# Making TV Out Ubiquitous on the PC

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**Abstract**

PC TV out is a relatively new multimedia feature, which gives PC users the ability to display PC content on their home television sets rather than a monitor. Now consumers can play video games, watch DVDs or use a variety of home/office applications with their televisions being the display device.

The PC OEM and graphics card market is experiencing rapid growth for the TV out function. All major card manufacturers, and many PC OEMs, are just beginning to ship products that include this feature.

Not just any TV out will do for these card makers and OEMs. Analog technologies and lesser digital techniques do not provide the TV out quality required. End-user's experience flicker and/or unclear image quality if lesser technologies are used. Extended viewing of a flickering image can cause headaches or other discomfort if the TV out device does not employ techniques such as "flicker-filtering."

**This paper will provide a:**

- Synopsis of the market opportunity
- Description of some of the most important features required for quality TV out on the PC
- Summary of the recommended application user interface required for today's VGAs and motherboard designs.

## Market Opportunity

The PC market experienced explosive growth for the TV out function for the first time in the second half of 1999. In the year 2000, growth is expected to be approximately 150% above that of 1999. Today, major graphics card manufacturers have added TV out in record numbers. Creative Labs, 3DFX, ATI, Diamond and many others have added the feature to one or more SKUs. Some board makers have already shipped over 1 million cards with TV out and others have even gone as far as to make it a standard feature for every product they ship. ATI has integrated TV out function into their graphics chips and other manufacturers are considering integration.

PC OEMs are just introducing the first graphics cards with TV out. In late 1999, Gateway was one of the first manufacturers to begin shipping, with several others about to be announced at the time of the drafting of this paper. The figure below shows projected market results through the year 2001 for TV out unit shipments either through retail or directly from PC OEMs.

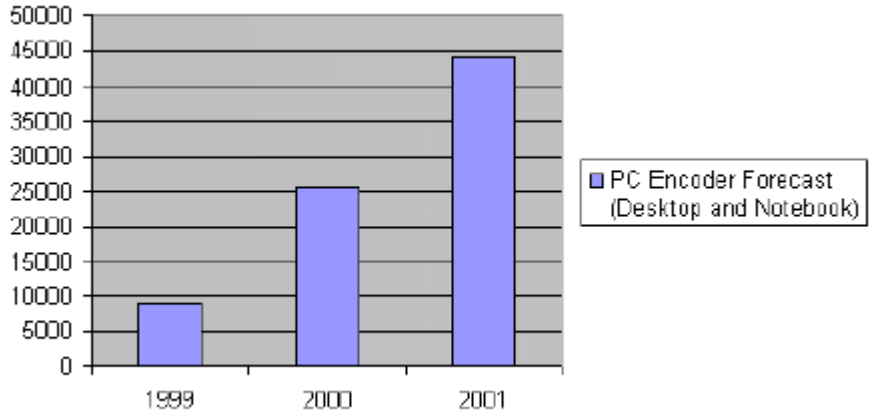


*Figure 1 - PC TV Out Forecast (Desktop and Notebook) in K units*

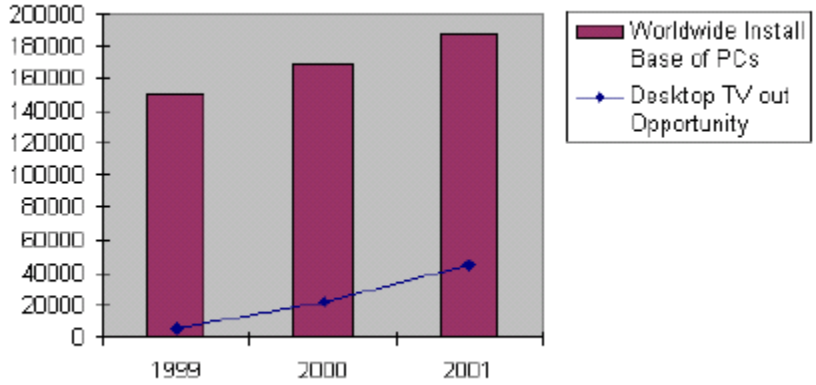


Figure 2 - PC TV Out Market Opportunity vs. the Install Base of Consumer PCs

Figure 1 shows the worldwide forecast for PC TV out in the desktop and notebook space. Figure 2 shows a comparison between the PC TV encoder projected shipments and the install base of consumer PCs. By the end of the year 2001, nearly 50% of consumer PCs will support TV out. The install base of PCs forecast is based on recent reports provided by Dataquest and In-Stat.

