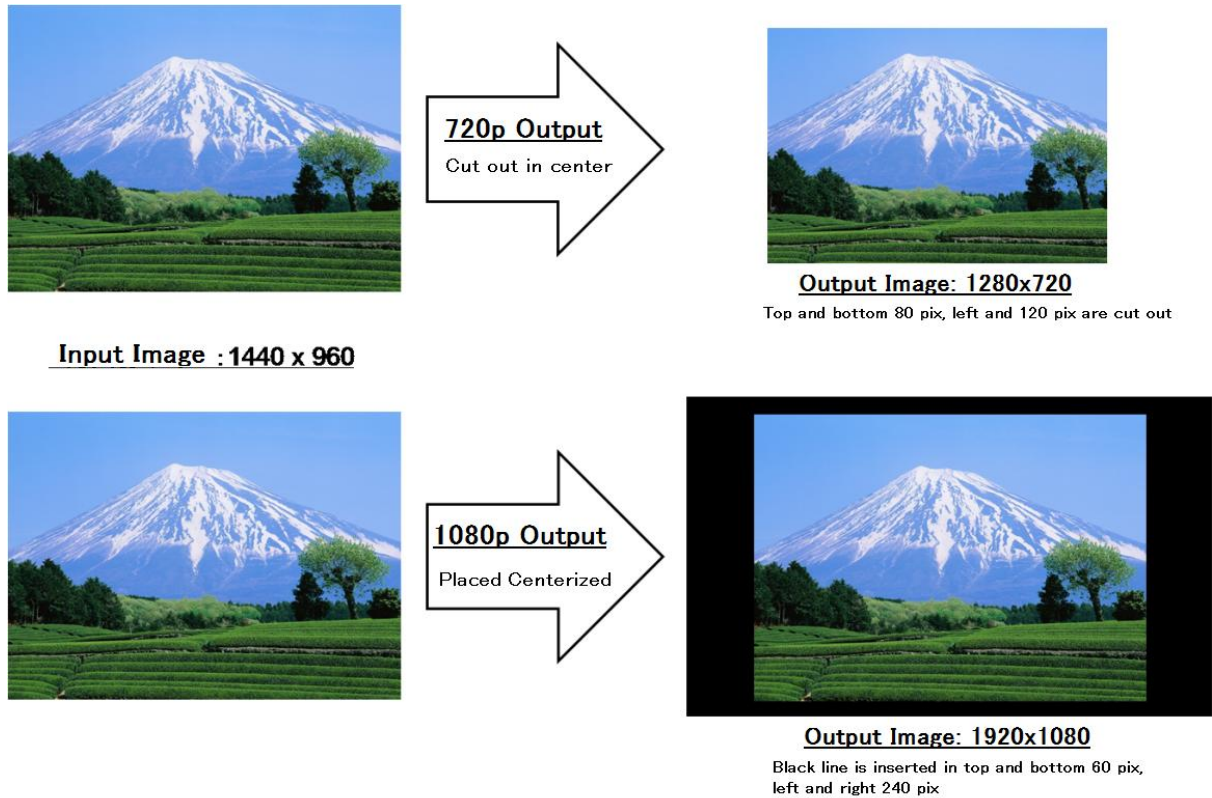
2.6.   Custom resolution

You can select the output resolution other than 1080p/720p by setting DIP SW #4 to ON. The current version corresponds to a resolution of 640x480/800x480/800x600/1024x768. When outputting at a custom resolution, the frame rate is fixed at 60 fps.

Custom resolutions and pixel formats are linked to UVC settings in SVM-03U mode. The resolution to be output is selected by the SVMCtl tool (PC). After booting to SVM-03U mode (Setting   DIP SW #8 to on when power up), start the SVMCtl and call the "SVM Setting" screen. Select a pixel format in the "UVC Color Space" and the appropriate resolution in the "UVC Resolution", and then click the "Set" button to save the settings to the SVM-03 board. FPS settings are ignored. To perform the HDMI output again, you need to revert to SVM-03 mode (Setting DIP SW #8 to off when power up).

3.   Detail of SVM-03U Mode

In this section, we are going to describe about **SVM-03U Mode (Parallel-in, USB-out)**.

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

- In the SVM-03U Mode, the parallel input video signal from a target device is converted and output to PC through USB 3.0 connection.
- 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.

- Multi channel capture and the I2C transmission by Extension Unit interface is supported.

- Usable DirectShow multi-channel capture software [NVCap] is enclosed to the attached CD-ROM.

- By high-speed transmission of USB3.0, a maximum of 3.2 Gbps (theoretical value) can be taken.

