



EMULATION OF COMPUTER MONITOR IN A WIDE SCREEN TELEVISION

Background of the Invention

Current wide screen televisions, for example as described in PCT/US91/03740 do not have the capability of displaying analog
5 computer RGB signals. There have been many requests for a simple modification to current televisions that would enable them to display analog computer RGB inputs with separate horizontal and vertical synchronization signals.

Current televisions as described accept analog RGB inputs via
10 the $2f_H$ I/O Module (Schematic Number 8T46007) inside the television. The $2f_H$ I/O provides a method of interfacing external $2f_H$ inputs (either RGB or YPrPb) into the internal signal path after the progressive scan IC. The synchronization signals come from either the composite sync input (for RGB inputs) or from the composite sync
15 on luma (for the YPrPb inputs). See figure 3 to see how the $2f_H$ I/O relates to the rest of the television system.

VGA computer monitors operate at a horizontal frequency of 31.47 KHz, that is, at $2f_H$. Current wide screen television receivers already have the capability of receiving and displaying analog RGB
20 inputs at a horizontal frequency of 31.47 KHz. The problem is that the $2f_H$ I/O is expecting composite sync for the RGB inputs rather than the separate horizontal and vertical synchronizing signals from the VGA computer inputs.

Summary of the Invention

25 This application teaches the procedures and circuitry necessary to display VGA and SVGA computer inputs, both graphic and text, on a wide screen television while still maintaining all the capabilities of the wide screen television.

A method for displaying images created in a computer on a wide
30 screen television receiver, in accordance with inventive arrangements, comprises the steps of: programming a first video circuit in said computer to use less than a normal number of horizontal lines when formulating a picture for display, said less than normal number of horizontal lines resulting in a picture having a
35 wide format display ratio; generating in said programmed first video circuit a $2f_H$ RGB video signal indicative of said picture, including separate synchronizing signals; converting said synchronizing signals to a form recognizable by a second video circuit in said



television receiver, said second video circuit being adapted for receiving a $2f_H$ RGB video signal with separate synchronizing signals; and, coupling said $2f_H$ RGB video signal and said converted synchronizing signals to said second video circuit for displaying said wide format display ratio picture on said wide screen television receiver.

An apparatus for generating a wide screen picture in a computer for display on a wide screen television receiver, in accordance with inventive arrangements, comprises: a programmable video circuit in said computer, adapted to generate a $2f_H$ RGB video signal having separate synchronizing signals, said video circuit having at least one display mode in which a generated picture has a conventional format display ratio and a given number of horizontal lines; means for programming said video circuit in said computer to generate a picture corresponding to said at least one display mode, except for having fewer than said given number of horizontal lines, said fewer than normal number of horizontal lines resulting in a picture having a wide format display ratio; means for converting said synchronizing signals to a form recognizable by a video circuit in said television receiver, said video circuit in said television receiver being adapted for receiving a $2f_H$ RGB video signal with separate synchronizing signals; and, means for coupling said $2f_H$ RGB video signal and said converted synchronizing signals to said video circuit in said television receiver to display said wide format display ratio picture on said wide screen television receiver.

Brief Description of the Drawings

FIGURE 1 is a schematic diagram of a synchronizing signal converter/generator according to the invention.

FIGURE 2 is a schematic diagram of an equivalent circuit of a synchronizing signal converter/generator according to the invention.

FIGURE 3 is a partial system diagram of a wide screen television receiver which can be utilized with this invention.

Detailed Description of the Preferred Embodiments

The current "off-the-shelf" wide screen television, for example as described in PCT/US91/03740, expects a negative going, composite sync input time aligned with its associated analog RGB video input. An example of such a wide screen television receiver is the Thomson PROSCAN® wide screen television receiver, designated

as chassis CTC-172, which uses a Thomson W86 (34V) 16:9 standard commercial picture tube. The RGB video input can either be a progressive 525 line with a horizontal line frequency of 31.47 KHz and a vertical frame frequency of 59.94 with two fields per frame.

