



mulTVideo
Reference Design Kit

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1.0 Introduction

mulTVideo is a reference design/evaluation board that offers video and audio on the PC via an extensive range of sources: MPEG-1 video/audio decoders, a composite video source, an S-VHS video source, or a TV video/audio tuner. This board features Zoran's ZR36120 PCI Multimedia Adapter, an IC that transfers digital video across the PCI bus directly into a VGA card's frame buffer, eliminating the need for feature connector cables and loopthrough cables commonly found on overlay-based multimedia add-in cards. This allows for true "plug n' play" multimedia. Along with the ZR36120, also featured is the ZR36100 or ZR36110 MPEG-1 decoder. mulTVideo comes with both Windows95 and Windows3.1 software drivers to allow a board manufacturer to go quickly to market with a complete product. Zoran also licenses an MPEG audio software decoder to be used with mulTVideo. With this option, the hardware audio decoder on mulTVideo can be removed, lowering the total board cost.

2.0 Features

- Video sources: MPEG-1 video decoder, TV tuner, composite video signal, S-VHS video signal
- Audio sources: MPEG-1 audio decoder, TV tuner
- Outputs: VGA video-in-a-window, composite video, stereo sound
- Full PCI 2.1 compatibility
- Plug & Play installation (dependent on operating system support)
- On-board system level parsing and synchronization of MPEG audio and video - no software parsing of audio and video required during playback (for hardware audio decoding)
- Video in a window with scaling, high-resolution VGA modes support, and 16M color support
- CD Quality stereo audio output for hardware audio decoding. User-selectable audio quality for software audio decoding
- Fully OM-1 compatible driver for Windows95 and Windows3.1 MCI applications
- A royalty-free software license is provided to distribute the software drivers and libraries (hardware audio decoding only)
- Supports CD-i (green book), Video CD (white book) and Karaoke CD formats. A mulTVideo equipped with the ZR36110 supports Video CD 2.0 with high-resolution still images
- MPEG decoder supports automatic standards conversion for (NTSC <-> PAL), user-selectable

3.0 Description

mulTVideo, shown in Figure 1, is a PCI card that features the Zoran ZR36120 Multimedia Adapter and Zoran ZR36100 or ZR36110 MPEG decoder. Due to the on-board system level parsing and synchronization of audio and video, very little host cpu overhead is achieved if hardware audio decoding is used. The following is a description of the mulTVideo design and functionality.

3.1 Functional Overview

mulTVideo interfaces to the PCI bus via the ZR36120. All data transfer to/from the board is done through this device. The primary functions of the ZR36120 are to read in coded MPEG data and transfer it to the ZR36100/110 and to send uncompressed video data to the VGA card's frame buffer.

During MPEG playback, the ZR36120 reads the coded MPEG bitstream from the system memory and writes the stream to the ZR36100/110. The ZR36100/110 decodes the system headers and separates the stream into its individual video and audio component bitstreams. It decodes the MPEG video into a reconstructed sequence of pictures and sends the output in the form of a standard CCIR601 YUV 4:2:2 16-bit digital video signal, together with synchronization signals, back to the ZR36120 to be transferred to the frame buffer of the VGA card. Interrupts are generated and sent back to the host for the software to keep track of the frame count and the internal buffer fullness of the ZR36100/110. If hardware audio decoding is used, synchronization of audio and video is done by the ZR36100/110 which decodes the time stamps present in the MPEG bitstream and passes the MPEG audio bitstream, fully synchronized with the displayed video, directly to the CS4920 audio decoder. The CS4920's stereo audio DAC provides a line-level output that is multiplexed through a TEA5582 audio decoder and out to a sound system or powered speakers. If Zoran's software audio decoder is used, the decoded audio is sent to a wave driver of a sound card, through which the audio can be heard. In this case, the audio/video synchronization is maintained in the mulTVideo driver software.

16-bit YUV 4:2:2 video data, provided by either the ZR36100/110 or an SAA7111 video decoder, is sampled by the ZR36120. Downscaling of the video can be achieved by not sampling all of the pixels. The sampled video data is stored in temporary buffers and then transferred to the system display memory using bursts. The display memory buffer must be able to support PCI linear addressing, for this is the transfer method supported by the ZR36120. This uncompressed video is also sent to an SAA7185 video encoder for simultaneous video output on a TV monitor.