- 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 50/60 pin of a two-row 2.54-mm pitch. Since it is completely pin compatible with our SVI series, any devices currently used in SVI series are easily connected with SVM board.

- The input hardware specification by the side of target connection supports to 8bit - 32bit / 100MHz data in CMOS parallel. Moreover, the data input in 32 bits is also possible by combining with 16 bit-GPIO port.

- In default YUV 4:2:2 input and RGB24 format are supported. Other pixel formats could be supported (contact to our support).

- 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

Capture Software on Host PC
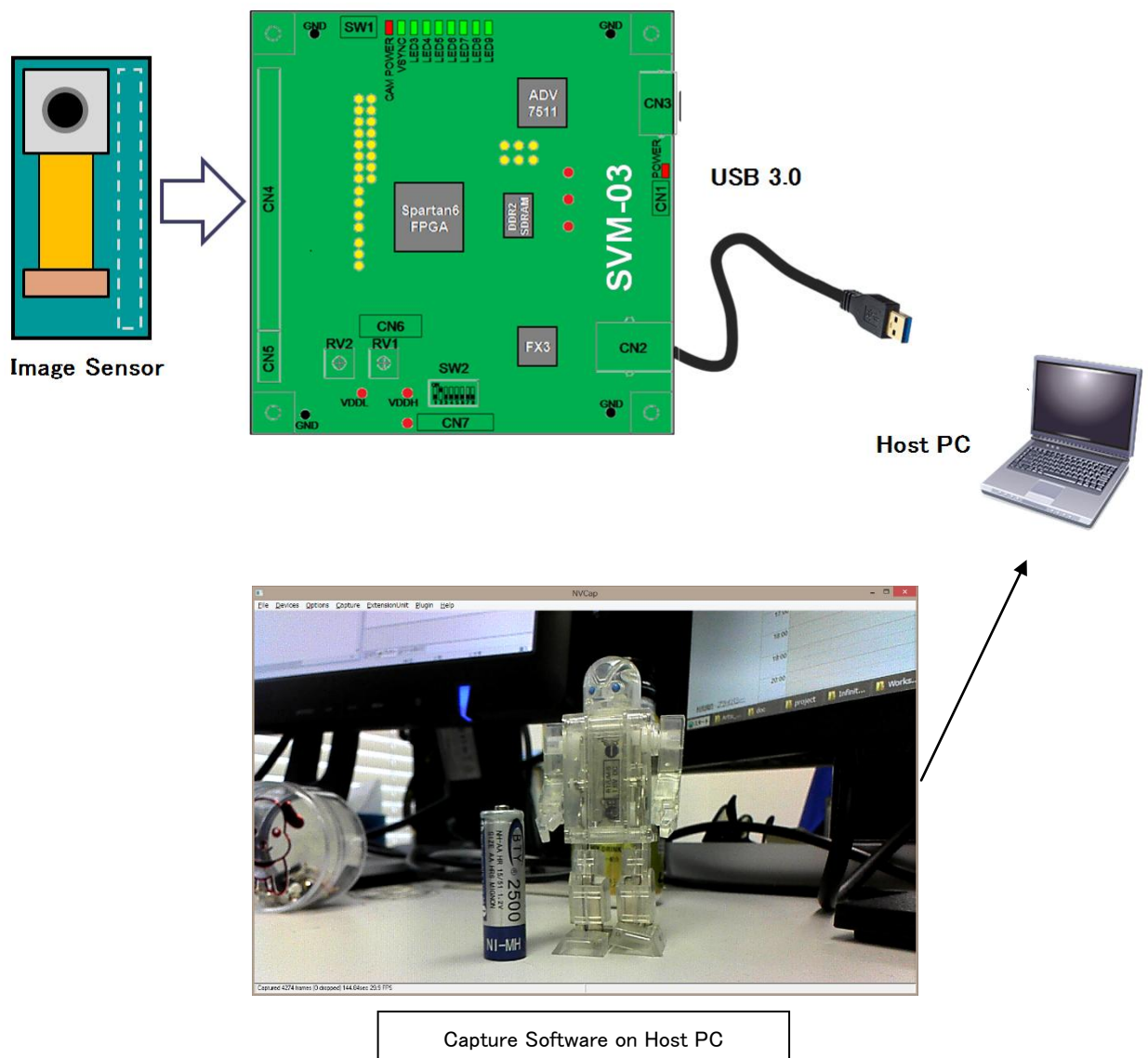
3.3. Initial Setting Procedure in SVM-03U Mode

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.

