PCIe/104 or PCI/104-Express
4-Channel Audio/Video Codec
Model 953
User's Manual

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SENSORAY | embedded electronics

Designed and manufactured in the U.S.A

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Special handling instructions

The circuit board contains CMOS circuitry that is sensitive to Electrostatic Discharge (ESD). Special care should be taken in handling, transporting, and installing circuit board to prevent ESD damage to the board. In particular:

- Do not remove the circuit board from its protective anti-static bag until you are ready to install the board into the enclosure.
- Handle the circuit board only at grounded, ESD protected stations.
- Remove power from the equipment before installing or removing the circuit board.

Introduction

Model 953 is a 4-channel PCIe/104 audio/video codec. It is capable of simultaneous capture of up to four channels of analog video and audio at full TV frame rate (30 fps for NTSC or 25 fps for PAL). Model 953 implements H.264, MPEG-4, or MJPEG compression for video, and G.711 or AAC for audio. The following container formats are supported: MPEG-TS and MP4 (for H.264 and MPEG-4), AVI (for MJPEG and raw). Elementary video and audio streams are available as well.

A low latency uncompressed stream is provided for each channel for real-time preview.

Each channel of model 953 is capable of producing two concurrent output video streams. The streams could be any combination of compressed and uncompressed. Compression type, target bitrate, and resolution could be set independently for each of the eight output streams. The total amount of sent data can not exceed approximately that of one full resolution uncompressed (YUV) stream.

Each of the four channels can work as a decoder, converting digital audio/video stream into analog (composite video and line audio). Decoding is guaranteed only for streams captured with model 953. Simultaneous encode and decode are supported with some limitations (see the Software Manual for details).

Model 953 provides general purpose optoisolated inputs and outputs (4 of each).

The board is implemented using a single-lane (x1) PCI-Express interface, and designed for PC/104 and/or EPIC form factor. All signals are passing through a PCIe/104 bus connector supporting both stack-up and stack-down configurations. Model 953 implements link shifting allowing the use of up to four PCIe/104 boards in one stack. Power is supplied via the PCIe/104 bus connector.

