65550

TV Video with the 550
HiQVideo™ Series

Application Note

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P R E L I M I N A R Y

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Revision History

Revision	Date	By	Comment
0.1	6/26/95	EC/lc	First Draft- Internal Review
0.2	7/31/95	LC	Initial Release
0.3	1/4/96	SP/lc	Removed confidential markings. Updated FAX number and Trademark Acknowledgment page.

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TV Video with the 550 Hi QVideo™ Series

Introduction

The 550 HiQVideo™ Series brings to notebooks a new and low cost means of adding television as a feature to notebook computers. Previously, retiming incoming TV video data required external control logic (PC Video by CHIPS) to the graphics/video controller and expensive VRAMs (See Figure 1). With the 550 HiQVideo ™ Series, retiming the incoming TV video data only requires a low cost NTSC/PAL decoder and standard DRAMs. (See Figure 2).

The 550 HiQVideo™ Series provides notebook designers the flexibility of two methods for adding television to a notebook computer.

(1) The NTSC/PAL decoder can be placed directly on the motherboard with an external connection, such as an RCA jack, to a TV tuner.

(2) The video capture port of the 550 HiQVideo ™ Series allows the designer to implement the Zoom Video (ZV) specification where the NTSC/PAL decoder and TV tuner can reside inside a PCMCIA card.

The application note discusses the trade-offs between these two methods.

A third configuration is also possible. Philips has developed a chipset that includes a decoder, scaler plus color converter, and a PCI bus master chip (8758, 7196, and 7116, respectively). This method works well using Chips and Technologies' 65548 and 550 HiQVideo ™ Series because of their leading edge burst mode capabilities. The PCI bus interface of the 65548 and 550 HiQVideo ™ Series can handle the high video data rate (~25MB/sec for 30fps at 640x480, 16.8M colors) over the PCI bus. This application note briefly discusses this configuration.

Previous Configuration

Historically, TV video data required external control logic (PC Video by CHIPS) and expensive VRAMs. Figure 1 shows this configuration. These systems use CHIPS developed drivers and an application program to support functionality in the PC Video CHIPSet, i.e., window size, frame freezing and color keying. These features established the foundation in the PC industry for video overlay.