Setting items required are as follows:

・Setting Target Power Voltage (VDDL)

Before connection to the target device, set VDDL voltage to adequate level (normally set to the IO voltage of image sensor.) In default, VDDL is set to 3.3 v.

・Set DIP Switch

Set DIP switch adequately as the bit width of the target device. For the detail setting of DIP SW, please refer section 7.2.

・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".

In default, SVM-03 is configured as follows:

Pixel Clock: Sample in rising edge
Sync Signal: Low Active
Resolution: 1280x720
Frame Rate: 30 FPS
Color Space: UYVY

- Latest version of SVMCtl application could be downloaded from our web page.

4. Block Diagram of SVM-03 Board

A schematic block diagram of the SVM-03 board is shown below.
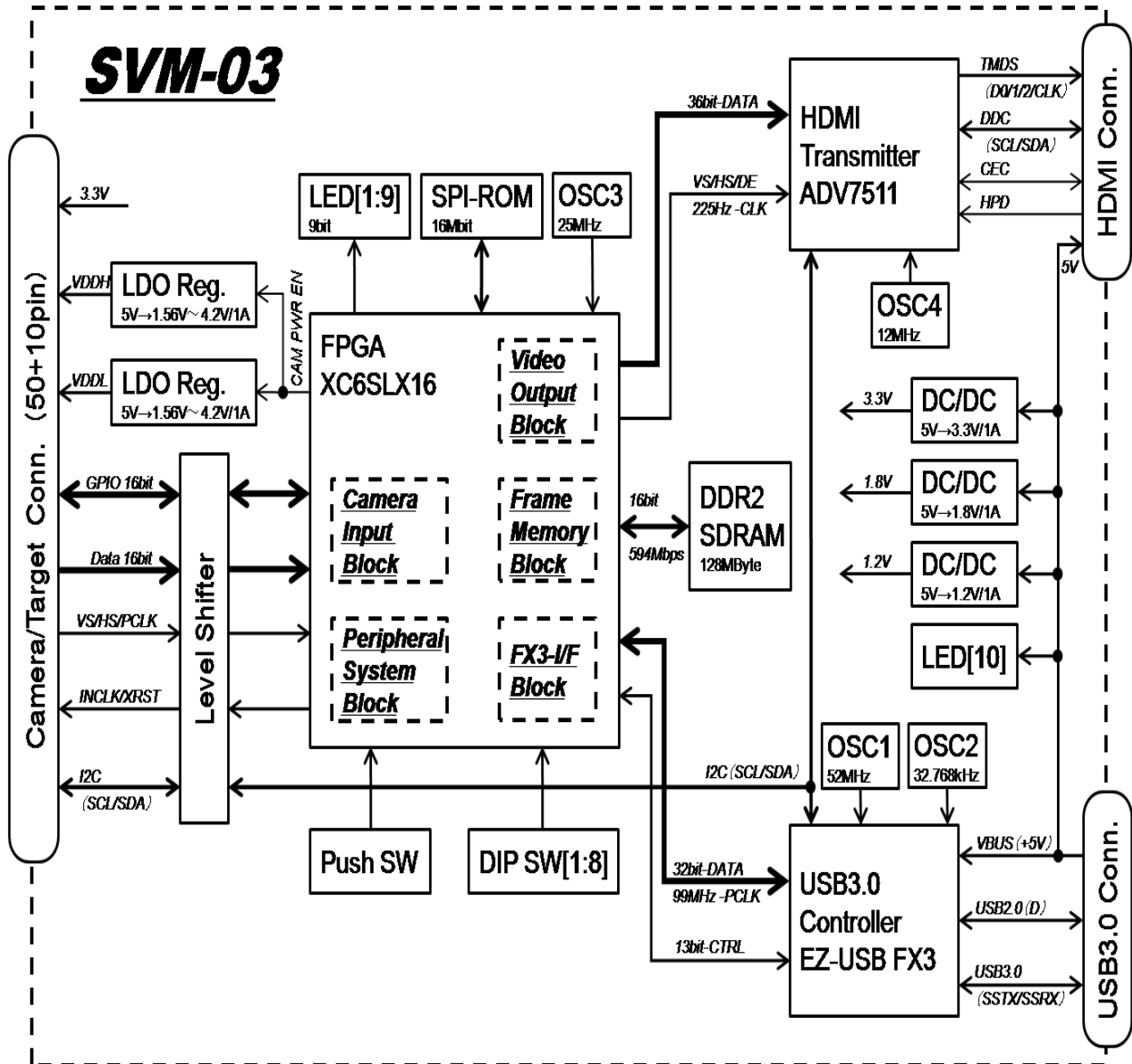
5.　　Exterior of SVM-03 Board

A photo and a picture of the outline of the SVM-03 board is shown below.