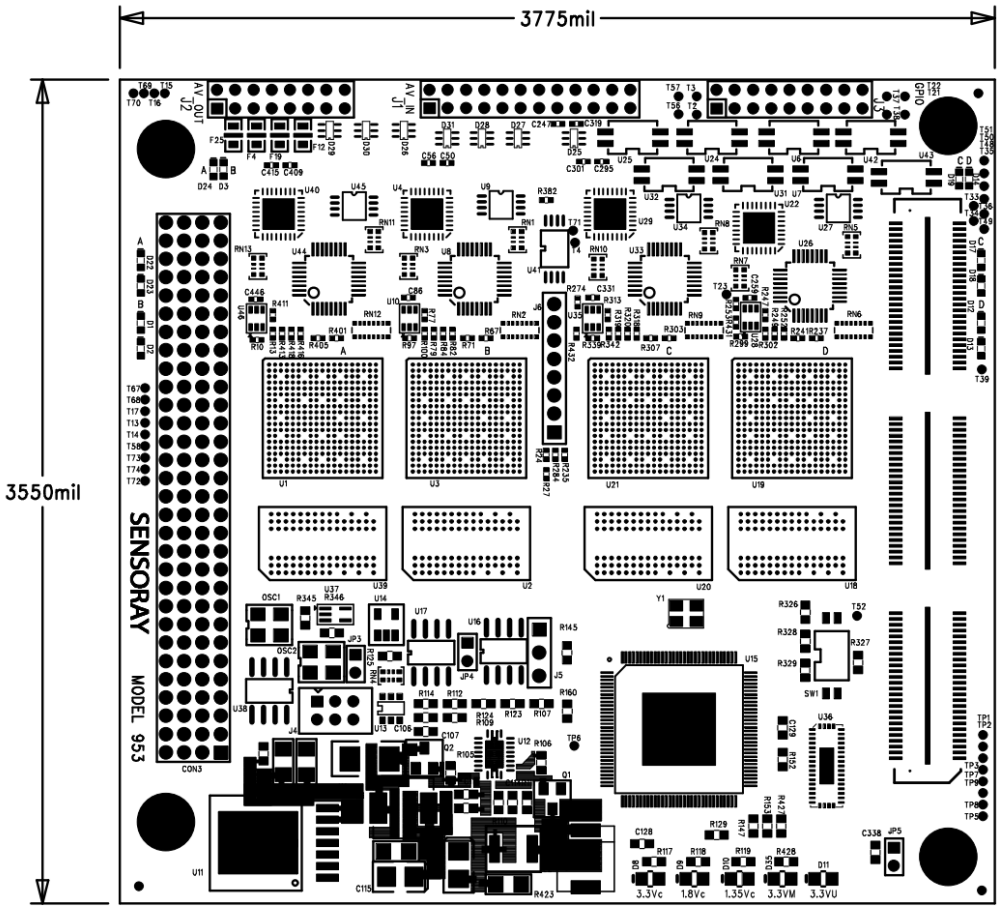
System Requirements

A basic Model 953 application (capture of four compressed streams and preview of four compressed streams) will work on an ATOM class processor based PCIe/104 or PCI/104-Express SBC (Single Board Computer).

RAM size is dictated more by an operating system and application requirements. A list of tested PC/104 form factor SBCs is posted at model 953 web page. Please contact Sensoray for an evaluation unit of model 953 to test it with an embedded SBC of your choice.

Board Reference

Board Picture and Connector Layout



Connectors

Connector List

CON1	PCIe/104 Bus connector –- top
CON2	PCIe/104 Bus connector –- bottom
CON3	PC/104+ PCI Bus connector (optional, for PC/104+ signal pass-through only)
J1	16-pin connector: composite video outputs; audio outputs.
J2	24-pin connector: composite video inputs; audio inputs.
J3	18-pin connector: digital inputs and outputs.

Connector Pin/Signal Definitions

PCIe/104 Bus Connectors: CON1 (Top) and CON2 (Bottom)