The SAA7111 digitizes one of three analog sources: either a composite input directly from an RCA connector on the board, an S-VHS input, or a composite signal tuned from a television RF input. The TV tuning is performed by a Philips FI1236 (or equivalent). If the TV tuner is the video source, the demodulated audio is sent to the TEA5582 audio decoder for output to a sound system or powered speakers.

3.2 Physical Description

As Figure 1 shows, mulTVideo consists of seven major components:

- **Zoran ZR36120** - A single-chip PCI multimedia controller. The ZR36120 is a PCI bus master that serves two primary purposes. First, the ZR36120 reads MPEG-1 data from a memory buffer and transfers it to a Zoran MPEG-1 decoder. Second, the ZR36120 converts 16-bit YUV 4:2:2 data to RGB and writes this data to a frame buffer, typically a VGA card frame buffer, but the data can also be written to system memory. Pixel-by-pixel masking is supported, allow-

ing for overlay on the video. The ZR36120 has a proprietary “GuestBus” that interfaces to various multimedia IC’s. This allows for a “glueless” design. Along with this GuestBus, an I²C bus is provided to support Philips and Crystal Semiconductor IC’s.

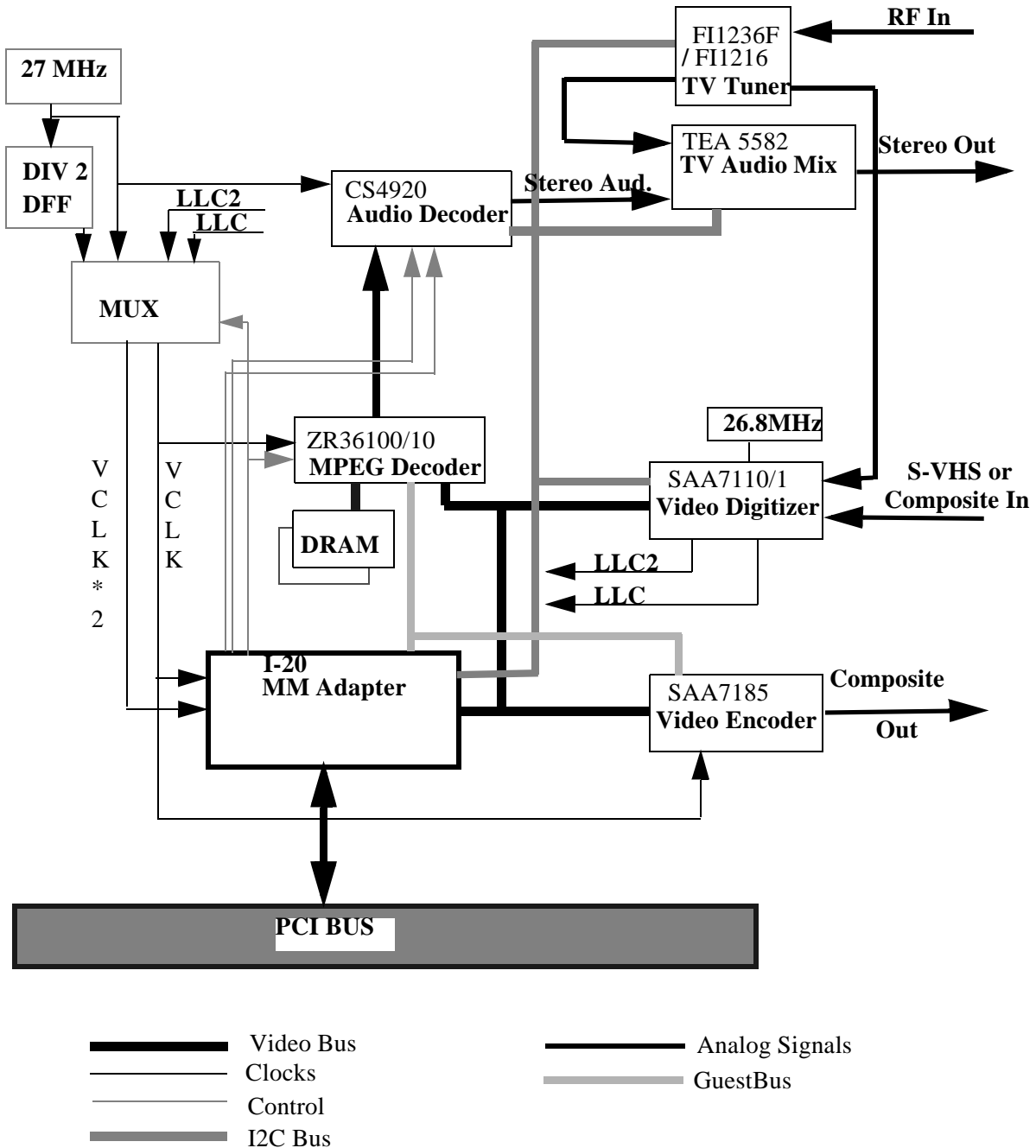


FIGURE 1. multVideo Block Diagram

- **Zoran ZR36100/110**- A single-chip MPEG-1 System and Video Decoder. The ZR36100/110 can parse an MPEG system bitstream and decode the video stream into a standard digital video format while simultaneously serially transmitting the MPEG audio data to an external MPEG audio decoder, thus maintaining audio/video synchronization on the board with no software help required. Up to 5 Mbits/s system bitstream and up to 3 Mbits/s video bitstream can be decoded. MPEG video resolutions up to 352x240 at 30 fps and 352x288 at 25 fps can be fully-decoded, both standards used by Video CD and Karaoke CD formats. The ZR36110 can also decode images at 384x240 at 24fps for CD-i greenbook support as well as decode Video CD 2.0 high-resolution still images. The ZR36100 requires 0.5MB DRAM for its frame buffer. The ZR36110 also requires 0.5MB DRAM, but also requires an extra 0.5MB DRAM for high-resolution PAL images to be shown at full resolution. However, without this extra DRAM the ZR36110 can still decode and display high-resolution PAL images, but at one-half the vertical resolution.
- **Crystal CS4920** - A single-chip audio subsystem with integrated DSP, PLL, peripherals and DAC. The CS4920 is an audio DSP that is programmed via microcode to decode MPEG-1 layer I & II audio provided by the ZR36100/110. All sample rates are supported (32 kHz, 44.1 kHz, and 48 kHz) as well as all MPEG audio bit rates. The CS4920 allows for digital volume control and mute/unmute capabilities. The CS4920 DAC provides standard stereo line-level output. The CS4920A is interchangeable with the CS4920 on multVideo.