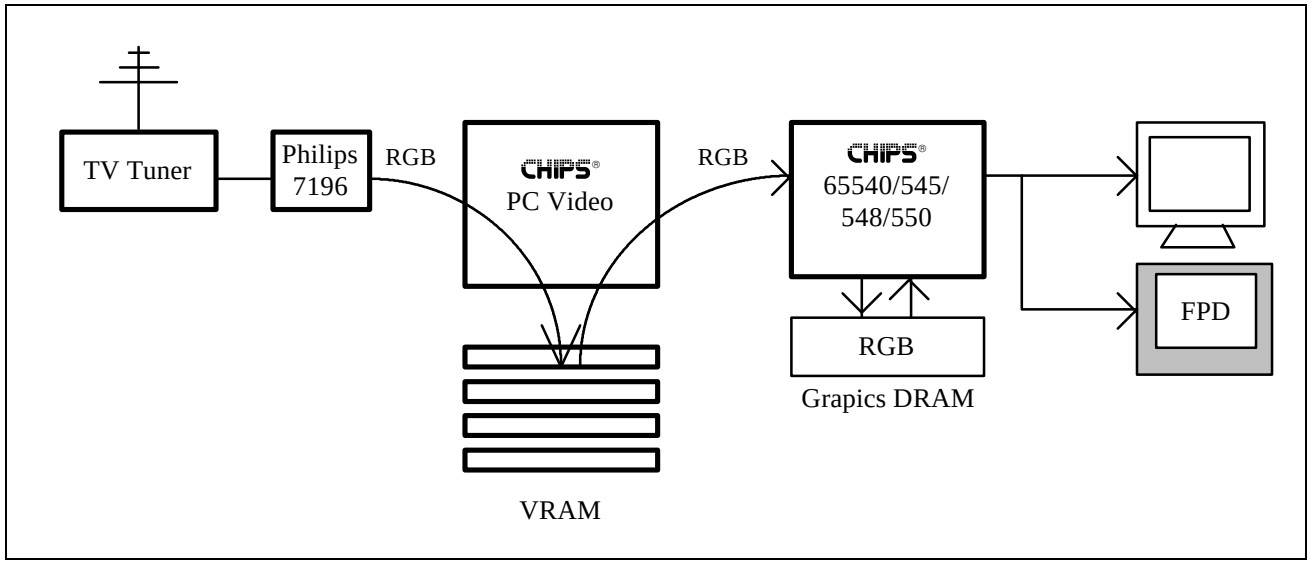

Figure 1: Historical PC Video

550 HiQVideo™ Current Configuration

The new 550 HiQVideo™ Series integrated configuration requires only a low cost NTSC/PAL decoder and standard DRAMs, without additional memory. CHIPS software strategy uses code from the PC Video software to develop drivers and an application program to support the above live TV overlay functionality. The 6555x Development Kit demonstrates the configuration in Figure 2.

For TV viewing on a notebook computer, the 65550 has the advantage of not requiring the PC Video CHIPSet, the 7196 NTSC to RGB decoder or expensive VRAM as shown in Figure 1. Instead, the 65550 only requires a low cost 7110 for NTSC to YUV decoding and a simple TV tuner for real-time television viewing.

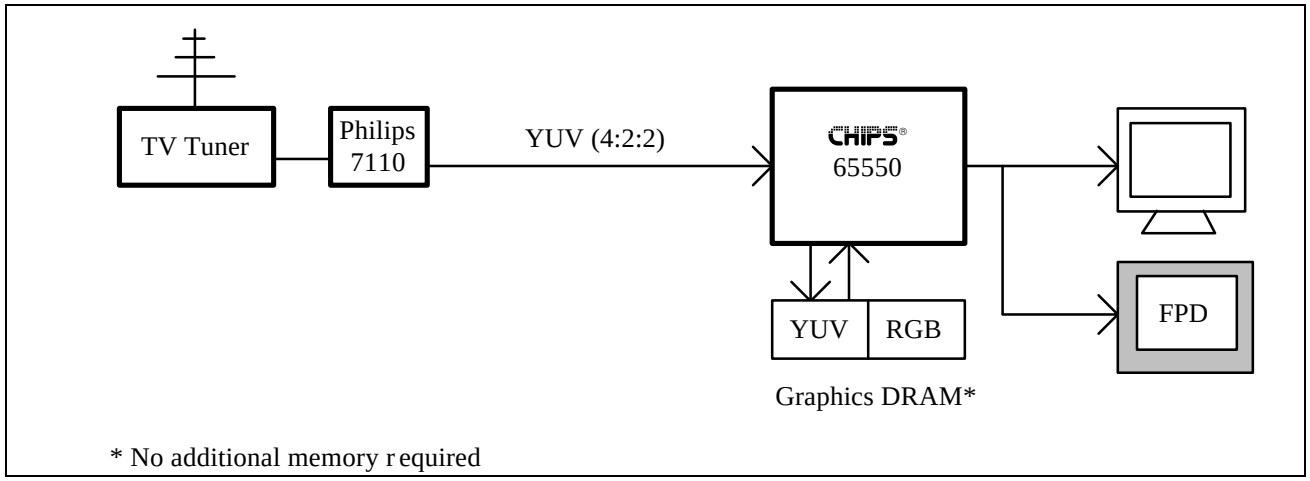

Figure 2: Configuration with the 550 HiQVideo ™ Series

Panel Recommendation and Issues

Active Matrix Liquid Crystal Display (AMLCD) and Passive Matrix LCD (PMLCD) panels both work well for graphics applications. But for TV video applications, the panel's response time directly affects the quality of the video. AMLCD panels have a very fast response time for each pixel which allows fast video motion. Sudden movements on the display panel appear equivalent to what you would expect on a television screen. For the PMLCD panels with slower response times, the fast video motion and "jerkiness" causes a "ghosting" effect. However, if the end consumer is only interested in low motion video clips, such as news clips, the video appears near normality. Therefore, the video quality is dependent on the panel technology and the application/expectation of the end consumer.