5.1.　　Picture of SVM-03 Board

5.2. Drawing
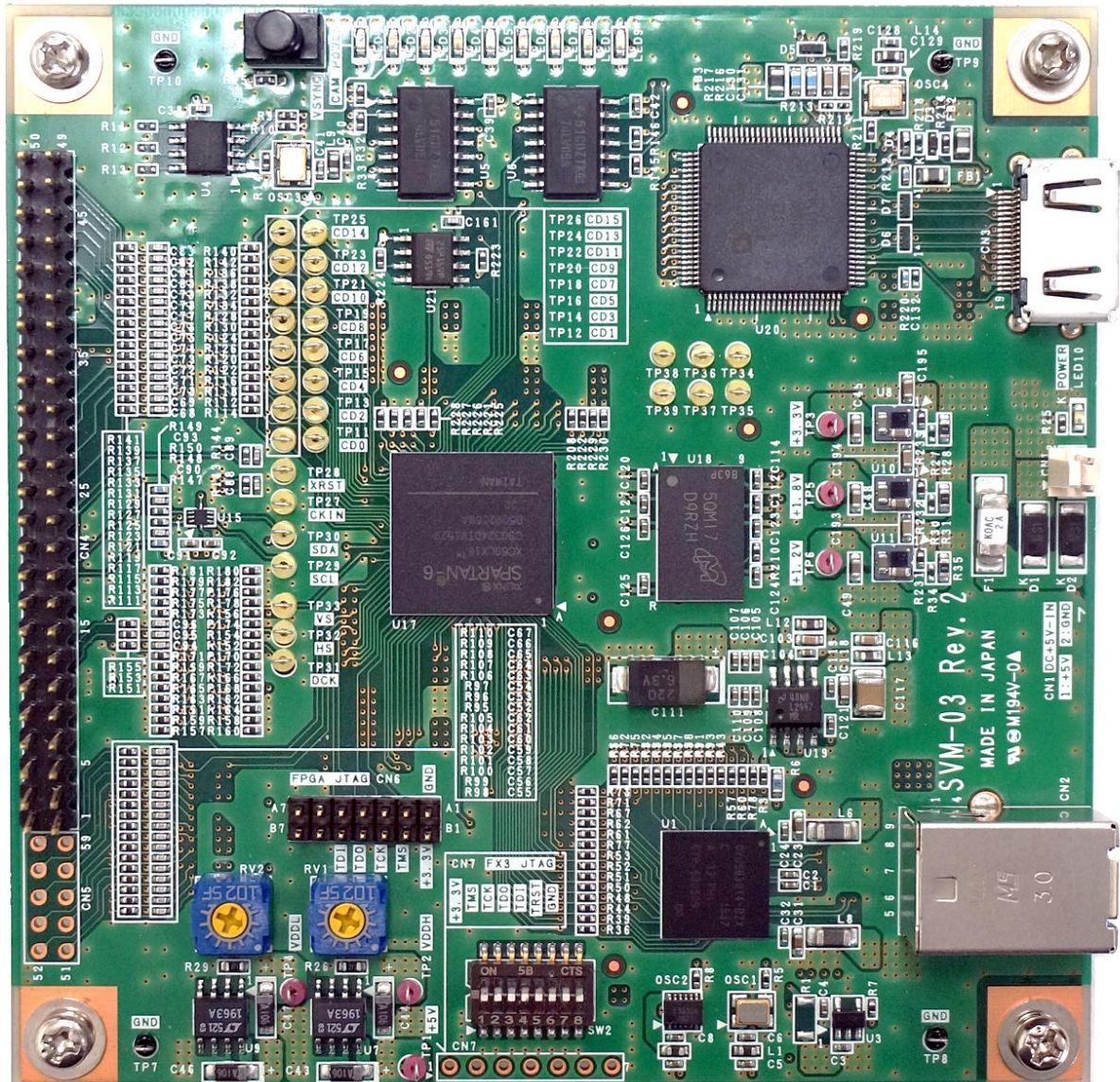
The dimensions of the SVM-03 board are listed below. The actual board does not include 10mm parts