Notes on Video Conversion

Version 1.76

Table of Contents

- Mac (16") Monitor Info
- Mitsubishi Diamond Scan Monitors
- Sun 13W3
- Sony PVM-2030 and PVM-2530 Profeel Pro Monitors
- SGI Octane to Sony GDM-17E21 Cable

Preface

Author and Copyright

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DISCLAIMER

Interconnecting a video source and display device that are not compatible can potentially result in expensive damage to either or both pieces of equipment. While this isn't that likely with just a bit of care, it cannot be ruled out.
We will not be responsible for damage to equipment, your ego, blown parts, county wide power outages, spontaneously generated mini (or larger) black holes, planetary disruptions, or personal injury that may result from the use of this material.

Introduction

Scope and Purpose of This Document

Questions relating to various aspects of converting one video format (like PC SVGA) to another (like NTSC) are very common.
Most of the articles in this document have been compiled over the last two years based on replies from myself and others to postings on the USENET newsgroups comp.sys.ibm.pc.hardware.video and those of the sci.electronics hierarchy. I apologize if your response is not here - it could have been that I missed the posting and will welcome contributions.
As always, comments, suggestions, and corrections are welcome.
Note: in this document, the terms 'VGA' and 'SVGA' are used somewhat interchangeably. However, strictly speaking:

- VGA refers to the basic original IBM VGA standard of 640 x 480 at 60 Hz.
- SVGA refers to scan rates greater than and including the basic VGA rate.

TV (NTSC/PAL) to RGB

Watching TV on a VGA/SVGA Monitor

Depending on the monitor, you may need a lot of electronics. VGA uses a 31.47 kHz horizontal scanning frequency - twice NTSC.

1. If it is auto-scan and goes down to 15 kHz horizontal, then you need an NTSC to RGB converter. There are chips from companies like Sony, Signetics, and others that will do this without too much pain.
2. If it will not sync at 15.734 kHz, you will need a real time digital scan converter consisting of a video digitizer and a full frame buffer with suitably fast I/O, For the special case of basic VGA, a subset of this called a line doubler or scan doubler will also work but there are some problems with this approach. See the section: What is a Scan Doubler?.

For PAL (625/50) the relevant resolution is closer to 800x600.
There are boards for your PC that will take NTSC/PAL and put it into a window.
What you may find in the end is that your $150 TV gives you a better picture.
(The following from: Stan Rohrer<ROHRERS@DMAPUB.DMA.ORG)
For cards as well that take NTSC and put it into a window on your PO:
Check in the PC mail-order catalogs and your local PC parts outlets. There are a number of TV boards and frame grabber boards that do what you want. Prices start (I think) around $150. Professional level conversion boxes soar above there somewhere.
I've just started investigating such devices. PC Zone (800-258-2088 for orders/catalog) and MicroWarehouse (800-367-7080) carry Computer Eyes and TelevEyes by Digital Vision. Prices here range from $300 to $600 with the highest reported to include genlock and overlay capability. PC Zone has an AITech TV board for $150. I don't know if it will take NTSC video input or not. One of the guys I work with just bought an (unknown brand) TV board that takes NTSC but he doesn't have it installed yet.

TV to Fixed Frequency Monitor

The hardware needed to watch TV on a typical high resolution fixed frequency monitor would cost more than a nice large TV. In two words, forget it! In addition to decoding the NTSC/PAL to RGB, the scan rates are SO different that the only hope would be to build a full blown scan converter.

TV to MGA

> "How hard would it be to make my amber Hercules monitor display the output from my VCR? the VCR has a RCA video output and a coaxial RF output and I want to use the monitor as an orange TV."