Key Advantages of the 65550

The simplicity of the 65550 interface illustrated in Figure 2 is possible because of the following 65550 video capture and playback features:

- The Video Capture Buffer stores incoming video information in the off-screen display memory. Sharing the main display memory in this manner is also known as a "shared frame buffer."
- The Video Capture Buffer can use **double buffering** to assemble complete video frames before the video overlay mechanism attempts to display the video information on the screen. This prevents frame tearing and glitching when parts of different incoming frames appear in the same output frame.
- Incoming TV video information is synchronized to its own timing, completely independent from the graphics engine that is controlling the display screen. Unlike the 65548 and earlier graphics controllers, the 65550 can accept decoded NTSC or PAL video input directly in YUV (or RGB) format. There is no need for external buffering, retiming, or color conversion.
- The 65550 combines "color keying" and windowing to specify where on the screen the video overlay information should appear. After designating one or more colors as the "key," software creates a window containing the "key" color using the normal Windows mechanisms. As information is read out of display memory for display on the screen, detection of the "color key" causes the 65550 to substitute video overlay information for the "color key."
- The 65550 uses a 6-bit fractional zoom to scale video information **up or down** to occupy window sizes larger or smaller than the original video capture resolution. When enlarging the video overlay image, the 65550 uses a programmable option called vertical interpolation and horizontal filtering to improve the quality of the zoomed image.
- Video capture information typically consists of 16 bits per pixel, encoded in YUV 4:2:2 format, with 320x240 total resolution (NTSC). The effective pixel rate is approximately 6.2 Mpps. The 65550 can also accept 640x480 resolution for video capture, but the 65550 compresses this to 320x240 before storing the information into the video capture buffer. Video information is stored exactly as received, e.g., YUV 4:2:2. **Conversion to RGB** occurs when the video information is subsequently read out of the capture buffer for display on the screen.
- A total of 320 x 240 x 2 ÷ 1024 = 150KB of off-screen display memory is needed for each video capture buffer. Double buffering requires a total of 300KB
- Because the Video Capture Buffer resides in an off screen area of the main display memory and is part of the same address space as the on-screen areas, system software can read or write to the Video Capture Buffer directly. Incoming video frames can be **copied to disk** across the system bus and saved for later playback. For playback, the same information can be copied back into the Video Capture Buffer from disk or CD-ROM across a high-speed PCI bus. This data is usually in a YUV format. The software uses the 65550 status bits to indicate when the Video Capture Buffer has received a complete input frame or is currently being displayed by the playback mechanism.
- For higher speed playback from disk or CD-ROM, the 65550 may use external logic and/or software algorithms such as MPEG to compress previously captured video information. On playback, the external hardware or software will decompress the compressed video information before sending the data across the PCI bus to the 65550 Video Capture Buffer. Compression reduces the disk or CD-ROM storage space needed for the video information and may also allow playbacks to sustain a higher video frame rate, particularly if the decompression is performed "on-the-fly" in external hardware.
- PCMCIA: The "ZV Port" concept discussed below can be used for hardware video decompression as well, with the decompressed video sent to the 65550 Video input port instead of being written into the Video Capture Buffer across a PCI bus. This approach greatly reduces the PCI bus bandwidth used for video playback.

Three Main 65550 System Configurations:

System Configuration 1:

Using PHILIPS 7110 and CHIPS 65550 on the motherboard with TV tuner external to the motherboard (See Figure 3):

The motherboard can accept TV video signals from an external tuner through an RCA jack or an S-jack mounted on the edge of the board. This method requires special care of the motherboard layout since the analog TV signals are very sensitive to noise from high-speed digital circuitry (see Noise Considerations section). A complete example schematic for the video and audio aspects of this approach is attached. (See Figure 4) The example design includes the following major components, all made by Philips:

- Tuner module (miniature television receiver without TV screen).
- Video decoder chip (converts tuner output into YUV for the 65550).

Both elements contain programmable registers to control their operation. These registers are accessed (read and write) using a serial I2C bus (Philips design). The I2C bus is driven by GPIO pins on the 65550. The GPIO's are controlled by software according to the Philips I2C bit-serial start-stop protocol.