**TV Out Architecture**

The block diagram below (figure 3) shows an optimized architecture for a powerful PC TV encoder that would offer the latest in features and functions such as overscan compensation, adaptive flicker-filtering and international standards support.

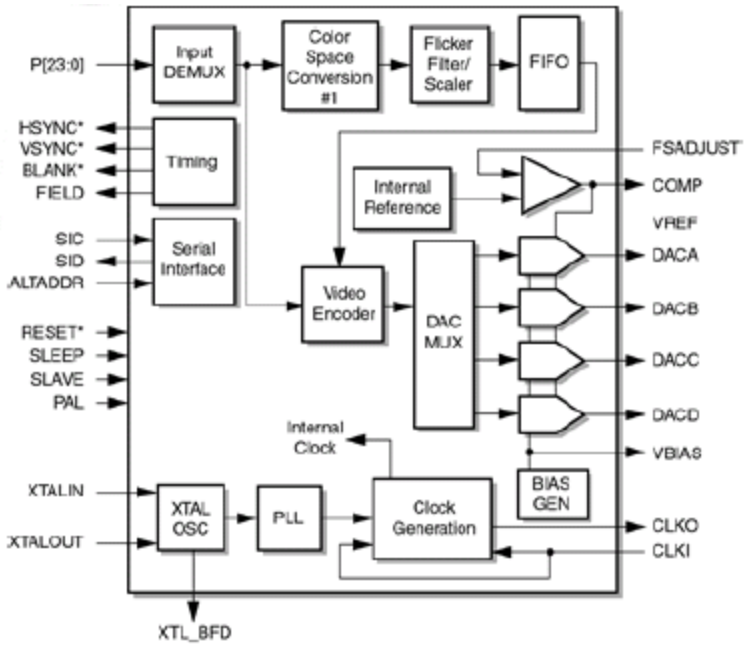


*Figure 3 - Functional Block Diagram*

**Overscan Compensation and Flicker-Filtering**

A digital flicker filter video encoder allows PC users to enjoy the "big screen experience" with their PCs. Digital flicker-filtering is a highly sophisticated feature that converts the high resolution progressive scan 2D/3D VGA image generated by a PCs graphics subsystem into a format that can be displayed as an interlaced TV signal. This conversion process is called "flicker-filtering" because if you were to directly display a VGA image on a TV set, the image would "flicker" due to the reduced resolution of the TV set compared to a VGA monitor. Most flicker filter encoders do not incorporate digital techniques and rely on analog technology to do this conversion. This results in a fuzzy, poor quality video image that will give end-users headaches after only a few minutes of use. Digital techniques, along with 10-bit video resolution, provide razor sharp video quality required for a pleasant viewing experience.

The process of overscan compensation and digital flicker-filtering converts the lines of input pixel data to the appropriate number of output lines for producing a full-screen image on the television receiver. The image can be scaled to 100% within the viewable area of the screen. Vertical flicker-filtering can also be applied to reduce the effects of picture flicker due to the interlacing of the output image.

The amount of flicker-filtering should be programmable because it allows adjustment of the vertical resolution to reduce the flicker to optimize the image to the given environment. Horizontal scaling should also be available to insure the viewed image is not too wide or too narrow. Additionally, overscan compensation and flicker-filtering should be available for a variety of resolutions from 320 x 200 to 1024 x 768. The ability to disable flicker-filtering completely for unique applications is also important.