This is almost certainly not worth the effort as the monitor accepts TTL (2 bits) and can display at most 4 gray (well, amber) levels without extensive modifications. In addition, the scan rates differ substantially between NTSC or PAL and the Hercules standard. As noted below and elsewhere in this document, a CGA monitor with a composite video input would be a better choice.
(From: Jerry Penner (jpenner@sentex.net).)
You want to connect a Herc Mono TTL monitor to a composite video signal? Can you say 'Big Waste of Time and Effort'? If you want a black and orange or black and green TV screen, connect your RCA video output on your VCR to the input of a composite CGA monitor. These monitors were used on Sanyo MBC computers, and early Apple clones as well as some XT's. Colour composite CGA monitors used to be used on C-64 and Vic-20 computers. Their usefulless as TV/game monitors is legendary, and you'll be lucky to find a used one for under CDN$80.

TV to CGA

> "I have a RGB CGA monitor and would like to use it to display a composite or S-video signal from a VCR. I was wondering if anyone knows how to accomplish this or knows of any economical products that will be able to do this. Any info on S-video pinouts would also be greatly appreciated."

Is it strictly CGA? If so, that is TTL and you can forget about displaying VCR S-video without extensive and not worth-it modifications. Some CGA monitors have composite inputs or analog RGB inputs. With analog RGB inputs, you need an NTSC to RGB converter. These can be built with a single chip and some discrete components. There are probably converter boxes available as well. If it accepts composite, then just use the normal video out from your VCR. S-video won't gain you anything unless the monitor has separate Y and C inputs as well.

I have a Magnavox CM8762-074T RGB Color Monitor which accepts both CGA TTL and NTSC color composite video inputs. Locating monitors of this type may be an alternative to video format conversion. These may be available for next to nothing as the owners have upgraded and are often not interested in (or aware of) their present utility. They are often of relatively high quality and display a very nice picture since their original intended resolution is similar to that of NTSC. I use the Magnavox CM8762-074T for testing of VCRs and other baseband video sources.

PC VGA/SVGA to/from TTL

VGA to TTL (MGA, CGA, EGA)

Both the signal format and scan rates are incompatible. Therefore, simple conversion between analog VGA/SVGA and any of the TTL formats - Mono, CGA, and EGA - is generally not realistically possible.
Some (mostly older high-end) monitors will accept multiple input types like VGA, EGA, and composite. Some examples are: Mitsubishi AUM1371/81, Tatung CM1495, Princeton Ultra-14, and NEC MultiSync. These can select between VGA and EGA input (either a switch or cable) and the Mitsubishi (at least) will also accept composite (NTSC) video.

VGA to CGA1

The following applies with minor changes (scan rates, number of bits) to MGA, CGA, EGA, and most other TTL video signal formats as well.

> "I am trying to use an old Sony monitor, (PVM-1342Q), which only accepts a CGA video signal through a 9 pin connector. My output is SVGA via a HD15 pin connector. Any suggestions on pin assignments or existing converters to do the job?"

Assuming the monitor is actually CGA, it is probably not worth it. CGA is TTL and SVGA is analog - you would need a converter and then only end up with CGA's 8 colors or whatever.
The scan rates differ by a significant factor. If you can program your VGA card for the monitor's horizontal scan rate (around 15.734 Hz - similar to NTSC in the case of CGA), then the remaining problem is converting from analog to TTL. This will require some high speed comparators and logic.

VGA to CGA 2

For the general case of desiring to drive a true CGA-TTL monitor from a VGA card, there are three options:

1. Replace the monitor with a VGA monitor.
2. Replace the video card with a CGA card if you can find one.
3. Completely redesign the CGA monitor to accept the VGA scan rate and analog video input. Neither of these is easy or necessarily even possible and the resolution of the CRT may be inadequate in any case.

If the monitor accepts analog RGB, it may be possible to program you VGA card to put out the CGA (15.734 kHz) horizontal scan rate to be compatible with a CGA monitor of this type. Your hardware and software may or may not support this easily or at all.
If it's a true CGA monitor, there simply is no practical way to use it with a VGA card. Period. If it's one of the original multisyncs that happens to work with CGA, then there's some hope. However, these weren't so common: Sony 1302, Mitsubishi AUM1381 or Diamond Scan, plus a few others).
In this case, you just need the proper cable and the appropriate switch settings for the monitor.