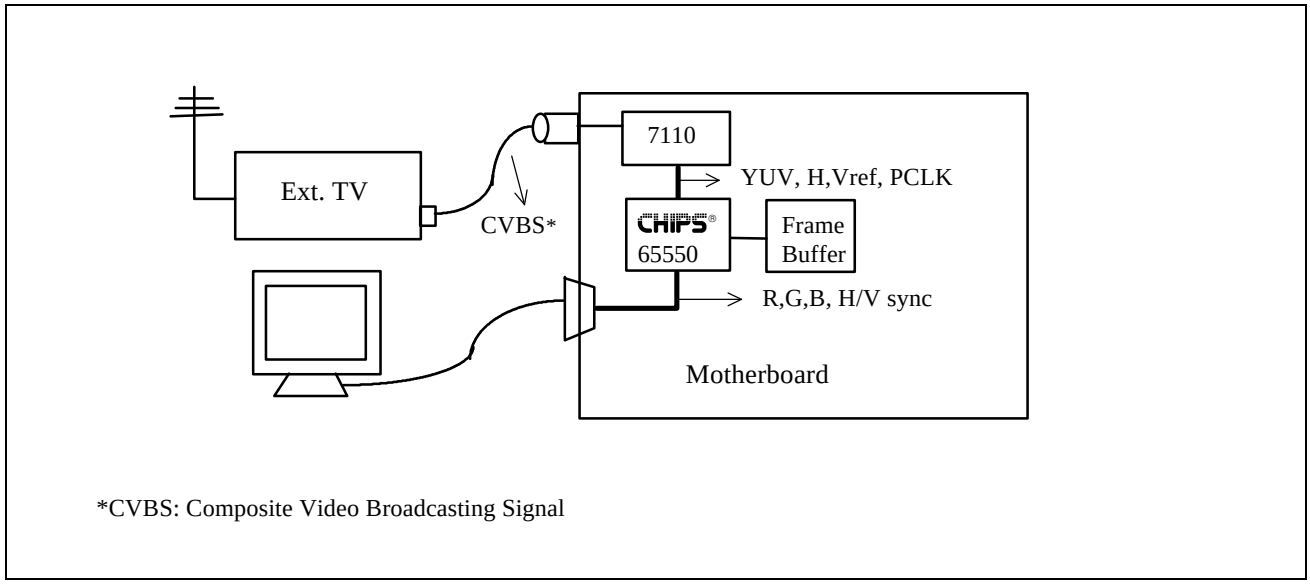

Figure 3: System Configuration 1

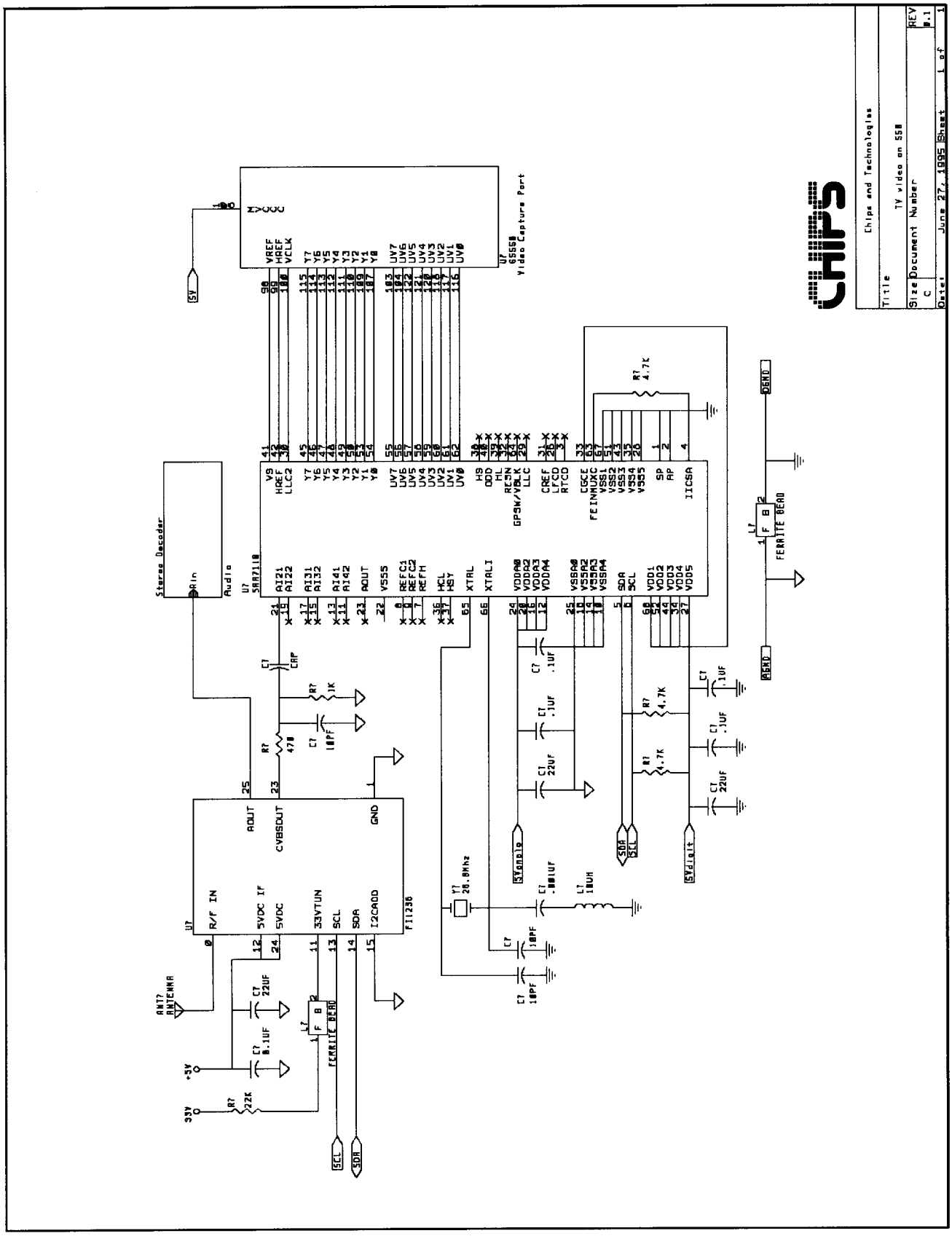

Figure 4: Schematic for System Configuration 1

System Configuration 2:

Using ZV port configuration: The PCMCIA card contains a TV tuner and the Philips 7110 decoder chip. The 7110 converts the NTSC/PAL signal to a 16-bit 4:2:2 YUV data.

Two options exist for the PCMCIA controller to be "ZV Compatible":

Option 1) The TV video data goes through the ZV port of the PCMCIA controller (integrated buffer) and then to CHIPS's 65550 video capture input port. The PCMCIA controller must be 100% ZV compatible with a buffer built in for 3V/5V design considerations.