Top Connector – CON1					Bottom Connector – CON2				
Pin	Signal		Signal	Pin	Pin	Signal		Signal	Pin
1	USB_OC#*		PE_RST#	2	2	PE_RST#		USB_OC#*	1
3	**+3.3V***		**+3.3V***	4	4	**+3.3V***		**+3.3V***	3
5	USB_1p*		USB_0p*	6	6	USB_0p*		USB_1p*	5
7	USB_1n*		USB_0n*	8	8	USB_0n*		USB_1n*	7
9	**GND**		**GND**	10	10	**GND**		**GND**	9
11	PEx1_1Tp		PEx1_0Tp	12	12	PEx1_0Tp		PEx1_1Tp	11
13	PEx1_1Tn		PEx1_0Tn	14	14	PEx1_0Tn		PEx1_1Tn	13
15	**GND**		**GND**	16	16	**GND**		**GND**	15
17	PEx1_2Tp		PEx1_3Tp	18	18	PEx1_3Tp		PEx1_2Tp	17
19	PEx1_2Tn		PEx1_3Tn	20	20	PEx1_3Tn		PEx1_2Tn	19
21	**GND**	+	**GND**	22	22	**GND**	+	**GND**	21
23	PEx1_1Rp	5	PEx1_0Rp	24	24	PEx1_0Rp	5	PEx1_1Rp	23
25	PEx1_1Rn	V	PEx1_0Rn	26	26	PEx1_0Rn	V	PEx1_1Rn	25
27	**GND**	o	**GND**	28	28	**GND**	o	**GND**	27
29	PEx1_2Rp	l	PEx1_3Rp	30	30	PEx1_3Rp	l	PEx1_2Rp	29
31	PEx1_2Rn	t	PEx1_3Rn	32	32	PEx1_3Rn	t	PEx1_2Rn	31
33	**GND**	s	**GND**	34	34	**GND**	s	**GND**	33
35	PEx1_1Clkp		PEx1_0Clkp	36	36	PEx1_0Clkp		PEx1_1Clkp	35
37	PEx1_1Clkn		PEx1_0Clkn	38	38	PEx1_0Clkn		PEx1_1Clkn	37
39	**+5V**		**+5V**	40	40	**+5V**		**+5V**	39
41	PEx1_2Clkp		PEx1_3Clkp	42	42	PEx1_3Clkp		PEx1_2Clkp	41
43	PEx1_2Clkn		PEx1_3Clkn	44	44	PEx1_3Clkn		PEx1_2Clkn	43
45	**CPU_DIR**		**PWRGOOD**	46	46	**PWRGOOD**		**CPU_DIR**	45
47	SMB_DAT*		PEx16_x8_x4_Clkp*	48	48	PEx16_x8_x4_Clkp*		SMB_DAT*	47
49	SMB_CLK*		PEx16_x8_x4_Clkn*	50	50	PEx16_x8_x4_Clkn*		SMB_CLK*	49
51	SMB_ALERT*		PSON#*	52	52	PSON#*		SMB_ALERT*	51
53	RSVD/WAKE#*		PEG_ENA#*	54	54	PEG_ENA#*		RSVD/WAKE#*	53
55	**GND**		**GND**	56	56	**GND**		**GND**	55
57	PEx16_0T(8)p*		PEx16_0T(0)p*	58	58	PEx16_0T(0)p*		PEx16_0T(8)p*	57
59	PEx16_0T(8)n*		PEx16_0T(0)n*	50	50	PEx16_0T(0)n*		PEx16_0T(8)n*	59
61	**GND**		**GND**	62	62	**GND**		**GND**	61
63	PEx16_0T(9)p*		PEx16_0T(1)p*	64	64	PEx16_0T(1)p*		PEx16_0T(9)p*	63
65	PEx16_0T(9)n*		PEx16_0T(1)n*	66	66	PEx16_0T(1)n*		PEx16_0T(9)n*	65
67	**GND**		**GND**	68	68	**GND**		**GND**	67
69	PEx16_0T(10)p*	+	PEx16_0T(2)p*	60	70	PEx16_0T(2)p*	+	PEx16_0T(10)p*	69
71	PEx16_0T(10)n*	5	PEx16_0T(2)n*	72	72	PEx16_0T(2)n*	5	PEx16_0T(10)n*	71
73	**GND**	V	**GND**	74	74	**GND**	V	**GND**	73
75	PEx16_0T(11)p*	o	PEx16_0T(3)p*	76	76	PEx16_0T(3)p*	o	PEx16_0T(11)p*	75
77	PEx16_0T(11)n*	l	PEx16_0T(3)n*	78	78	PEx16_0T(3)n*	l	PEx16_0T(11)n*	77
79	**GND**	t	**GND**	70	80	**GND**	t	**GND**	79
81	PEx16_0T(12)p*	s	PEx16_0T(4)p*	82	82	PEx16_0T(4)p*	s	PEx16_0T(12)p*	81
83	PEx16_0T(12)n*	*	PEx16_0T(4)n*	84	84	PEx16_0T(4)n*	*	PEx16_0T(12)n*	83
85	**GND**		**GND**	86	86	**GND**		**GND**	85
87	PEx16_0T(13)p*		PEx16_0T(5)p*	88	88	PEx16_0T(5)p*		PEx16_0T(13)p*	87
89	PEx16_0T(13)n*		PEx16_0T(5)n*	90	90	PEx16_0T(5)n*		PEx16_0T(13)n*	89
91	**GND**		**GND**	92	92	**GND**		**GND**	91