up to vcut at the top and bottom, and the vertical size is 101.6 [mm] in the same way as other SV series substrates.
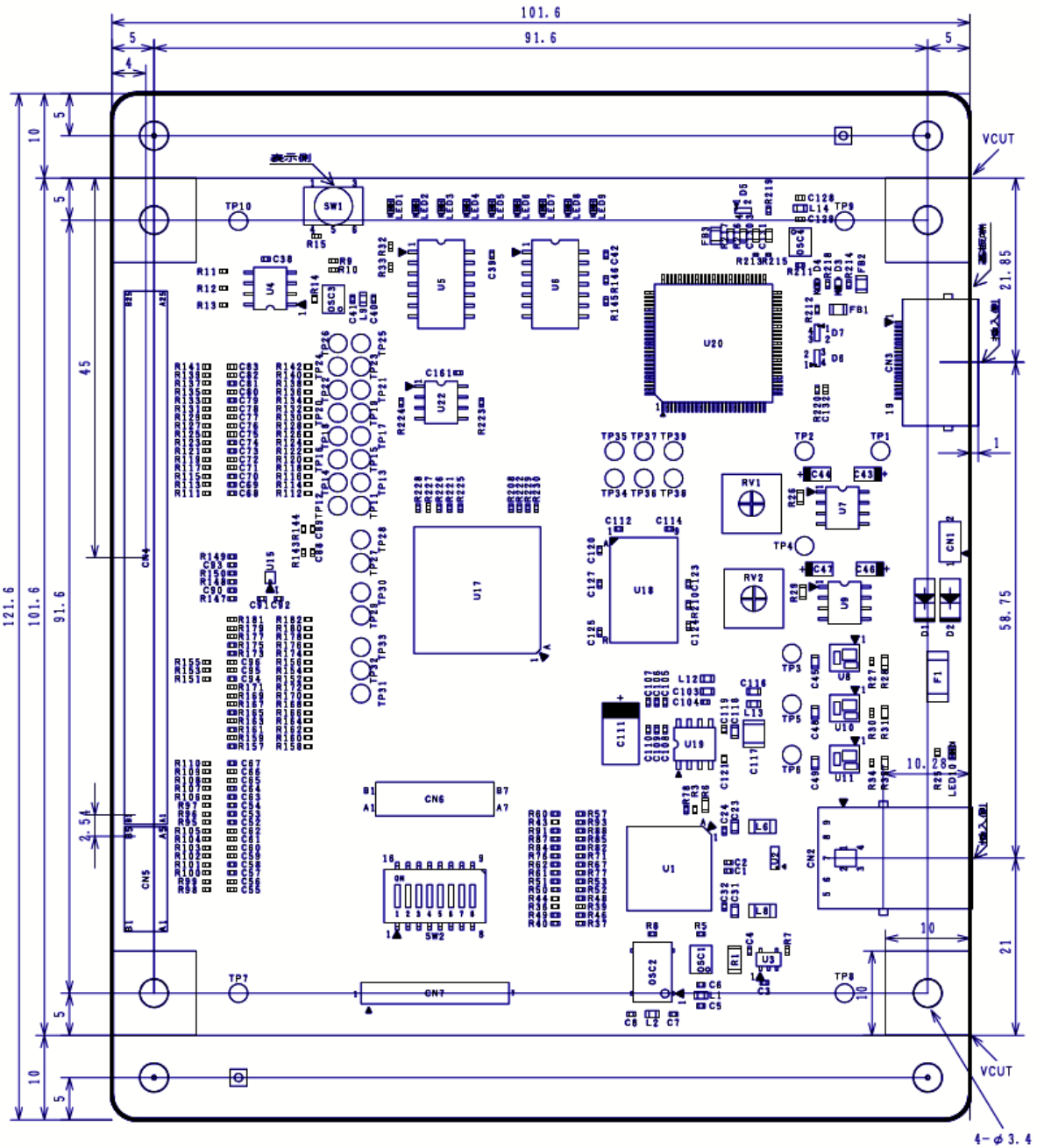
6. Connector Specification