Option 2) Use external 3V/5V buffers between the PCMCIA connector and the 65550, with buffer enable and direction controlled by the PCMCIA controller. This approach is illustrated in the attached example schematic. The video capture port of the 65550 cannot be directly interfaced to the outside environment of the notebook computer.

(For additional information, refer to the 65550 Video Capture Port application note)

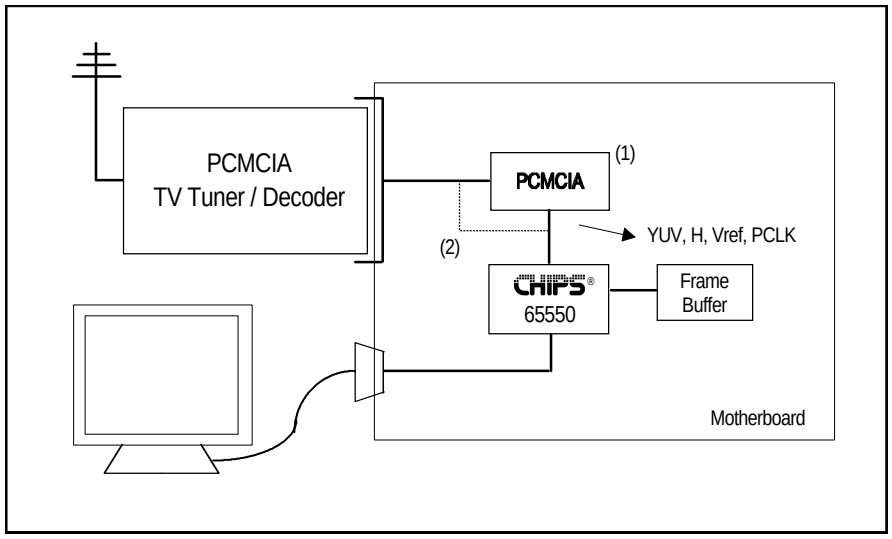

Figure 5: System Configuration 2

Software support for TV channel selection, volume control and other TV features must be developed by the PCMCIA TV tuner developer. Software developers can take advantage of CHIPS VPM (Video Port Manager) interface for direct access to off screen memory and registers for specific features, such as frame capture or clipping.