- **Philips FI1236** - A TV tuner that receives an RF TV signal and outputs both a composite video signal and either AF or IF audio. The FI1236 is controlled via I²C protocol. The FI1236 tunes NTSC signals, but can be replaced with an FI1216 to tune PAL signals.
- **Philips SAA7111** - A video decoder that digitizes analog composite video or S-VHS video into CCIR601 16-bit YUV 4:2:2. The SAA7111 digitizes both NTSC and PAL signals. Programming of the device is done via I²C.
- **Philips SAA7185** - A video encoder that converts the YUV 4:2:2 pixels from the ZR36100/110 (or SAA7111) to an analog composite signal that can be connected to a TV. The SAA7185 supports both NTSC and PAL. Programming of the device is done via I²C.
- **Philips TEA5582** - An audio decoder/mux that decodes AF or IF audio from a TV tuner into line-level stereo. The mux switches between the TV tuner audio and a stereo signal from an external source, such as a CS4920. The TEA5582 enables mute and stereo/mono functions and supplies stereo/mono indication.

3.2.1 Data Transfer (Host <-> multVideo)

All transfers are done via the ZR36120. The ZR36120 allows for a glueless interface, so understanding how the ZR36120 works means understanding how multVideo works. Refer to the ZR36120 Data Sheet for in-depth explanation on how the ZR36120 communicates between the host and its “guests” (e.g. ZR36100/110, SAA7111, etc.).

3.2.2 Interrupts

The ZR36120 creates an interrupt pulse to the host based on several sources. Two pins on the ZR36100/110 are connected to the two external interrupt source pins on the ZR36120: VSYNC

and IDLE. Neither, one, or both can be used as an interrupt trigger. The ZR36120 also generates interrupts based on internal conditions regarding its code memory buffer pointer. For more information regarding the interrupt mechanism of the ZR36120, refer to the ZR36120 data sheet.

3.2.3 Clock Generator Circuit

The ZR36100/110 requires a 13.5MHz clock. The CS4920 requires a 27MHz clock. These can be provided by one of two sources. A 27MHz TTL oscillator and a 74F74 gate to divide the frequency in half can be used, or the clock generation circuit of the SAA7111 can be used. The SAA7111 requires a 24.576MHz crystal in any case. It is recommended that if an SAA7111 is assembled, the TTL oscillator and clock mux (U13) be left off the board and 3 zero-ohm resistors (R71, R72, R73) be assembled to bypass these parts. If the SAA711 is replaced with an SAA7110, then the TTL oscillator and mux must be left on the board. The SAA7110 requires a 26.8MHz crystal and will generate a 12.27MHz clock for NTSC and a 14.5MHz clock for PAL. These frequencies, Square Pixel and not CCIR, will not work properly with the ZR36100/110 and thus the two separate clock sources are required.