VGA to CGA 3

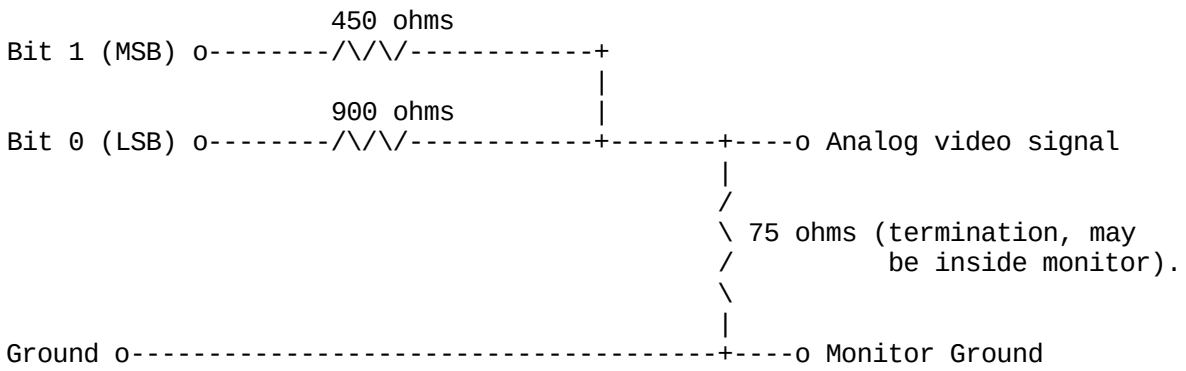
> "We are trying to upgrade our print servers and have a lot of CGA monitors and a lot of PS2 computers with VGA cards. We don't need more than 2 colors (mono) but when we make an adapter to connect the R to R, G to G, B to B, H to H, V to V, Ground to Ground and the rest NC we don't really get what is wanted.
>
> Well, what happens is that the display is quite acceptable other than the fact that there are two of everything on the screen indicating timing problems. Covering the right side of the screen with a sheet of paper works to cure the problem but a more acceptable solution is needed.
>
> Adjustments to the monitor frequency, width, phase, H-hold, etc. don't help."

This is not surprising as the horizontal scan rates for VGA and CGA differ by about a factor of two. This is much too large change for the monitor to accommodate.

Note that CGA outputs TTL level signals (0 to 3-5V) and VGA outputs analog levels (.7 V p-p). Therefore, what you have done may not work in any case if the monitor expects strictly a TTL input. However, your monitor must be compatible with the VGA levels.
The monitor would have to sync at double its normal scan rate for the picture to properly fill the screen. First, it would be difficult to modify the monitor for such a substantial change in horizontal scan rate. Second, and more importantly, any such change could compromise the safety - stressing the monitor's circuitry - increasing the risk of failure and the possible fire hazard. Therefore, I would not recommend even making the attempt unless you are quite knowledgeable in the design of monitor deflection circuits and power supplies.
One other option other than replacing the video card or the monitor would be to determine if your PC is capable of putting out CGA scan rate video. Many video cards do have this capability not so much for CGA as for NTSC/PAL compatibility. However, some programming or use of special video drivers (software) may be required.
Alternatively, you may be able to find an inexpensive card that would be able to provide the correct timing or even some old CGA cards that no one wants anymore. Also, monochrome video rates are 18.43 kHz. If you can find some MGA cards, you may be able to tweek the monitor that far.
Actually, for your intended application, painting over one half of the screen isn't such a bad idea. :-)

TTL to VGA/Analog

This requires matching the scan rates and implementing a suitable digital to analog converter to take the TTL data and produce analog signals.
A scan converter can be used on the analog signals once they are generated to adapt the video to your monitor. However, I don't know if scan converters with suitable input and/or output capabilities exist.
The digital to analog conversion can be done with a few resistors if you are not terribly fussy about the quality. For example, the following circuit should be able to generate a reasonable VGA signal from a 2 bit input (e.g., MGA or one of the EGA color channels):



This assumes the H and V sync are separate signals. If this is not the case, these will need to be combined into this signal (at least one of the channels) as well.
I have not tested this circuit. Using low value pullups on the TTL signals (say 220 ohms) should help improve the high level consistency.