Note: If using an 18-bit or 24-bit TFT panel in this application, the panel voltage must be equal to the video capture port voltage because they both are controlled by voltage pin MVCC.

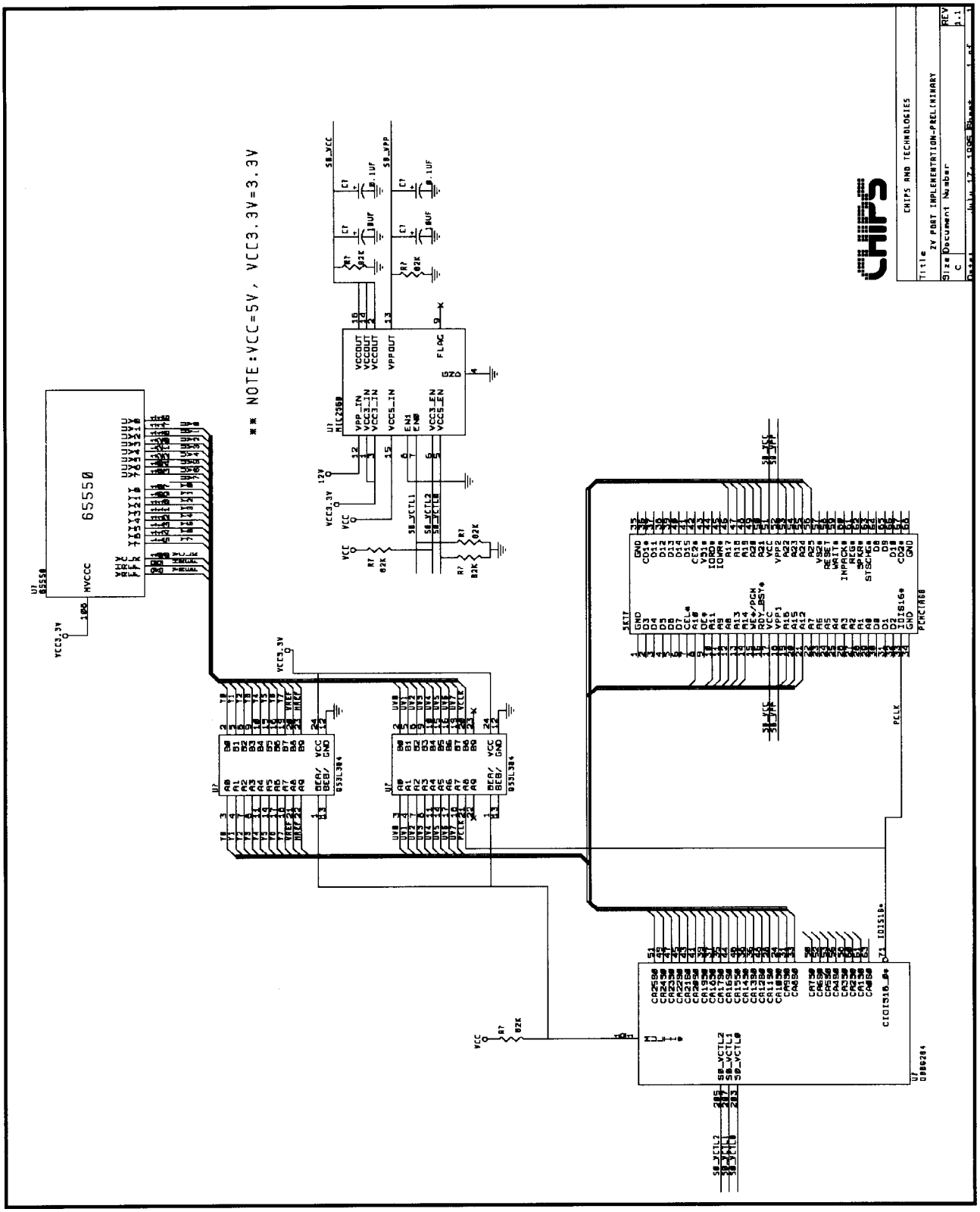

Figure 6: Schematic for System Configuration 2

System Configuration 3:

