VGA to PAL and NTSC converter

Design and copyright by Tomi Engdahl 1996,1999

NOTE: There are few mistakes on the dawings shown on this page. I have recieved lots of questions related to them and I don't want to get the same questions all over again. I am in the process of updating the contents of this page to correct the errors but I can't promise when I have time to correct all mistakes. At the meantime you can trust the component values on component list and not the values shown on the circuit diagrams. The circuit boards are the actual scans of boards I used to build my prototypes, so they are OK. Only the circuit diagrams have some errors. Sorry for all problems this might have caused to this.

NOTE2: The AD722 IC used in this design is not available anymore. It is obsoleted by the manufacturer (Analog Devices). There are for this reason plans to update this web page anymore (no plans to correct any errors etc.). Suitable replacements for AD722 could be AD724 or AD725, although using them might need some modifications to the circuit design.

General information

This is my VGA to TV circuit I have designed at 1996 for one one company I worked for. Since this design is no longer in production and my agreement has ended, I ma free to publish the details on the web.

Note: The cocuments is based on my notes from more than two years back (1996). I haven't developed the circuit since then.

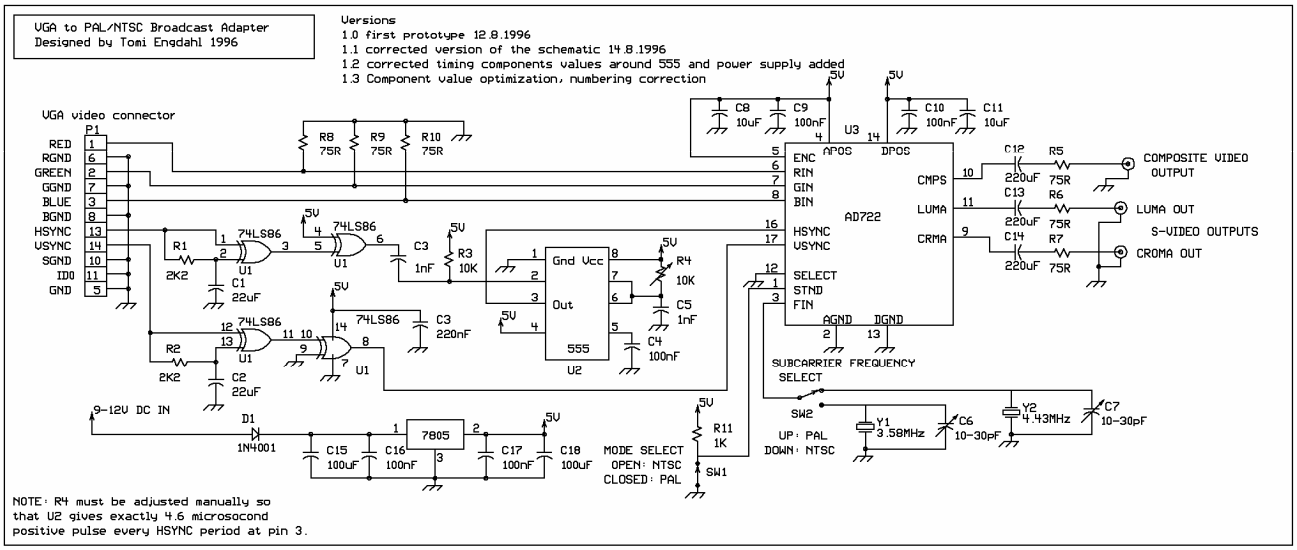
Technical data of the circuit

- Power supply: Regulated +5V power supply, needs less than 300 mA
- Video input: R G B + HSYNC + VSYNC from VGA card, refresh rate compatible to PAL or NTSC standards
- Video outputs: Composite video and S-video (Y/C)
- Video standards supported: PAL B,G,H and NTSC M

The circuit needs that the VGA card sends out the video signal the the RGB format compatible with PAL or NTSC standard video timings. This is accomplished with right VGA to TV driver.