CGA to VGA

There are two problems:

- CGA is TTL; VGA is analog. Relatively simple circuitry can deal convert the TTL levels into the .7 or so V signal.
- CGA scan rate is approximately 15.75 kHz; VGA is 31.4 kHz. Therefore, unless the VGA monitor can scan at the lower rate (some early multiscan monitors like the Mitsubishi AUM1371/81/91 can do this), a scan doubler will be needed. See the section: What is a Scan Doubler?.

In general, where only 1 (or a few) of these are needed, locating true CGA monitors at used computer stores or thrift shops is definitely the easier way to go!

VGA to Analog RGB

Note that in some cases, no actual hardware is needed - the video adapter may be programmed to do what you want either using existing or special driver software or at a low level by directing controlling the video chipset:
(From: Jack Schidt (jack@wintel.net).)
Most questions regarding changing or using VGA signals in non-standard (PC) methods, is answerable only by consulting either:

1. Graphics adapter manufacturer (if known) of the VGA adapter, or integrated motherboard. They may have the information you need.
2. Graphics chip manufacturer. They will have programming information or books you can read to change the device programming. NTSC mode set commands are sometimes on the graphics chip mfg's Website or BBS.
   However, this is not always simple!

If you are lucky, you can reach an apps engineer in either case who has knowledge of your requirements, and has the means to supply you a solution. Otherwise, you need to write a short assembly language program to stuff the VGA controller registers with the correct parameters for what you are trying to do.

VGA to Fixed Frequency Monitor (3, 4, or 5 BNC Connectors)

Questions about this specific problem are among the most common as low cost fixed frequency monitors become available when their workstation hosts are decommissioned due to the march of progress.
You will have to obtain the specs to have any idea of whether what you want to do is possible. These are very often high resolution with a typical horizontal scan rate of 64 kHz.
There are several issues:

- Video compatibility - here is the one area where you are likely fine - your monitor is probably compatible with VGA analog video levels - .7 V p-p.
- Scan rate - your horizontal and vertical refresh rate. I would expect that the monitor is not auto-scan and probably not compatible with VGA or SVGA. Please check the specs if you have them or post a message so that someone else can identify it. You need to know its horizontal and vertical scan frequency range.
  If it is fixed frequency, you will be able to use it only in your high resolution (probably) applications. Booting the PC will require a normal VGA monitor for the messages to be seen.

Assuming you are willing to use something else to boot and only run at a single resolution, then the last hurdle is sync:

- Sync. You have 5, 4, or 3 BNC (coax) connectors on the back of the monitor.
  - 5 BNC connectors - this means that your likely have separate horizontal and vertical (H and V) sync inputs - just what your VGA card wants. In this case, as far as sync is concerned at least, all you need is a VGA-to-5 BNC cable.
  - 4 BNC connectors - this means that your monitor requires composite sync. The H and V sync signals must be combined into one TTL level signal. Some cards like those from ATI will probably drive it with just a VGA to 4 BNC cable since they can be programmed to generate composite sync with no additional hardware. (Actually, get a VGA to 5 BNC - you just won't use one of the syncs and this may come in handy at a later time).
    You need to determine what its expected H and V rates are to see if they fall within the range of the video card. Some internal twiddling may be possible depending on the monitor. Also, the software size adjustment in the ATI Install program also affect rates so that adds another couple of degrees of freedom.
    If you need to combine the H and V sync, a TTL gate, single transistor circuit, or sometimes just a couple of resistors will do it.
    For example, if you are able to program your video card for negative sync polarity, then an AND gate (which will act as an OR for negative logic) should do it. For positive sync polarity, a NOR gate or NPN transistor will work. It is also possible to build an auto-polarity switching circuit to accommodate any combination of positive and negative sync polarities. In some cases, just using a resistor in series with each sync line will be enough.
  - 3 BNC Connectors - these monitors need what is known as 'sync-on-green'. This will require some circuitry to combine the H+V+video into one signal. The circuitry is quite simple if you are electronically handy. Commercial boxes to do this are also available.
    (From: Exar (exar@aol.com).)
    For any type of video converters call ALTINEX,INC. in California 714-524-5400 they make a device that will combine sync, separate sync, put it on Green, shift image left or right. Product name is DA1910SX. I have several of them for my PC, MAC SGI and SUN.