APPENDIX A - Bill of Materials

Item	Quantity	Reference	Part	Package/Manufacturer
Caps, Resistors, etc.				
1	2	C51, C52	10pF Capacitor	0805 surface-mount (SMT) ceramic, 50V
2	1	C65	20pF Capacitor	0805 SMT
3	2	C67, C66	560pF Capacitor	0805 SMT
4	1	C68	680pF Capacitor	0805 SMT
5	1	C86	820pF Capacitor	0805 SMT
6	4	C37, C38, C42, C53	0.001uF Capacitor	0805 SMT
7	2	C28, C30	0.0022uF Capacitor	0805 SMT
8	1	C20	0.01uF Capacitor	0805 SMT
9	1	C80	0.027uF Capacitor	0805 SMT
10	2	C78, C79	0.033uF Capacitor	0805 SMT
11	1	C34	0.047uF Capacitor	0805 SMT
12	75	C10, C1N, C1M, C1L, C1K, C1J, C1I, C1H, C1G, C1F, C1E, C1D, C1C, C1B, C1A, C2M, C2L, C2K, C2J, C2I, C2H, C2G, C2F, C2E, C2D, C2C, C2B, C2A, C3C, C3B, C3A, C4C, C4B, C4A, C5J, C5H, C5F, C5D, C5B, C7J, C7I, C7H, C7G, C7F, C7D, C7C, C7B, C8J, C8I, C8H, C8G, C8F, C8E, C8C, C8B, C11, C12, C13, C21, C32, C36, C39, C44, C46, C47, C48, C49, C50, C54, C55, C56, C59, C61, C70, C89	0.1uF Capacitor	0805 SMT
13	3	C76, C77, C85	0.15uF Capacitor	1206 SMT
14	1	C74	0.22uF Capacitor	1206 SMT
15	1	C81	0.33uF Capacitor	1210 SMT
16	1	C82	1uF Capacitor	2220 SMT (ceramic)
17	8	C5I, C5G, C5E, C5C, C29, C31, C83, C84	1uF Capacitor	"A" size SMT (3216) 6V Tantalum

Item	Quantity	Reference	Part	Package/Manufacturer
18	6	C1P, C2N, C8D, C26, C27, C33	10uF Capacitor	“C” size SMT (6032) 6V Tantalum
19	1	C35	10uF Capacitor	“C” size SMT (6032) 16V Tantalum
20	8	C5A, C7E, C7A, C8A, C45, C57, C60, C62	22uF Capacitor	“C” size SMT (6032) 6V Tantalum
21	3	C43, C58, C88	22uF Capacitor	“C” size SMT (6032) 16V Tantalum
22	1	C69	47uF Capacitor	“C” size SMT (6032) 6V Tantalum
23	2	C40, C41	47uF Capacitor	“B” size Through-hole 50V Aluminum Electrolytic
24	1	C22	100uF Capacitor	“D” size SMT (7343) 16V Tantalum
25	1	C75	330uF Capacitor	“B” size Through-hole 6V Aluminum Electrolytic
26	1	D1	Diode: 1N4001	Package: DO-41 Suggested Mfr: Diodes Inc.
27	1	D2	Z-Diode: 1N4752	Package: DO-41 33V
28	1	D3	Diode LED (red)	Part: Panasonic LNRPHL or equivalent
29	1	FB2	Ferrite bead	1608 SMT 80R, 100MHz
30	2	J1, J3	RCA connector, female	Part: SMK LPR6520-08xx xx=01=black, 02=red, 03=white, 04=yellow, 05=blue
31	1	J2	S-VHS female mini-DIN connector	Part: CUI Stack #MD40SM or equivalent
32	1	J4	Mini-stereo connector, female	Part: Singatron SJ373
33	1	J5	Header 25x2	SMT - do not assemble
34	2	L7, L8	2.7uH Inductor	1812 SMT Suggested Mfr: Delevan
35	2	L6, L9	10uH Inductor	1812 SMT
36	1	L1	33uH Inductor	1812 SMT
37	2	L3, L4	100uH Inductor	1812 SMT
38	1	L5	1mH Inductor	1812 SMT