Circuit diagram

This circuit diagram is as I draw it at 1996. I hope this drawing is entirely correct, because I have not done much with my documents since end of 1996.



Click picture for high resolution picture or download Postscript version of the circuit diagram.

Note: There is one mistakes on the circuit diagram which should be corrected.

- **The AD722 pin which is marked as to be pin 17 is really pin 15.**
- **On some version of circuit diagram R4 is marked to have value of 10 kohm. R4 should really be 1 kohm as listed in component list and small circuit diagram picture. C5 should be 15 nF (not 1 nF as listed in some picture versions).**

Circuit operation

This circuit is based on AD722 IC from Analog Devices. The AD722 is a low cost RGB to NTSC/PAL Encoder that converts red, green and blue color component signals into their corresponding luminance (baseband amplitude) and chrominance (subcarrier amplitude and phase) signals in accordance with either NTSC or PAL standards. These two outputs are also combined to provide composite video output. All the outputs can drive standard 75 ohm terminated video cables directly without extra amplifiers. The chip is a very compact solution, because operates from a single +5 V supply and it need no external delay lines or filters.

Because the AD722 IC does almost everything necessary, only very little extra electronics is needed. The chip needs external clock crystals to operate, so the circuit provides the color subcarrier frequency crystals: 4.43MHz for PAL and 3.58MHz for NTSC. The circuit here also provides necessary components for power decoupling and proper termiantion of video lines (inputs and outputs).

The most complicated part of the circuit is the sync signal processing. Because the sync signals from VGA card can be at any polarity, U1 and circuit around it will guarantee that the sync signal are always correct polarity when they enter AD722 conversion IC (U1 makes polarity inversion if needed). The circuit as this would already work, but with some VGA card on some grpahics modes it is hard to generate HSYNC signal which has exactly right width. The HSYNC width must be quite accurately correct for proper color video signal receoption, so I thought it was a good idea to add a circuit which would generate a sync signal which always has right pulsewidth. In this circuit monostable multibirato built around U2 (555 timer) generates the right pulse width for HSYNC signal. The pulse width of this circuit is adjusted using R4.

Circuit use

When using this circuit a right VGA to TV driver must be loaded. This driver does the job of making the VGA card to generae the picture signals at right format and refresh rate. The drivers which cna be used with this circuit are the same as with my VGA to SCART circuit. You have to select a driver which matches the video standard you want to output.

Then you have to select the output standard on the circuit to match the vide output standard. Use the following table to set the switched SW1 and SW2 to match the video output standard you want to use:

Standard	SW1	SW2
PAL	Closed	Up
NTSC	Open	Down

You must adjust also the width of HSYNC signal using R4. NTSC signal asks for 4.59 microsecond HSYNC signal and PAL asks for 4.60 microsecond HSYNC signal. If the HSYNC signal pulse width is not right, quite many TVs have problems in receiving the color signal correctly or even sync to the video signal at all. Best option to adjust the HSYNC signal is to use some measuring equipment like oscilloscope, video vectorscope or frequency counter (which has period measurement capabilities). If you don't have the necessary measusing equipments, you have just to adjust R4 so that you get the colors workign well with your TV. Basically uou have to adjust this setting once, because when you get the setting right, the same setting usually works for PAL and NTSC standard (they timing is so near each other in this).

The last setting is to to fine-tune the color subcarrier frequency. C6 adjusts NTSC subcarrier frequency and C7 adjusts PAL subcarrier frequency. You have to adjust those so that you get the best color reproduction. You have access to vectorscope or similar vidoe signal analyzer, you can use it to fine-tune the color subcarrier frequency to be exactly right. Otherwise you have just to approximate what is the best setting for your TV.