93	PEx16_0T(14)p*		PEx16_0T(6)p*	94	94	PEx16_0T(6)p*		PEx16_0T(14)p*	93
95	PEx16_0T(14)n*		PEx16_0T(6)n*	96	96	PEx16_0T(6)n*		PEx16_0T(14)n*	95
97	**GND**		**GND**	98	98	**GND**		**GND**	97
99	PEx16_0T(15)p*		PEx16_0T(7)p*	100	100	PEx16_0T(7)p*		PEx16_0T(15)p*	99
101	PEx16_0T(15)n*		PEx16_0T(7)n*	102	102	PEx16_0T(7)n*		PEx16_0T(15)n*	101
103	**GND**		**GND**	104	104	**GND**		**GND**	103
105	SDVO_DAT(PENA#)*		SDVO_CLK*	106	106	SDVO_CLK*		SDVO_DAT(PENA#)*	105
107	**GND**		**GND**	108	108	**GND**		**GND**	107
109	PEx16_0R(8)p*		PEx16_0R(0)p*	110	110	PEx16_0R(0)p*		PEx16_0R(8)p*	109
111	PEx16_0R(8)n*		PEx16_0R(0)n*	112	112	PEx16_0R(0)n*		PEx16_0R(8)n*	111
113	**GND**		**GND**	114	114	**GND**		**GND**	113
115	PEx16_0R(9)p*		PEx16_0R(1)p*	116	116	PEx16_0R(1)p*		PEx16_0R(9)p*	115
117	PEx16_0R(9)n*		PEx16_0R(1)n*	118	118	PEx16_0R(1)n*		PEx16_0R(9)n*	117
119	**GND**		**GND**	120	120	**GND**		**GND**	119
121	PEx16_0R(10)p*		PEx16_0R(2)p*	122	122	PEx16_0R(2)p*		PEx16_0R(10)p*	121
123	PEx16_0R(10)n*	+	PEx16_0R(2)n*	124	124	PEx16_0R(2)n*	+	PEx16_0R(10)n*	123
125	**GND**	**12**	**GND**	126	126	**GND**	**12**	**GND**	125
127	PEx16_0R(11)p*	**V**	PEx16_0R(3)p*	128	128	PEx16_0R(3)p*	**V**	PEx16_0R(11)p*	127
129	PEx16_0R(11)n*	**o**	PEx16_0R(3)n*	130	130	PEx16_0R(3)n*	**o**	PEx16_0R(11)n*	129
131	**GND**	**l**	**GND**	132	132	**GND**	**l**	**GND**	131
133	PEx16_0R(12)p*	**t**	PEx16_0R(4)p*	134	134	PEx16_0R(4)p*	**t**	PEx16_0R(12)p*	133
135	PEx16_0R(12)n*	**s**	PEx16_0R(4)n*	136	136	PEx16_0R(4)n*	**s**	PEx16_0R(12)n*	135
137	**GND**	*	**GND**	138	138	**GND**	*	**GND**	137
139	PEx16_0R(13)p*		PEx16_0R(5)p*	140	140	PEx16_0R(5)p*		PEx16_0R(13)p*	139
141	PEx16_0R(13)n*		PEx16_0R(5)n*	142	142	PEx16_0R(5)n*		PEx16_0R(13)n*	141
143	**GND**		**GND**	144	144	**GND**		**GND**	135
145	PEx16_0R(14)p*		PEx16_0R(6)p*	146	146	PEx16_0R(6)p*		PEx16_0R(14)p*	145
147	PEx16_0R(14)n*		PEx16_0R(6)n*	148	148	PEx16_0R(6)n*		PEx16_0R(14)n*	147
149	**GND**		**GND**	150	150	**GND**		**GND**	149
151	PEx16_0R(15)p*		PEx16_0R(7)p*	152	152	PEx16_0R(7)p*		PEx16_0R(15)p*	151
153	PEx16_0R(15)n*		PEx16_0R(7)n*	154	154	PEx16_0R(7)n*		PEx16_0R(15)n*	153
155	**GND**		**GND**	156	156	**GND**		**GND**	155