The third option for TV playback on a notebook computer uses the Philips chips 8758, 7196, and 7116. For a 640x480x24bppx30fps display, the bandwidth requirement is approximately 25 megabytes per second. A 320x240x8bppx30fps picture requires around 4.6 megabyte per second. These numbers are way under the 65550's PCI burst capability, allowing TV data to be displayed on the flat panel display.

This option has similarities to the cardbus definition. The cardbus definition is simply an extension of the PCI Bus. This will allow for Philips "like" TV chipsets to have direct access to the 65550's double frame buffer over the PCI bus for retiming video information. The Figure 7 shows this configuration:

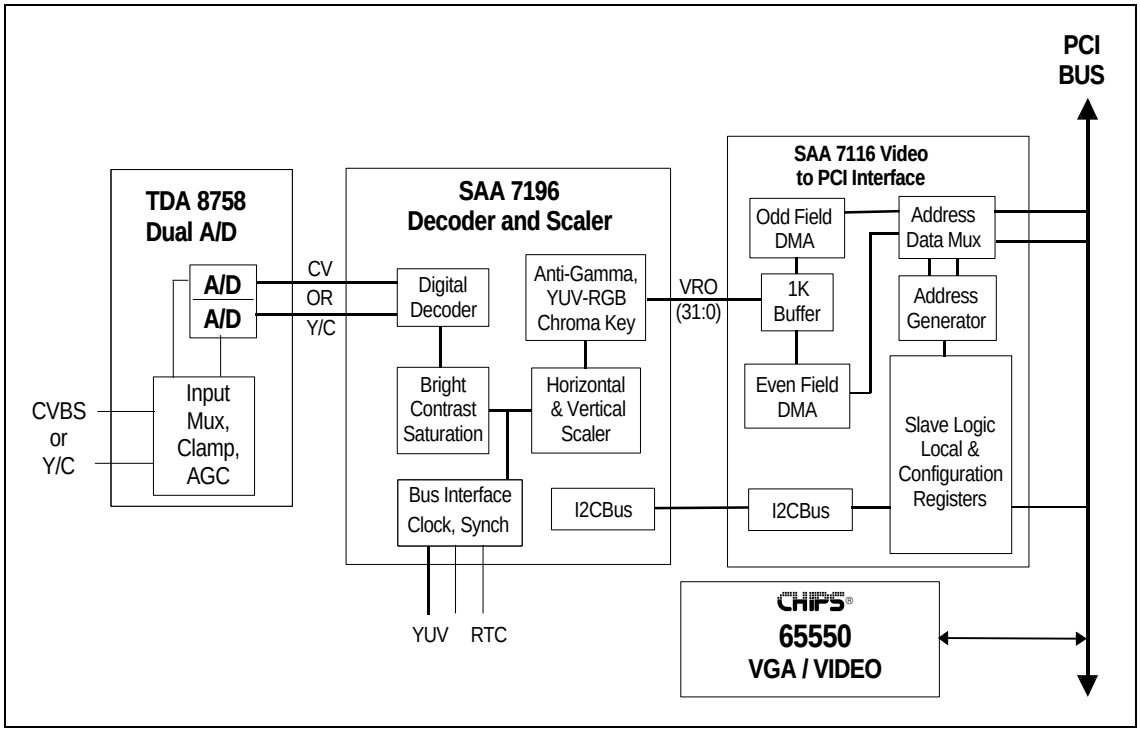

Figure 7: The Third Option

Noise Considerations

In Figure 7 above, the 7110 and 65550 are on the same motherboard. This brings in a noise issue that may affect the analog portion of 7110. The board designer must take some precautions. Placing the 7110 close to the video jack, or preferably close to the corner of the motherboard reduces risk of noise. In addition, some ground plane cuts are needed to isolate the analog area from digital noise. (See figure 8.)