## Adaptive Flicker-Filtering

Adaptive flicker-filtering is a new term. Encoders supporting adaptive flicker-filtering analyze the image content to detect areas that require stronger flicker-filtering, and adjust the vertical filtering to apply stronger flicker-filtering to those regions. This analysis and adjustment occurs on a pixel by pixel basis, so each pixel in the output line will have the optimal amount of flicker-filtering applied to it.

## Vertical flicker-filtering serves three purposes:

- Vertical polyphase interpolation filtering to up-sample the image data vertically. This increases the resolution and accuracy of the subsequent vertical down-sampled data required to fit the entire image into the visible region of the television.
- Anti-alias filtering to reduce aliasing artifacts when down-sampling vertically
- Flicker-filtering to reduce the flicker produced when vertical high frequency content is displayed on an interlaced device.

The vertical interpolation filtering and vertical anti-alias filtering requirements are driven by the amount of vertical down scaling required, and do not vary substantially with image content The flicker-filtering requirement, however, is dependent upon the image content. Regions of the image with vertical high frequency content will flicker in proportion to the amplitude of that high frequency content. Regions with high amplitude and vertical high frequency content will require substantial flicker-filtering, but regions with low amplitude or no vertical high frequency content will require little or no flicker-filtering.

## International Support

Many international standards exist when it comes to television. Starting with the very basics, there is NTSC (National Television Standards Committee), PAL (Phase Alternate Line) and SECAM (Systeme Electronique Couleur Avec Memoire). In a general sense, NTSC is the standard used in the United States,
Taiwan and Japan. Most of Europe, South America and much of Asia have adopted PAL. SECAM is a standard adopted primarily by France. In order to truly design a single graphics adapter with TV out for worldwide use, the device must support all standards. This means the software and hardware must support: NTSC-M, NTSC-J, PAL-B, D, G, H, I, M, N, Nc and 6 as well as SECAM.

Not only are there many standards, the differences between NTSC, PAL and SECAM are significant. When the broadcast TV industry began, the powers-that-be in the United States selected 525 lines-per-frame at 60 Hz as the standard. This became known as NTSC-M. Europe decided on 625 lines per frame at 50 Hz. This is now known as PAL. From these basics the other PAL derivatives evolved, as did SECAM.

A truly worldwide TV out device needs to be able to take video information in resolutions from 320 x 200 to 1024 x 768 and place it perfectly on the TV screen of the given country. This is amazing when considering all the options available in terms of resolutions and standards. Primarily in Europe, there are additional standards besides the different television formats to consider. Many televisions in Europe support wide screen display WSS (Wide Screen Systems) or 16 x 9 mode. The TV out device must be able to display content from the PC

system on these wide screen sets properly. TV out devices that support WSS meets the requirements of EIAJ CPR-1204 and ITU-R BT.1119.

### Auto Configuration Modes

With all the standards and resolution options, clearly an easy way to program the TV out device is necessary to be up and running quickly. Die space always being a premium, an infinite number of configuration modes is not feasible. Based on the number of standards and most common resolutions used by consumers today, it seems something on the order of 36 or 48 modes should cover 95% of the bases. Lesser-used modes can be programmed through traditional register by register means.

### 1024 x 768 Resolution

For TV out on the PC, the bar is set at a resolution of 1024 x 768. This is the base requirement for notebooks and clearly the resolution most consumers run their systems on today.

### Video DACs

Today the minimal DAC (digital to analog converter) resolution for good quality TV out is 10-bits. TV out devices supporting international standards, specifically SCART mode will offer 4 of these 10-bit DACs.

### Digital Television

Digital television (DTV) has several different definitions. To the broadcast industry, digital television means high-definition (HDTV). To the cable industry, the current definition is digital compression and transport of a signal to increase channel capacity. To the satellite industry, digital television means digital broadcast satellite (DBS) or digital video broadcasting (DVB), depending on the worldwide location of the transmission and respective standard adopted. To the consumer, digital television provides a better way of watching TV with sharper pictures, clearer sound and a wider viewing area.

New, low-cost PC analog and digital television receiver cards are now coming to market and will make the benefits of DTV accessible to a broad base of consumers at a much lower price point than early generation digital television sets. It is realistic that consumers who will soon be viewing digital television on their PC monitor will at some point want to be able to send that content over to their television sets for display.