Note:
* Pass-through only for PCIe/104 Stacking

PC/104-Plus PCI Bus Connectors: CON3

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	GND/Key*	B1	RSVD*	C1	+5 V*	D1	AD0*
A2	VIO*	B2	AD2*	C2	AD1*	D2	+5 V*
A3	AD5*	B3	Ground	C3	AD4*	D3	AD3*
A4	C/BE0#*	B4	AD7*	C4	Ground	D4	AD6*
A5	Ground	B5	AD9*	C5	AD8*	D5	Ground
A6	AD11*	B6	VIO*	C6	AD10*	D6	M66EN*
A7	AD14*	B7	AD13*	C7	Ground	D7	AD12*
A8	+3.3V*	B8	C/BE1#*	C8	AD15*	D8	+3.3V*
A9	SERR#*	B9	Ground	C9	SB0*	D9	PAR*
A10	Ground	B10	PERR#*	C10	+3.3V*	D10	SDONE*
A11	STOP#*	B11	+3.3V*	C11	LOCK*	D11	Ground
A12	+3.3V*	B12	TRDY#*	C12	Ground	D12	DEVSEL#*
A13	FRAME#*	B13	Ground	C13	IRDY#*	D13	+3.3V*
A14	Ground	B14	AD16*	C14	+3.3V*	D14	C/BE2#*
A15	AD18*	B15	+3.3V*	C15	AD17*	D15	Ground
A16	AD21*	B16	AD20*	C16	Ground	D16	AD19*
A17	+3.3V*	B17	AD23*	C17	AD22*	D17	+3.3V*
A18	IDSEL0*	B18	Ground	C18	IDSEL1*	D18	IDSEL2*
A19	AD24*	B19	C/BE3#*	C19	VIO*	D19	IDSEL3*
A20	Ground	B20	AD26*	C20	AD25*	D20	Ground
A21	AD29*	B21	+5 V*	C21	AD28*	D21	AD27*
A22	+5 V*	B22	AD30*	C22	Ground	D22	AD31*
A23	REQ0#*	B23	Ground	C23	REQ1#*	D23	VIO*
A24	Ground	B24	REQ2#*	C24	+5 V*	D24	GNT0#*
A25	GNT1#*	B25	VIO*	C25	GNT2#*	D25	Ground
A26	+5 V*	B26	CLK0*	C26	Ground	D26	CLK1*
A27	CLK2*	B27	+5 V*	C27	CLK3*	D27	Ground
A28	Ground	B28	INTD#*	C28	+5 V*	D28	RST#*
A29	+12 V*	B29	INTA#*	C29	INTB#*	D29	INTC#*
A30	-12 V*	B30	RSVD *	C30	RSVD *	D30	Ground

Note:
* not connected, only pass-through for PC/104+ Stacking

A/V (Video+Audio) Output Connector: J1

Pin	Signal	Pin	Signal
1	Audio Output – Left, Channel 4	2	Audio Output – Right, Channel 4
3	Audio Output – Left, Channel 3	4	Audio Output – Right, Channel 3
5	Audio Output – Left, Channel 2	6	Audio Output – Right, Channel 2
7	Audio Output – Left, Channel 1	8	Audio Output – Right, Channel 1
9	Composite Video Output, Channel 4	10	Ground
11	Composite Video Output, Channel 3	12	Ground
13	Composite Video Output, Channel 2	14	Ground
15	Composite Video Output, Channel 1	16	Ground

Note:
V Video Output Impedance: 75 Ω
A Audio Output Impedance: 10 kΩ
Line outputs, providing standard output level of 0.707V RMS

A/V (Video+Audio) Input Connector: J2

Pin	Signal	Pin	Signal
1	Not Used *	2	PCIeGPIO4 *
3	PCIeGPIO3 *	4	PCIeGPIO2 *
5	PCIeGPIO1 *	6	Ground
7	Audio Input – Left, Channel 4	8	Audio Input – Right, Channel 4
9	Audio Input – Left, Channel 3	10	Audio Input – Right, Channel 3
11	Audio Input – Left, Channel 2	12	Audio Input – Right, Channel 2
13	Audio Input – Left, Channel 1	14	Audio Input – Right, Channel 1
15	Ground	16	Ground
17	Composite Video Input, channel 4	18	Ground
19	Composite Video Input, channel 3	20	Ground
21	Composite Video Input, channel 2	22	Ground
23	Composite Video Input, channel 1	24	Ground