Component list

site	part	value
C1		22uF
C10		100nF
C11		10uF
C12		220uF
C13		220uF
C14		220uF
C15		100uF
C16		100nF
C17		100nF
C18		100uF
C2		22uF
C3		1 nF
C3'		220nF
C4		100nF
C5		15nF
C6		10-30pF
C7		10-30pF
C8		10uF
C9		100nF
D1		1N4001
P1		15 pin VGA connector
R1		2K2
R2		2K2
R3		10K
R4		1K
R5		75R
R6		75R
R7		75R
U1		74LS86
U2		ne555
U3		AD722JR-16
U4		7805 regulator IC
Y1		3.58MHz crystal
Y2		4.43MHz crystal

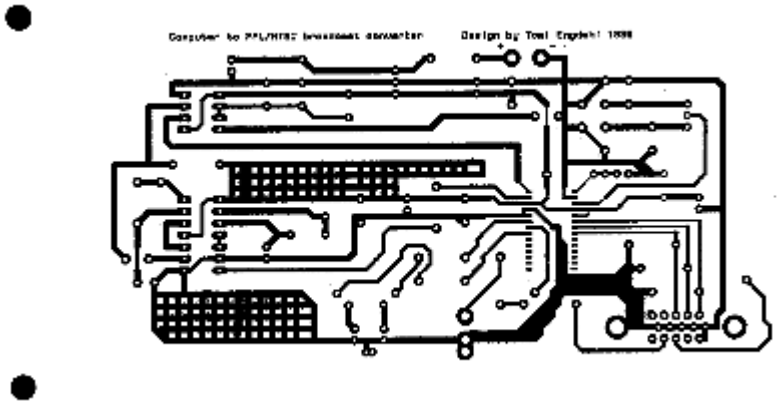
Other items needed:

- 75 ohm BNC connector (PCB mountable)
- 4 pin mini-din connector (PCB mountable)
- Enclosure made of metal

Building the circuit

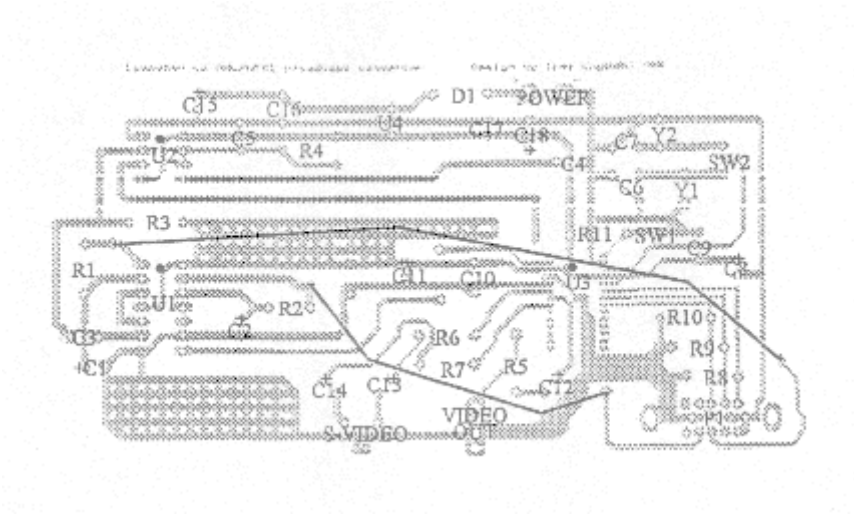
I have built my first prototypes to a veroboard. This method worked very well with other componets on the circuit than the AD722 IC, which was only available in SOIC enclosure. I built my first prototype by carefully solvering small wires to each pin in the AD722 IC and then soledered those to veroboard (not an easy task and fun to do).

The later prototypes I built to the following circuit board (click the picture for larger view, 300x300 dpi scanned picture):



You can print out the picture at correct resolution to a laser printer (6.83x3.87 inches) to a slide and propaly use it as a mask for making a circuit board of your own. If you have a postscript printer or a suitable viewer/printing program you can download zipped Postscript version of the circuit board which automatically prints to right size.