Item	Quantity	Reference	Part	Package/Manufacturer
39	2	Q2, Q1	NPN Transistor: 2N3904	Mfr: National Semiconductor Specs: SSGP 40V, 100mA
40	5	R22, R39, R71, R72, R73	Resistor	Do not assemble
41	6	FB3, R9, R86, R87, R88, R89	0 ohm Resistor	0805 SMT 25 Watt, 5%
42	1	R50	20 ohm Resistor	0805 SMT
43	7	R16, R19, R20, R21, R41, R42, R43	22 ohm Resistor	0805 SMT
44	4	R12, R13, R14, R15	33 ohm Resistor	0805 SMT
45	2	R44, R49	47 ohm Resistor	0805 SMT
46	1	R59	68 ohm Resistor	0805 SMT
47	4	R34, R35, R36, R37	75 ohm Resistor	0805 SMT
48	2	R6, R8	220 ohm Resistor	0805 SMT
49	1	R30	300 ohm Resistor	0805 SMT
50	2	R5, R7	330 ohm Resistor	0805 SMT
51	1	R65	470 ohm Resistor	0805 SMT
52	1	R4	560 ohm Resistor	0805 SMT
53	2	R24, R25	604 ohm Resistor	0805 SMT
54	1	R33	680 ohm Resistor	0805 SMT
55	21	R1, R2, R3, R10, R11, R23, R28, R40, R56, R64, R69, R70, R77, R78, R79, R80, R81, R82, R83, R84, R85	1K Resistor	0805 SMT
56	1	R52	1.5K Resistor	0805 SMT
57	2	R60, R61	2.2K Resistor	0805 SMT
58	1	R62	2.7K Resistor	0805 SMT
59	2	R54, R68	5.6K Resistor	0805 SMT
60	1	R31	6.2K Resistor	0805 SMT
61	1	R63	8.2K Resistor	0805 SMT
62	3	R32, R53, R67	10K Resistor	0805 SMT
63	2	R47, R48	20K Resistor	0805 SMT
64	1	R55	22K Resistor	0805 SMT
65	1	R58	47K Resistor	0805 SMT
66	2	R27, R26	75K Resistor	0805 SMT
67	1	R57	100K Resistor	0805 SMT
68	1	R66	200K Resistor	0805 SMT
69	2	R51, R38	680K Resistor	0805 SMT
70	2	R45, R46	1M Resistor	0805 SMT
IC's				

Item	Quantity	Reference	Part	Package/Manufacturer
71	1	U1	ZR36120 PCI Multimedia Adapter	160-pin PQFP Mfr: Zoran Corporation
72	1	U2	ZR36100/110 MPEG system & video decoder	128-pin PQFP Mfr: Zoran Corporation
73	1	U3	256Kx16-bit DRAM 70ns	40-pin SOJ Part: NEC 42S4260-70 or equivalent
74	1	U4 (optional, socketed)	256Kx16-bit DRAM 70ns	40-pin SOJ Part: NEC 42S4260-70 or equivalent
75	1	U5	CS4920A MPEG audio decoder	44-pin PLCC Mfr: Crystal Semiconductor
76	1	U6	TEA5582 TV Audio Mux	20-pin DIP Mfr: Philips Semiconductor
77	1	U7	SAA7111 Video decoder	68-pin PLCC Mfr: Philips Semiconductor
78	1	U8	SAA7185 Video encoder	68-pin PLCC Mfr: Philips Semiconductor
79	1	U11	27MHz TTL Oscillator	Half or Full size Suggested Mfr: Abracon
80	1	U12	74F74 Dual D-Flip Flop	SOIC, 0.15" body, 14-pin
81	1	U13	74F157 Quad 2-to-1 Mux	SOIC, 0.15" body, 16-pin
82	1	U14	SMT78M05 Voltage regulator	Package: DPAK369A Suggested Mfr: Motorola
83	1	U15	LM555 Timer	SOIC, 0.15" body, 8-pin
84	1	U16	FI1236/1216/1246/ 1256 TV Tuner	Mfr: Philips Semiconductor
85	1	U17	SMT78L05 Voltage regulator	SOIC, 0.15" body, 8-pin
86	1	Y1	24.576MHz crystal	Package: HC-49/U Suggested Mfr: Abracon
87	1		PCB bracket	specs available from Zoran
88	1		TV tuner cable	
89	1	socket - U4	40-pin SOJ socket	

APPENDIX B - Schematics