See the documents: "Fixed Frequency Monitor FAQ" and "Sync-On-Green PC Video FAQ" for details.
Some monitors have the required circuitry to accept separate sync internally that is not brought out for a particular model. In this case, some careful exploration may reveal hidden treasures.

So, check your scan rate. If that is not compatible, then you will need a new display board anyway. If it is compatible, then you will just need the sync combiner. Then there is the problem of booting DOS or Windows - these usually want 640x400 at boot.
There are video cards designed for just this purpose. Whether the investment is worth it compared with a new PC compatible monitor is questionable IMO.
See the document: Notes on Approaches to Using Fixed Frequency Monitors on PCs for additional information and names of companies who manufacture the special video adapters.

VGA to Apple RGB

> "Is there any way to modify an Apple 12-inch RGB color monitor so that it can display 640x480 (instead of 512x384)?
>
> Has anyone ever managed to do this? Any opinions on whether or not it is possible?"

I assume you want VGA resolution - 31.4 kHz horizontal.
This would require changing the horizontal scan rate by a large amount and is unlikely to be easily accomplished without extensive modifications to the monitor's circuitry. This should not even be attempted unless you are knowledgeable in the design of monitor deflection circuits and power supplies.
For other Apple (MacIntosh) monitors, see the section: VGA to Fixed Frequency Monitor (3, 4, or 5 BNC Connectors) as most of these run at a fixed frequency. For example, the Mac II rate is 35.0 kHz H and 66.67 Hz V.

VGA to Mac (Monitor) Conversion

I have no idea of what this gadget actually does but it may be worth checking out:
(From: James Willcox (jwillcox@spitfire.net).)
Boca makes an adapter. I have one and it works fine. It has little switches on it to select resolution and refresh rate.

VGA to Sun/Sony GDM1960

(From: Flupke ut Warns (P.O.Langemeijer@student.utwente.nl).)
The most important thing is to get the sync pin(s) connected and the horizontal scan rate as close to the required value.
There is much more info and links at:

- http://www.ifi.uio.no/~karld/fixedsync.html

VGA to Amiga 1024

From: jcaldwel@iquest.net (Mr. Caldwell)
It is a CGA frequency only monitor. It has an 8 pin analog jack on the back and may have a 5 pin ttl jack and ttl to analog converter inside for standard CGA, you can use a cable for the analog plug to a 9 pin d plug for MCGA and get 320 x 200 by 16 Million colors. Some IBM cards will put out the correct frequency and analog signal, most won't. I used an ATI Wonder VGA card that would work correctly *if* manually configured.
Otherwise you need a VGA to NTSC converter. See the section: VGA to TV - NTSC or PAL for more information.

VGA to SCART

SCART is basically an analog RGB + composite sync interface found mostly on PAL (and maybe other European standard) TVs but rarely on TVs in the U.S. Signal conversion from VGA to SCART is straightforward - just a matter of generating composite sync and making the proper cable. However, it has the same problems as the others with respect scan rates unless you are running an O/S like Linux or an X-server - for the latter case, see: X on TV.