Note:
* Reserved for future use
V Video Input Impedance: 75 Ω
A Audio Input Impedance: 10 kΩ
Line inputs, designed to work with standard input level of 0.707V RMS

GPIO Connector: J3

Pin	Signal	Pin	Signal
1	GPO-E4	2	GPO-C4
3	GPI-C4	4	GPI-A4
5	GPO-E3	6	GPO-C3
7	GPI-C3	8	GPI-A3
9	GPO-E2	10	GPO-C2
11	GPI-C2	12	GPI-A2
13	GPO-E1	14	GPO-C1
15	GPI-C1	16	GPI-A1
17	Not Used *	18	Not Used *

Note:

* Reserved for future use

GPIO Connections

Model 953 provides one general purpose optoisolated input (GPI) and one general purpose optoisolated output (GPO) per channel. A recommended connection circuit is shown in Figure 1 below:

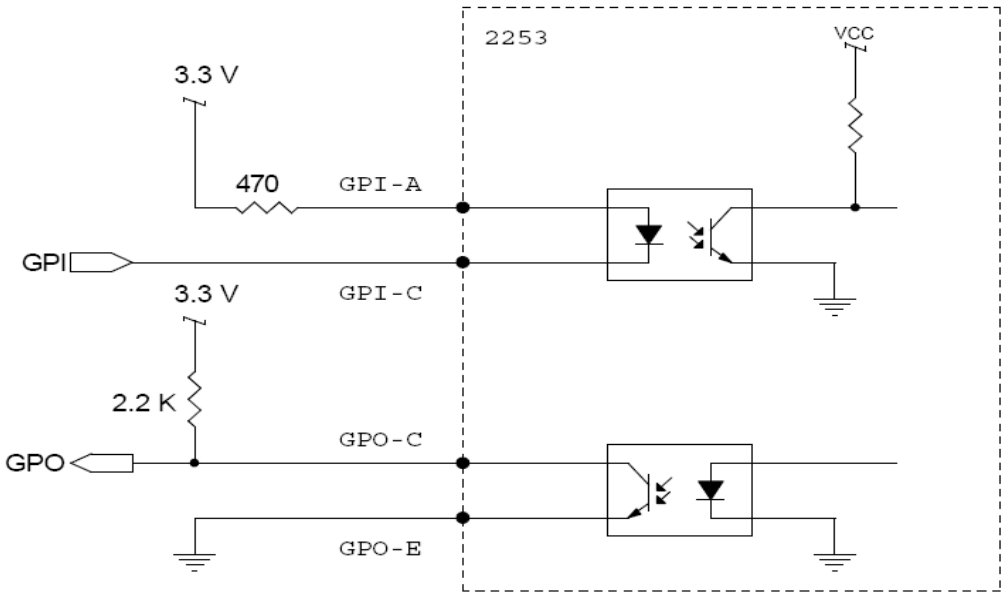


Figure 1. Optoisolated GPIO.

DIP Switches

Stack up/Stack down Control DIP Switch: SW1

In most cases both SW1-1 and SW1-2 should be in OFF positions. The only exception is the case when

a) the CPU does not provide the DIR signal (for example, when the 953 is used with an extender plugged into a desktop PC), and

b) the 953 needs to be configured as "stack down" (the CPU is above the 953, using the connectors on the component side of the 953).

In this case SW1-1 has to be set to ON position.

LEDs

Power indicators: D8-D10, D35, D11

The following LEDs are used for indicating on-board power status.

LED	Indication
D8	Codec 3.3V
D9	Codec 1.8V
D10	Codec 1.35V
D35	Main 3.3V
D11	PCIe-to-USB Bridge 3.3V

Video Input Signal Indicators: D24, D3, D19, D14

LEDs D24, D3, D19 and D14 indicate input video signal status for channels 1, 2, 3 and 4, respectively. LED behavior is software configurable. By default LED is blinking in the absense of input video signal, and is on in presence of input video signal.