I don't have a nicely drawn out component placement diagram. I found an old paper version of one component placement diagram which might be helful:



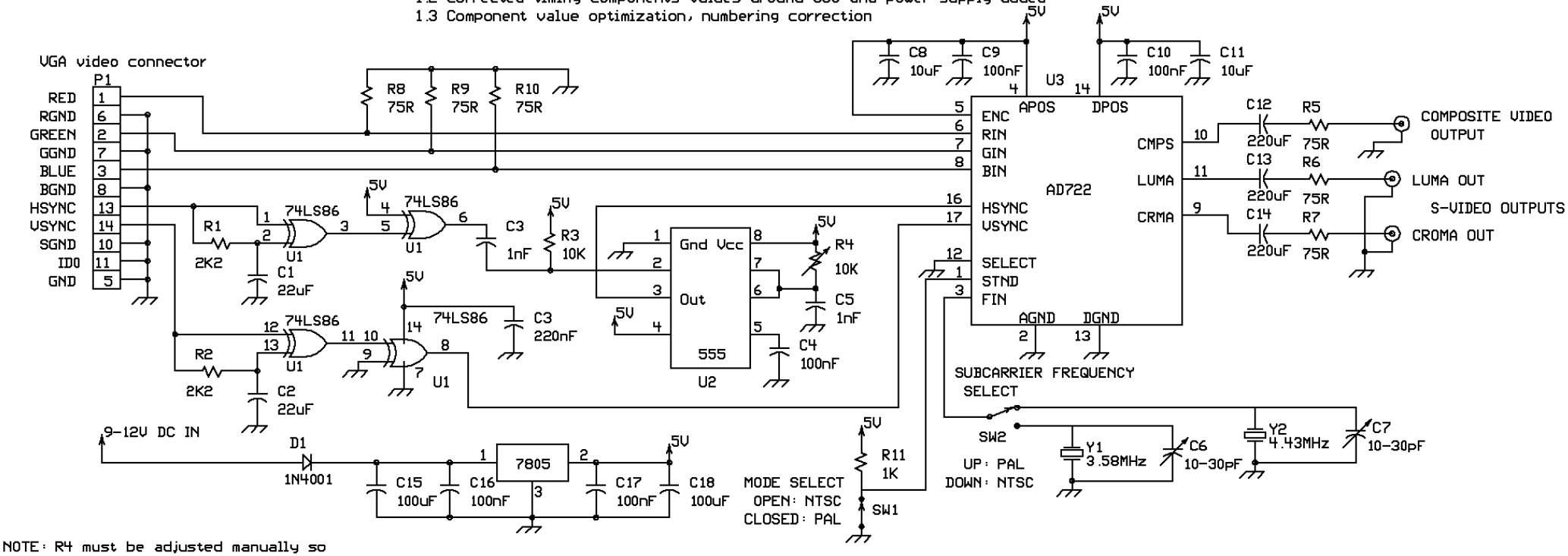
It is not very clear and does not show orientation of all components, so you have to figure out that part of circuit construction yourself. That's all I can provide at the moments (I don't have my old protoype circuit boards anymore).

Addition made 2003:

Because AD722 component is nowadays obsolete, some people have asked what is the right replacement. AD724 is the nearest replacement that could be used. Fortunately this IC is pretty similar and uses same pinout. The only modification with repsect to your schematic is that the RGB inputs (pins 6,7 and 8) need a DC-blocking capacitor in series to work correctly. A suitable capacitor value is 0.1 uF (ceramic or polyester capacitor). This DC blocking capacitor goes between 75 ohm termination resistor and AD724 RGB inputs. This can also be seen in the AD724 datasheet.

VGA to PAL/NTSC Broadcast Adapter
Designed by Tomi Engdahl 1996

Versions
1.0 first prototype 12.8.1996
1.1 corrected version of the schematic 14.8.1996
1.2 corrected timing components values around 555 and power supply added
1.3 Component value optimization, numbering correction



NOTE: R4 must be adjusted manually so that U2 gives exactly 4.6 microsocond positive pulse every HSYNC period at pin 3.

Computer to PAL/NTSC broadcast converter Design by Tomi Engdahl 1996