Notes on VGA to RGB Conversion

(From: Jon Jenkins (jenkinsj@ozy.dec.com).)
I use standard 74HC 14pin DIP gates available from any electronics store. I use a 14 pin DIP socket originally so that I could change gate types (OR/XOR/AND) easily. 74HC86 (XOR) works just great with the VR320 (I am using it now can also use OR, don't understand why ??).
The VN10KM is a small signal N channel enhancement mode MOSFET also available from most electronics store.
If the video card you are using is a standard VGA output (I'm using a diamond stealth 64 VRAM):

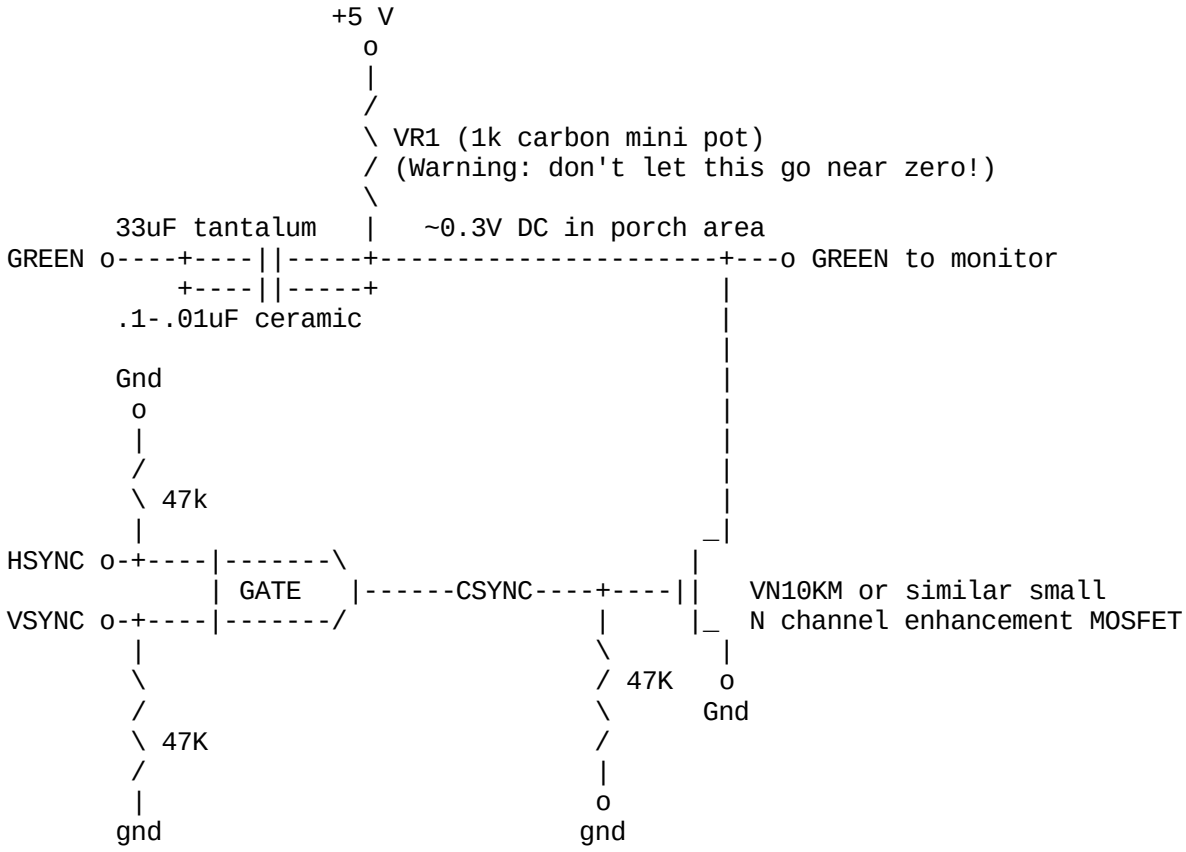
Pin 1: Red video
Pin 2: Green video
Pin 3: Blue video
Pin 4: Monitor ID bit 2
Pin 5: Ground
Pin 6: Red return
Pin 7: Green return
Pin 8: Blue return
Pin 9: NC
Pin 10: Sync return
Pin 11: Monitor ID bit 0
Pin 12: Monitor Id bit 1
Pin 13: H sync
Pin 14: V sync
Pin 15: NC