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.
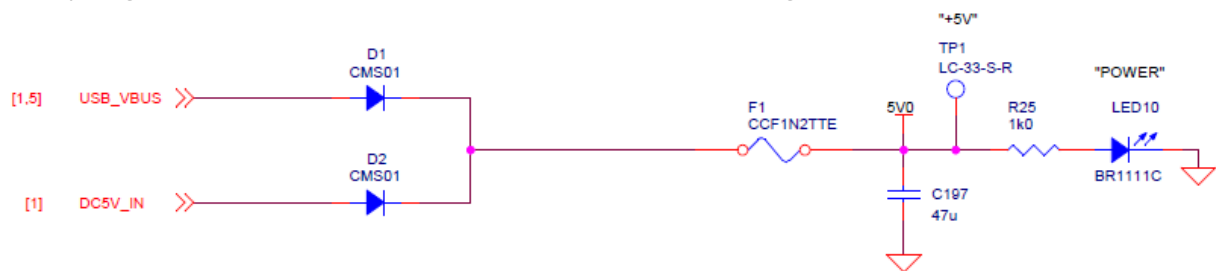
6.2. **CN4**: Target Connector

This connector is used to connect the target image sensor.

Top View
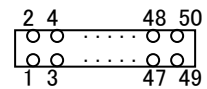
Connector	A1-50PA-2.54DSA: HRS						
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
1	VDDL	OUT	Target IO Power Supply (1.6 - 4.2V adjustable)	2	GND	-	-
3	P0	IN	Input Port 0 / Pixel DATA 16	4	GND	-	-
5	P1	IN	Input Port 1 / DE Input (8-16bit) / Pixel DATA17	6	GND	-	-
7	P2	IN	Input Port 2 / Pixel DATA 18	8	GND	-	-
9	P3	OUT / IN	Output Port 0 / Pixel DATA 24	10	GND	-	-
11	P4	OUT / IN	Output Port 1 / Pixel DATA 25	12	HSYNC	IN	Horizontal Sync Input
13	VSYNC	IN	Vertical Sync Input	14	XRST	OUT	Reset Output
15	VDDH	OUT	Target Power Supply (1.6 - 4.2V adjustable)	16	GND	-	-
17	SDA	IO	I2C_DATA	18	GND	-	-
19	SCL	IO	I2C_CLK	20	GND	-	-

21	DCK	IN	Pixel_CLK (Pixel Clock Input)	22	GND	–	–
23	Y0	IN	Pixel_DATA0	24	GND	–	–
25	Y1	IN	Pixel_DATA1	26	GND	–	–
27	Y2	IN	Pixel_DATA2	28	GND	–	–
29	Y3	IN	Pixel_DATA3	30	GND	–	–
31	Y4	IN	Pixel_DATA4	32	GND	–	–
33	Y5	IN	Pixel_DATA5	34	GND	–	–
35	Y6	IN	Pixel_DATA6	36	GND	–	–
37	Y7	IN	Pixel_DATA7	38	GND	–	–
39	CLKOUT	OUT	Target Ext. Clock Output	40	GND	–	–
41	Y8	IN	Pixel_DATA8	42	Y9	IN	Pixel_DATA9
43	Y10	IN	Pixel_DATA10	44	Y11	IN	Pixel_DATA11
45	Y12	IN	Pixel_DATA12	46	Y13	IN	Pixel_DATA13
47	Y14	IN	Pixel_DATA14	48	Y15	IN	Pixel_DATA15
49	+3.3V	OUT	+3.3V Output (up to 0.3A)	50	P5	OUT / IN	Output Port 2 / Pixel DATA 26

6.3. CN5: Target Connector (Optional)

The connector to connect the target to.

Top View

52　　60

51　　59
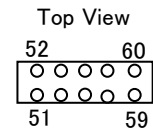
Connector		A1-10PA-2.54DSA: HRS					
Pin#	Name	DIR	Description	Pin#	Name	DIR	Description
51	P6	OUT / IN	Output Port 3 / Pixel DATA 27	52	P7	OUT / IN	Output Port 4 / Pixel DATA 28
53	P8	OUT / IN	Output Port 5/ Pixel DATA 29	54	P9	OUT / IN	Output Port 6/ Pixel DATA 30
55	P10	OUT / IN	Output Port 7/ Pixel DATA 31	56	P11	IN	Input Port 3/ Pixel DATA 19
57	P12	IN	Input Port 4/ Pixel DATA 20	58	P13	IN	Input Port 5/ Pixel DATA 21
59	P14	IN	Input Port 6/ Pixel DATA 22	60	P15	IN	Input Port 7/ Pixel DATA 23

- CN5 is optional; in standard SVM-03 this connector is not implemented.

- I2C slave address 0x38, 39, 3d, 3f is not available because it has been allocated internally.

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6.4. Relationships between **CN4 and CN5**

Top View
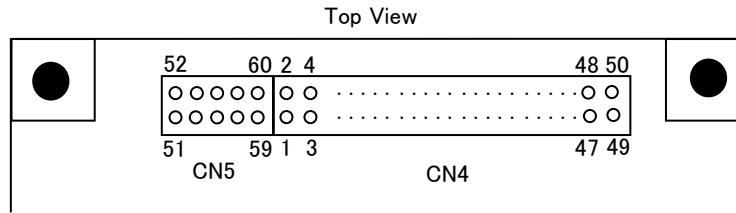
- ・ Together with CN5 and CN4, these connectors can be used as a 60P pin header.
- ・ The 60-pin connection connector becomes "Hirose Electric: HIF3BA-60D-2.54R"when connected by cable.
- ・ The 60-pin connection connector becomes "Hirose Electric: HIF3H-60DA-2.54DSA(71)" when connected by board-to-board connect.