5 A VGA input can be interfaced to such a wide screen television because:

a) The horizontal line frequency of all VGA modes is 31.47 KHz. This is the same horizontal frequency as the current wide screen television. It might be difficult to change the horizontal frequency of
10 the television to accommodate other multisync computer input modes.

b) Although the vertical frequency varies for the different VGA modes, this can be accommodated by changing the analog zoom voltage on the vertical board inside the television. In the VGA Graphics mode, the vertical frequency of 59.94 Hz is the same as the
15 "Fill" mode for the television. Since the television automatically goes into the "Fill" mode (the only mode possible for RGB inputs with the current television software) when a RGB input is selected to be displayed, no change to the analog zoom voltage is necessary. In the VGA Text mode, the vertical frequency is 70.08 Hz. Therefore, for the
20 VGA Text mode to entirely fill the screen vertically, the analog zoom voltage on the vertical board needs to be increased.

The "automatic" sync inversion can be described as follows:

a) The integrated vertical sync is LOW when the vertical sync is positive going. Therefore, for the output to be negative going, the
25 vertical sync needs to be inverted.

b) The integrated vertical sync is high when the vertical sync is negative going. Therefore, since the vertical sync is already negative going, it does not need to be inverted.

This description can be translated into hardware logic with a 2-
30 Input Exclusive NOR gate U5A, as shown in FIGURE 1. One of the inputs would be the vertical sync, while the other input would be the integrated vertical sync. The output of this logical Exclusive NOR gate (U5A) will always be negative going vertical sync pulses.

When combined (i.e., logically with a 2-Input AND gate U6A)
35 with the negative going horizontal sync pulses, negative going composite sync pulses will be formed. Therefore, the composite sync pulses will always be negative going for both VGA Graphics and VGA

Test modes. For RGB inputs, the television is expecting this polarity (i.e., negative going) for the composite sync input.

The last issue regarding the negative going composite sync signal concerns the horizontal pulse width and phasing with respect to the RGB analog video input. The width of the horizontal sync is wider than the television is expecting. If this pulse width is not reduced, the television would mistaken these wide horizontal sync pulses as being vertical sync pulses, and the television would not synchronize itself. To prevent this from happening, the width of the negative going horizontal sync pulses needs to be reduced before going "combined" (i.e., logically ANDed) with the negative going vertical sync pulses. Also, since the phasing of the horizontal sync with respect to the analog RGB video input differs from what the television is expecting, the phasing of this pulse needs to be adjusted before being "combined" (i.e., logically ANDed) with the negative going vertical sync pulses.

The next problem is determining which VGA mode is present so the analog zoom voltage can be changed at the appropriate time. When the user goes from VGA Graphics to VGA Text or vice versa, the analog zoom voltage should "automatically" (i.e., without user input) change to keep the screen vertically filled during the VGA Text mode. There is a method of determining which VGA mode is present. In the VGA Graphics mode, the vertical sync is negative going. In the VGA Text mode, the vertical sync is positive going. Using the polarity of the vertical sync to indicate which VGA mode is present, the analog zoom voltage during the VGA Text mode can be increased to vertically fill the screen. Further explanation of this analog zoom voltage follows below.

The fact that the vertical sync changes polarity introduces another problem. As stated earlier the television is expecting negative going composite sync. It is not simple enough to combine together the separate vertical and horizontal synchronizing signals from the computer to form the required composite sync. This composite sync would have the wrong vertical sync polarity during the VGA Text mode. Before being combined together, the vertical sync needs to be inverted during the VGA Text mode but not inverted during the VGA Graphics mode. Again, for the user to "gracefully" go

from VGA Graphics to VGA Text and vice versa, this inversion should take place "automatically" such that no user input is required.

Since the separate VGA sync signals are TTL levels with either very high duty cycles (for negative going synchronizing signals) or
5 very low duty cycles (for positive going synchronizing signals), integrating these sync signals provide TTL level signals which correspond to the polarity of the synchronizing signals. Integrating the negative going synchronizing signals produces a logic high signal while integrating the positive going pulses produces a logic low
10 signal.

The values of R1 and C1 which form the integrator are chosen large enough to provide adequate integration so that the ripple voltage would not cause a change in logic state, but small enough to allow the circuit to quickly change state when the user goes from
15 VGA Graphics to VGA Text and vice versa.