Many HDTVs in the United States are being equipped with a HD input port that accepts analog RGB or analog YPBPR signals or both. This being the case the TV out device needs to support a HDTV output mode for consumers to connect their PC to their new television. Specifically, the TV out device needs to generate the analog RGB or analog YPBPR component video necessary for driving the input port of a High Definition Television.

## End-User Interface

The end-user interface is where it all comes together for a graphics card supporting TV out. A good user interface provides the ability to adjust the TV out image to best suit the given environment. At the same time, too many options confuse end-users, so it must be simple to understand. The following diagrams detail one of many good implementations available today in retail in the United States. The product happens to be an S3 Diamond card, but there are many others with great user interfaces.

In this first screen (Figure 4) the user is able to select whether to display the content on the TV, the monitor or both. The user can also set-up the display as appropriate for his or her region by clicking on the TV type.

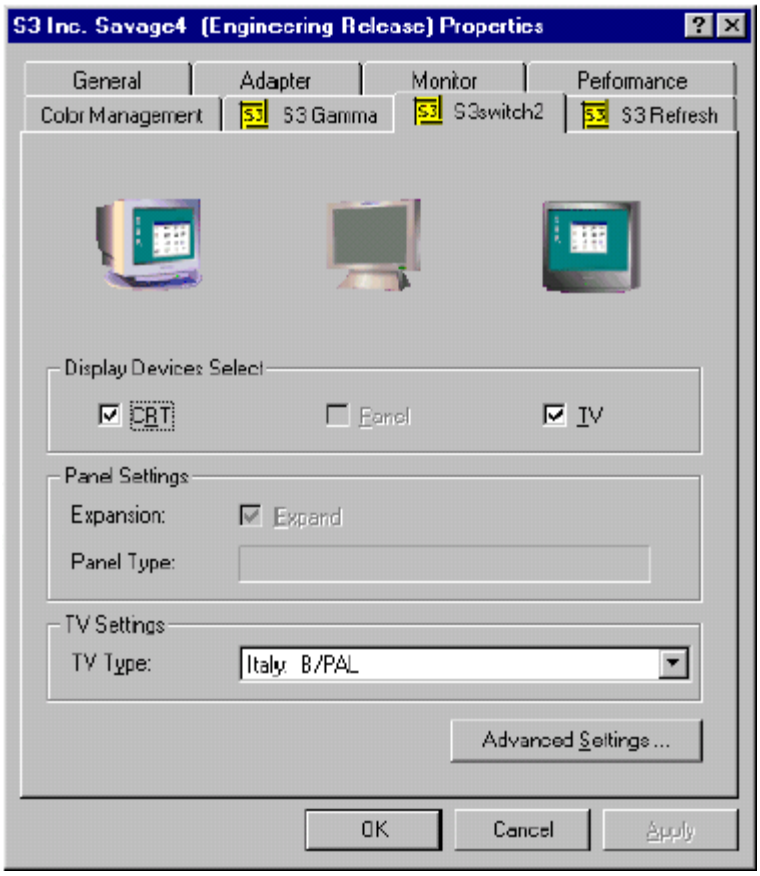


*Figure 4 - TV Out User Interface*

The second screen (Figure 5) provides the user the ability to use or not use flicker-filtering, select the amount of flicker-filtering and adjust the color and brightness. Again, just enough control without confusion for end-users.