6.5. Input Data Format

When YUV or RGB24 format image sensor is connected to SVM-03 board, please connect with the following list.

Format	YUV4:2:2			RGB24
Bit Width	8bit (UYVY/YUY2)	16bit (UYVY)	32bit (UYVY)	24bit
Pixel_DATA [31:24]	–	–	V	–
Pixel_DATA [23:16]	–	–	Y	R
Pixel_DATA [15:8]	–	U, V	U	B
Pixel_DATA [7:0]	Y, U, V	Y	Y	G

- Enable/disable polarity and DE input of VS, HS, DCK can be set arbitrarily.
- DE input is non-compliant with 24bit/32bit input.

7. User Interfaces

7.1. **SW1:** Push Switch

While the SW1 is being pressed, the video transfer inside the FPGA is interrupted as soon as the XRST signal line assigned to the CN4 is asserted. 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-03. The following settings can be set by the switch. DIP SW 1-3, 5-7 can be changed during operation.

Number	Name	Turns OFF	Turns ON
1	Input Data Width 1	8bit x 2 CLK	16bit x 1 CLK (YUV) 24bit x 1 CLK (RGB)
2	Test Pattern Output (SVM-03 mode)	Normal mode	Color Pattern Output
3	Input Data Width 2	(Follows DIP SW 1)	32bit x 1/2 CLK

4	Custom Resolution Mode (SVM-03 mode)	Normal mode (DIP #6 Resolution)	Custom Resolution Output (refer section 2.6)
5	HDMI Output Mode (SVM-03 mode)	HDMI Mode (YUV4:2:2)	DVI Mode (RGB4:4:4)
6	HDMI Output Resolution (SVM-03 mode)	1080p（1920 x 1080）	720p（1280 x 720）
7	HDMI Output Frame Rate (SVM-03 mode)	60[fps]	30[fps]
8	Working Mode (effective when power up)	SVM-03 Mode	SVM-03U Mode

Other settings such as signal polarity, UVC, etc., are performed by SVM-03 control application 〝SVMCtl.exe〟. When it works as SVM-03U Mode, only DIP SW 1, 3 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 VDDH power supply and the VDDL 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.　**RV1, RV2**：　VR for VDDH, VDDL Adjustment

These are variable resistors to adjust voltage level or power supply on the SVM-03 board for the target device. 1.6V – 4.2V adjustable.

Since VDDL is connected to voltage translator ICs, this voltage level must be equal to the parallel input signal level and GPIO voltage level. On the other hand, VDDH is just connected to the target connector and this is not used inside the board. Both voltages can be used as the power supply of external target device. For detail of VDDL、VDDH please refer section 9.

In default, **VDDL and VDDH are set to 3.3V.** Before using SVM-03 these voltage levels must be adjusted adequately.

8.　Check Terminal

8.1.　**TP2**: VDDH check terminal (red)

This is the check terminal used to adjust the VDDH.

8.2.　**TP4**: VDDL check terminal (red)

This is the check terminal used to adjust the VDDL.

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

This is check terminal for each supply voltage required by the SVM-03 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.

8.4.　**TP7-10**: GND check terminal (black)

Please use it as a GND terminal at the time of VDDH and VDDL adjustment.

8.5.　**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.　Target Power Supply

SVM-03 has two variable voltage power supplies for the target device in addition to the ICs power supply that is implemented in the board.

9.1.　VDDH: System Power Supply for Target Device

VDDH is system power supply of image sensor or target device. VDDH is just connected to the target connector and this is not used inside the board. This is adjusted by volume RV1 on the SVM-03 board from 1.6V to 4.2V. Output current rating is 200mA.

In default, it is set to +3.3V.

9.2.　VDDL: IO Power Supply for Target Device

VDDL is IO power supply of image sensor or target device. This is adjusted by volume RV2 on the SVM-03 board from 1.6V to 4.2V. Output current rating is 200mA.

In the SVM-03 board there is level converter ICs that convert input signal from VDDL level to internal IO level. Thus, **even if VDDL is not used in the target device, VDDL voltage level must be adjusted to the output IO voltafe level of the target.**

In default, it is set to +3.3V.