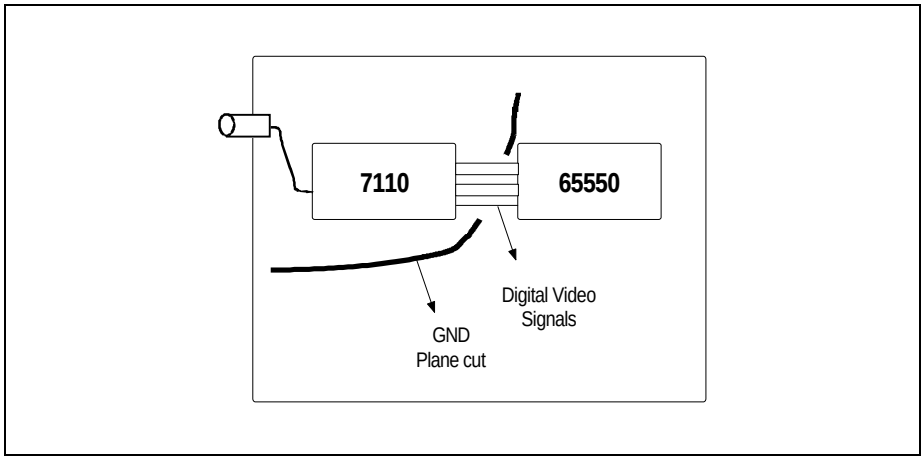

Figure 8: Ground Plane Layout

- Note: If the noise problem is serious, a separate analog power plane may be required.
- The above is only a reference example. The final ground and power plane layout may vary depending on the parts that are used and how they are placed on the motherboard.

Pin Connections Between 7110 and 65550

7110		65550		7110		65550	
Pin name	Pin #	Pin name	Pin #	Pin name	Pin #	Pin name	Pin #
Y0	54	Y0	107	UV2	60	UV2	118
Y1	53	Y1	109	UV3	59	UV3	120
Y2	50	Y2	110	UV4	58	UV4	121
Y3	49	Y3	111	UV5	57	UV5	122
Y4	48	Y4	112	UV6	56	UV6	104
Y5	47	Y5	113	UV7	55	UV7	103
Y6	46	Y6	114	HREF	42	HREF	99
Y7	45	Y7	115	VS	41	VREF	98
UV0	62	UV0	116	LLC2	30	PCLK	100
UV1	61	UV1	117				

Conclusion

Configuration #1 (7110 on the motherboard) has the advantage of allowing the end customer to hook up a TV tuner, camcorder or any other NTSC/PAL source to the notebook at a very low cost by using a simple external connector, i.e., RCA jack. However, the consumer still needs to control the TV channel selection and volume mechanically or electronically on the external TV tuner and not by software from the keyboard. Also, the notebook design engineer must consider noise from the analog portion (NTSC/PAL decoder) of the design.

Configuration #2 (using PCMCIA ZV option) has the advantage of providing the end customer upgrade capabilities with the well known PCMCIA form factor, and off-loads the video data from the PCI bus. As better TV tuners become available, the notebook owner has the capability to upgrade. Most consumers will be amazed at having a TV in a PCMCIA card form factor. The PCMCIA ZV port also allows for other features, such as video capture and H/W MPEG decoder cards. Controlling the TV volume and channel selection by software from the keyboard, will also allow other hardware control configurations for the notebook manufacturer.

Configuration #3, if implemented as a module that can access the PCI bus, has similar advantages for end consumers as the ZV specification listed above. However, sending video data over the PCI bus consumes valuable bandwidth that may be needed for future video-graphics games or other bus intensive applications.

With the 550 HiQVideo™ Series by Chips and Technologies, game developers will be able to send graphics information over the PCI bus to overlay on a MPEG video background. This is accomplished by using the color key feature found in the 550 HiQVideo™ Series. The color key allows graphics and video data to be multiplexed on a pixel-by-pixel basis.

The three configurations in this application note are possible because of the extensive features and flexibility available in the 550 HiQVideo™ Series.

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