Changing the phasing and width of the negative going horizontal sync pulses can be accomplished with the use of three non-retriggerable monostable multivibrators (U3A, U3B, and U4A) commonly referred to as one-shots. The width of the first one-shot
20 (U3A) is chosen to be less than one horizontal line wide (i.e., less than 31.78 μ sec). By choosing this width, this first one-shot is guaranteed to trigger every horizontal line. If the width of this one-shot is greater than one horizontal line, then this one-shot would only trigger every other horizontal line. If the width of this one-shot is
25 greater than two horizontal lines, then this one-shot would only trigger every third line. And so on... The width of the second one-shot (U3B) positions (i.e., adjusts the phase relative to the analog RGB video input) the horizontal sync pulse. The width of the horizontal sync pulse is controlled by the width of the third one-shot (U4A).

30 Voltage divider formed by R2 and R3 along with the Vbe threshold of NPN emitter follower (Q1) provide an approximate 300 mV p-p negative going composite sync signal when terminated on the 2f_H I/O by 75 ohms (R5843). The NPN emitter follower (Q1) also provides the necessary current to drive the 75 ohm termination
35 (R5843). The 75 ohm termination resistor (R5843) is accessible via the composite sync input (J5809 Female RCA Phono Jack) located on the back of the television.

As noted above, the appropriate analog zoom voltage must be generated to keep the screen completely vertically filled for both the VGA Graphics and VGA Text modes. The vertical field frequency of the VGA Graphics and the expected RGB input mode are the same (i.e.,
5 59.94 Hz), and thus, no changes to the analog zoom voltage are required. But in the VGA Text mode, the vertical field frequency is 70.08 Hz, and the analog zoom voltage is increased to vertically fill the entire screen.

During normal television operation, the analog zoom voltage is
10 generated by a Digital-to-Analog Converter (DAC) on the Wide Screen Processor (WSP) module. Only when VGA Text is present AND the user selects the VGA Text to be displayed on the screen should the analog zoom voltage be increased to vertically fill the VGA Text on the screen. Thus, this logic allows the television to operate normally
15 (i.e., analog zoom voltage not altered) when either a VGA Text input present but not selected or something other than a VGA Text is present at the RGB inputs to the wide screen television.

A logic hardware implementation uses the logic signal from the integrated vertical sync of the VGA Text Mode (i.e., low duty cycle,
20 positive going vertical sync) and the logic signal of the Select_Ext signal from the control system, a logic 2-Input NOR gate (U2D) to generate a logic high only when both of these inputs are low. The integrated vertical sync will be low only when the VGA Text mode is present, and the Select_Ext signal will be low only when the user
25 selects the High Resolution (i.e., RGB) input to be displayed on the screen. This logic high output from the NOR gate (U3D) is divided down by R4, R5 and POT1 and buffered by a NPN emitter follower (Q2) before being sent to the vertical board. When the output of the NOR gate (U2D) is low, the divided down voltage is not great enough to
30 overcome the V_{be} threshold of the NPN emitter follower (Q2). Thus, the NPN emitter follower (Q2) is cutoff, and has no effect on the analog zoom voltage. Since the analog zoom can possibly go to 10 V dc, a Schottky diode (CR1) was added in series with the emitter of the NPN transistor (Q2) to protect the emitter-base junction from
35 breaking down when the output of the NOR gate (U2D) is low.

Since the VGA modes use the entire active video time, the horizontal width and the vertical height need to be reduced from their "off-the-shelf" settings for the current televisions to allow the user

to see the entire text or graphics display being generated by the computer.

Finally, since the analog RGB video coming into the television via the $2f_H$ I/O never goes to the wide screen processing module, the
5 VGA material displayed on the CTC-172 receiver will have an aspect ratio of 16 X 9. Therefore, graphics appearing "correct" on the computer monitor will appear horizontally stretched on the television since the VGA video card produces graphics and text to be displayed on a 4 X 3 picture tube. This problem can be overcome for example, by
10 programming the VGA card in the computer to output a horizontally speeded-up video signal, by a factor of 4/3. This problem can also be overcome by programming the computer to output a wide format display ratio picture, for example 16:9.

Microsoft® Windows® software provides a flexible Graphical
15 User Interface (GUI) that can function with a variety of screen sizes and resolutions. The video presentation is determined by the generic Windows Graphics Display Interface program GDI.EXE (GDI), in conjunction with specific Dynamic Line Library display driver modules, which are crafted to each specific video system.