9.3.　Target IO Schematic Diagram
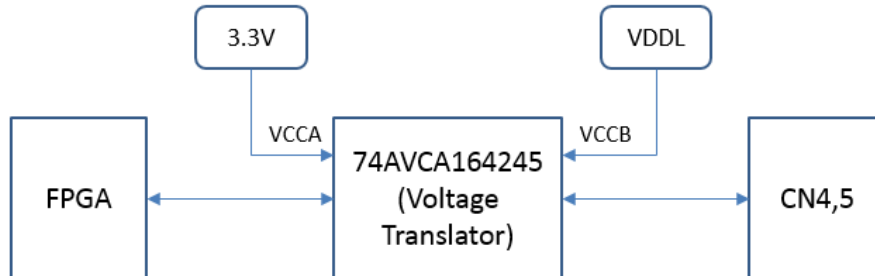
10.　Applicable version

Mode	FX3 Version	FPGA Version
SVM-03U Mode	63 or later	1.87 or later
SVM-03 Mode	123 or later	1.85 or later

11.　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. The horizontal resolution of the input video must be a multiple of 4.

5. 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.

6. We don't verify 5V power supply to monitor through HDMI cable. Operation is not guaranteed.

7. The contents of this document may be changed in the future without notice.

8. Reprinting of part or the whole of the contents of this document is strictly forbidden.

9. 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.

12. Appendix

12.1. 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 pair -	6	SSRX+	IN	USB 3.0 receiver Differential pair +
7	GND DRAIN	-	GND (Signal)	8	SSTX-	OUT	USB 3.0 Transmission Differential pair -
9	SSTX+	OUT	USB 3.0 Transmission Differential pair +				

12.2. 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				

12.3.　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	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.**

12.4.　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	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.**

12.5.　Color space conversion formula for HDMI output

When operating in SVM-03 mode, the color space and range conversion is performed by the HDMI transmitter on the SVM-03 board, depending on the input/output format (color space) and range settings.　The details of the color space transformation are described below. The following description applies to FX3 Version = 123 or later.

・Input format

The "Input Color Space" setting of "SVMCtl" is reflected.

・Input range

The "HDMI Input Range" of the settings in "Advanced Setting" of "SVMCtl" is reflected.　If the input format is YUV format, it is ignored.

・Output format

The DIP SW setting on the SVM-03 board (HDMI mode/DVI mode) is reflected.

・Output range

　The output range reflects the setting of the "HDMI Output Range" setting of "SVMCtl". This setting will also be reflected in the AVI infoframe setting at the same time. If the output format is YUV format, the range conversion does not occur even if the output range and input range are different, but the AVI infoframe settings are changed.

・Conversion expression

12.5.1.　　Input format = YUV

Input range	Output format	Output range	Conversion expression （range[0-1]）
(Ignored)	RGB	Full	Rout = 1.169Yin + 1.801Vin − 0.974 Gout = 1.169Yin − 0.215Uin − 0.535Vin + 0.302 Bout = 1.169Yin + 2.121Uin − 1.134
(Ignored)	RGB	Limited	Rout = Yin + 1.540Vin − 0.771 Gout = Yin − 0.184Uin − 0.458Vin + 0.321 Bout = Yin + 1.815Uin − 0.907
(Ignored)	YUV	(Disabled)	Yout = Yin Uout = Uin Vout = Vin

12.5.2.　Input format = RGB

Input range	Output format	Output range	Conversion expression （range[0-1]）
Full	RGB	Full	Rout = Rin Gout = Gin Bout = Bin
Full	RGB	Limited	Rout = 0.858Rin + 0.0625 Gout = 0.858Gin + 0.0625 Bout = 0.858Bin + 0.0625
Limited	RGB	Full	Rout = 1.164Rin − 0.073 Gout = 1.164Gin − 0.073 Bout = 1.164Bin − 0.073
Limited	RGB	Limited	Rout = Rin Gout = Gin Bout = Bin
Full	YUV	(Disabled)	Yout = 0.182Rin + 0.612Gin + 0.062B + 0.0625 Uout = −0.124Rin − 0.337Gin + 0.437Bin + 0.5 Vout = 0.437Rin − 0.397Gin − 0.040Bin + 0.5
Limited	YUV	(Disabled)	Yout = 0.213Rin + 0.715Gin + 0.072Bin Uout = −0.117Rin − 0.394Gin + 0.511Bin + 0.5 Vout = 0.511Rin − 0.464Gin − 0.047Bin + 0.5