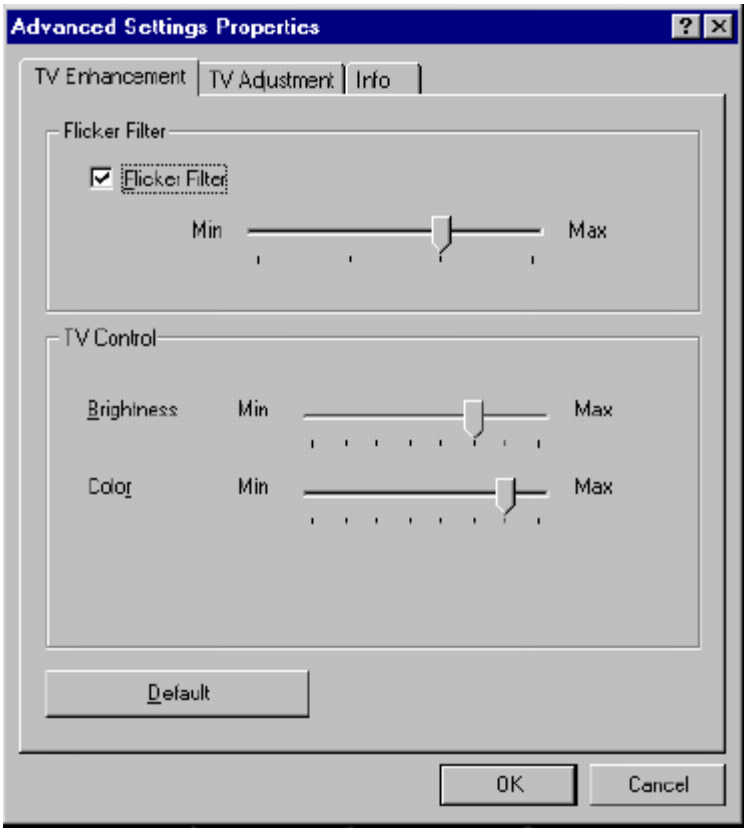


Figure 5 - TV Out User Interface

The last screen (Figure 6) provides horizontal and vertical centering to insure the title bar, for example, fits on the television set perfectly. This particular implementation shows the image in a window moving up/down/right or left as the user actually adjusts the image.

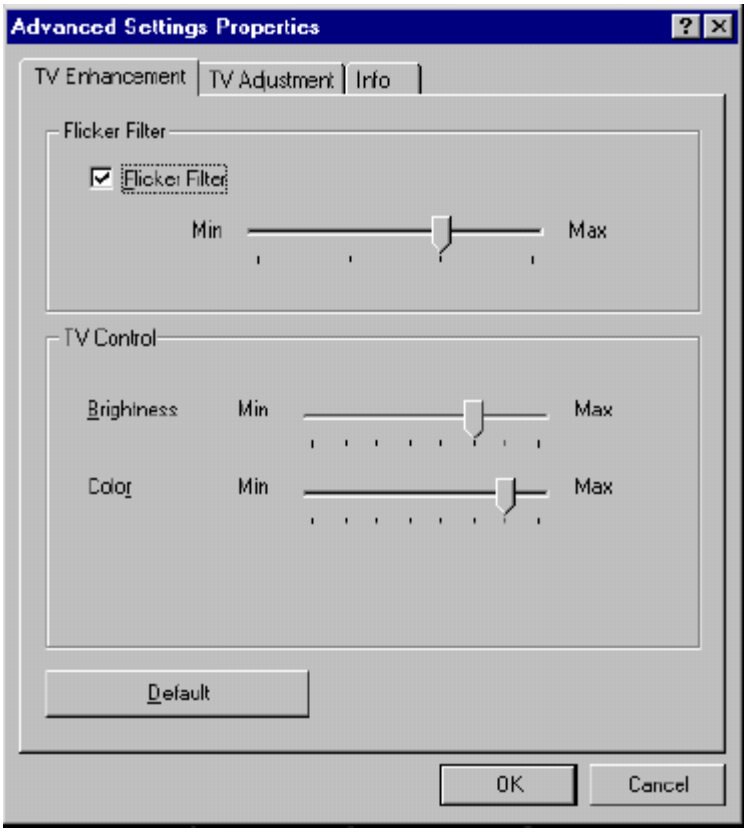


*Figure 6 - TV Out User Interface*

**Summary**

The TV out function has really taken off in the PC industry, particularly in retail.
The success of the first OEMs will determine how and/or when this feature will become ubiquitous in the PC space. The outlook is promising. As the attachment of TV out to shipping PCs hits a greater than 25 or 30% rate, it is expected that graphics chips manufacturers will respond be providing higher levels of integration that will likely include this feature.