20 At a more fundamental level, the Windows® GUI system runs "on top of" video BIOS software, which determines the video pixel format and timing produced by the graphics board hardware. Common display drivers include versions for VGA (640 by 480 pixels), SVGA (800 by 600 pixels), and 1024 by 768 pixels. The ratio of horizontal to
25 vertical pixels in all these systems, which is the same as the format display ratio, is 4 X 3, reflecting the 4:3 aspect ratio of conventional cathode ray tubes. This arrangement can be thought of as creating square pixels, which are desirable for certain software reasons.

When the software is ported from a 4:3 display, a problem
30 arises. The temptation is to expand horizontal scan to fill the screen; however, merely stretching the raster this way can be thought of as stretching each pixel horizontally by $1/3$. Normal Windows® Program Manager icons look distorted. A more serious example is Kodak® Photo-CD Images, which may assume a square pixel shape in their
35 transfer of real-world 35 mm images to video. Stretching pixels horizontally to fill the screen results in distorted pictures populated by horizontally elongated images. This requires both new display

BIOS and Windows® display drivers, or modifications to existing software.

One method is to modify an existing set of software. Starting with a 4:3 SVGA driver, the number of vertical pixels (horizontal lines) must be reduced by a factor which yields a format display ratio of 16:9, based on a horizontal width of 800 square pixels, namely $800 \times (9/16) = 450$ pixels. The new raster is 800 by 450 pixels, that is, 450 lines of video. Accordingly, modify the contents of the ??? file. Among other things, this file "tells" the GDI software what raster format it has to work with. The GDI software complies by producing a display having fewer than the usual number of horizontal lines in SVGA format, in this case, 450 lines. Next, create a software utility to modify the contents of the video controller card's CRT controller registers. These registers control the video timing and line counts produced by the CRT controller chip hardware on the video card. The counts are changed to produce an active raster of 450 horizontal lines. Finally, the modified software is loaded at system start up, and the result is a 16:9 video display of a picture without image aspect ratio distortion. In other words, the pixels in the wide screen display can still be thought of as square. This video display can be scanned directly onto the wide screen tube without image aspect ratio distortion. In effect, the video software and hardware are instructed to format a picture directly in a wide screen format.

- The reduction in the number of horizontal scanning lines will result in some reduction of vertical resolution, however, this method has been used on a Dell® 486 system to demonstrate a variety of material ranging from business software (Word®, Excel® and Powerpoint®) to Kodak® Photo CD images and Microsoft's Video for Windows®, all on a modified Thomson CTC-172 receiver using a Thomson W86 (34V) 16:9 standard commercial picture tube, with surprisingly good results.

CLAIMS:

1. A method for displaying images created in a computer on a wide screen television receiver, comprising the steps of:

programming a first video circuit in said computer to use less than a normal number of horizontal lines when formulating a picture for display, said less than normal number of horizontal lines resulting in a picture having a wide format display ratio;

generating in said programmed first video circuit a $2f_H$ RGB video signal indicative of said picture, including separate synchronizing signals;

converting said synchronizing signals to a form recognizable by a second video circuit in said television receiver, said second video circuit being adapted for receiving a $2f_H$ RGB video signal with separate synchronizing signals; and,

coupling said $2f_H$ RGB video signal and said converted synchronizing signals to said second video circuit for displaying said wide format display ratio picture on said wide screen television receiver.

2. The method of claim 1, wherein said first video circuit in said computer comprises a VGA board.

3. The method of claim 1, wherein said first video circuit in said computer comprises an SVGA board.

4. An apparatus for generating a wide screen picture in a computer for display on a wide screen television receiver, comprising:

a programmable video circuit in said computer, adapted to generate a $2f_H$ RGB video signal having separate synchronizing signals, said video circuit having at least one display mode in which a generated picture has a conventional format display ratio and a given number of horizontal lines;

means for programming said video circuit in said computer to generate a picture corresponding to said at least one display mode, except for having fewer than said given number of horizontal lines, said fewer than normal number of horizontal lines resulting in a picture having a wide format display ratio;

means for converting said synchronizing signals to a form recognizable by a video circuit in said television receiver, said video circuit in said television receiver being adapted for receiving a $2f_H$ RGB video signal with separate synchronizing signals; and,

means for coupling said $2f_H$ RGB video signal and said converted synchronizing signals to said video circuit in said television receiver to display said wide format display ratio picture on said wide screen television receiver.

5. The apparatus of claim 1, wherein said programmable video circuit in said computer comprises a VGA board.

6. The method of claim 1, wherein said programmable video circuit in said computer comprises an SVGA board.