Note:

Refer to Model 2253/953 Software Manuals, for configuring details.

Channel Status Indicators: D22-D23, D1-D2, D17-D18, D12-D13

These LEDs are used for manufacturing or troubleshooting purposes only.

Software and SDKs

Device Driver and SDK

Software Development Kits for Windows and Linux are available, including drivers, API, and demo applications. Model 953 is software compatible with model 2253, so they share SDKs.

Windows SDK

Sensoray provides a WDM driver and DirectX filters for Windows platform. The SDK includes the Windows driver, a DLL, and a demo application with the source code and is available as "sdk_2253_1.x.y_win.zip" at Sensoray's Model 953 web page.

Prior to the Sensoray 2253/953 Windows driver/SDK, a "**TUSB73x0 xHCI Driver**" by TI needs to be installed. Go to TI website: http://www.ti.com/lit/zip/sllc423, user(s) can get the driver package downloaded. Unzip and then perform installation.

For the Model 2253/953 Windows SDK, DLL, API, and programming details, please refer to the "Model 2253/953 Windows Software Manual", provided by Sensoray and downloadable at Model 953 web page.

Since the driver is built and based on the WDM BDA and DirectShow oriented architecture, the commonly-used Microsoft GraphEdit utility can be used for live A/V preview and/or capture application build. Also, 3rd party's freeware/shareware applications, like VLC player and AMCap software can be used, too.

Linux SDK

Sensoray provides Model 2253/953 driver and SDK for Linux. The driver and demo application programs are packed in a SDK package "SDK_2253_1.x.y_Linux.tar.bz2" available at the Model 953 web page. The Model 953 Linux device driver API complies with standard V4L2 (Video for Linux Version 2, formerly known as V4L) specification.

Refer to the "Model 2253/953 Linux Software Manual" for the driver, SDK, API, and application programming details.

Since the Linux driver API complies with V4L2 spec fully, some common and popular 3rd party media players/apps, like XawTV, VLC, Mplayer, GStreamer, etc. can be used for A/V preview, capture, and streaming.

Specifications

Form Factor	PCIe/104 or PCI/104-Express: Complies with PCI/104-Express and PCIe/104 Specifications (Ver 1.1)
Video Inputs	4 NTSC or PAL, composite video, 75 Ohms
Video Capture Rate	30 frames/second per channel, NTSC 25 frames/second per channel, PAL
Audio Inputs	4 stereo line input channels associated with 4 video channels.
Audio Sampling Rate	8KHz (for G.711 A-law / μ-law) 48KHz (for AAC)
Video Encoding	H.264 HP@L3, MPEG-4 ASP, or MJPEG
Audio Encoding	G.711 (A-law / μ-law) or AAC
Output Stream Format	Elementary Audio/Video, MPEG-4 Program Stream (.MP4), MJPEG Stream, Transport Stream
Video Preview Format	Up to 704x480 (NTSC) / 704x576 (PAL) YUV4:2:2, GRAY8, or JPEG
Text Overlay	Up to 160 characters for full resolution images
Video Outputs	4 NTSC or PAL, composite video, 75 Ohms
Audio Outputs	4 stereo line output channels associated with 4 video channels.
Digital I/O	4 pairs of optoisolated inputs and outputs
Bus/Interface	PCIe/104 or PCI/104-Express: PCI Express x1, compliant with: PCI/104-Express & PCIe/104 Specification (Version 1.1) PCI-Express Base Specification (Revision 1.1)
OS Platform	Windows and Linux
Power	< 7.5W (1.5A @ 5V)
Operating Temperature	-40 – +85 °C
Board Size	3.775” x 3.55” (96mm x 90mm)

Revision history

Version	Notes
Rev0, April 2013	Initial release.
RevA, June 2014	i) For new board revisions, RevA and RevB
	ii) Added note for **TUSB73x0 xHCI Driver** installation
RevB, October 2015	Revision, with adjustments for board RevA and RevB
RevC, September 2017	Fixed SW1 description