I join all the "returns" together with the ground on the small PCB and use that as a common ground for the RGB cable to the monitor. You can use separate if you want to but you should join the green return and sync returns together. I did find some small shadowing if I didn't group them all together.
Just a note, when you set up your video card in Windows (or Win95) set it to 1280x1024x72|66 or whatever is closest. I use a VR260 (1024x864) at 1027x768@66Hz (check with your manual DA or D4 are 72Hz) your VGA will not like this frequency so either disconnect it quickly or before you actually set the video card to this mode (i.e. put the OK as the active control in Windows and then connect the VR320 and hit return) My diamond setup gives me 10 seconds to do this adjustment
When you exit you will probably have to select the 1280x1024 mode with your old VGA connected again and from then on every time you start Windows you will be able to view it in "big" colour mode.
Note the vr320 will not work in DOS mode as it is not an auto-scan monitor so all you see when you boot up is garbage until Windows starts, I put "win" in my autoexec.bat file.
Note there is a danger here: I had set up the monitor and for some reason it did not work so I couldn't see what was going on: my old VGA wouldn't work and the VR wouldn't work either so I had to find the cards .ini files and edit by hand to get back to usable video!!
For FreeBSD/XF86 the lines are:

#VR260 monitor is 70MHz 1024x864
#VR320/319 monitor is 130MHz 1280x1024
Modeline "1280x1024" 130.81 1280 1312 1472 1696 1024 1027 1030 1063 +hsync +vsync
Modeline "1024x864" 69.2 1024 1040 1168 1272 864 864 867 904 +hsync +vsync

The circuit to do this is as follows:
Notes:

1. You may be dealing with 135MHz square waves so there are lots of high frequency stuff around; use good RF practices.
2. The coupling capacitors are a safeguard to start with. I don't use them because they caused shadowing around sharp colour changes (the old RC effect).
3. Use the XOR gate first as a test but you may need other gates to actually get it working.
4. An oscilloscope will be handy for final adjustment.
5. Make the device is as close as possible to the video outlet on the VGA card.
6. Take the 5V from the PC power supply inside the box. I just hooked one of the spare connectors which I also use for an external fan (Pentiums being the heaters they are!). Make sure (check it again!!) (and again!!!) you don't get the 12V one!!
7. You must use a VN10KM or other small signal N-channel enhancement mode MOSFET. Others will not work!!



HSYNC, VSYNC and CSYNC are grounded with 47k carbon resistors
Gate type=LS or HC types, HC preferred:

- OR: for -ve logic sync and no hsync during vsync.
- NAND: for +ve logic sync and no hsync during vsync.
- XOR: for -ve or +ve logic sync and hsync during vsync.

Capacitors are optional, I don't use them.
Use XOR gate with DEC monitors and as a first shot with others, then OR gate then NAND gate.
Get an oscilloscope and adjust porch levels to 0.3V and 0 level (sync level) to 0.0V

VGA to TV - NTSC or PAL

> "I am interested in converting a signal from my video card to a signal that can be taken into the video in on my vcr. I realize that it is not going to be easy. Still I would appreciate how to do it."

You are correct - this is not easy.

1. You need to convert RGB to NTSC or PAL - there are single chips for this. Try Sony, Philips, Motorola, and others. These will combine the R, G, B, Hsync, and Vsync into a single composite video signal using a minimum of additional components. The same part can usually do either NTSC or PAL by changing a jumper and possibly some of the external components.
   For example:
   (From: Brian B<BIERSACB@EXECPC.COM

   > "In the July 1996 issue of Electronics Now, a MC1377P (Motorola) is used to convert RGB to NTSC/PAL. The chip can be purchased through the Newark catalog. This chip is very easy to use and should make your circuit simple." (See the wiring instructions, below. --- sam.)
   >
   > Some other possibilities may be: ADV7175/ADV7176, UPC1352 (ECG/NTE1416).

   (From: Quick Fix (iradg@guru.nu).)

   > "The MC1377 is a 20 pin all-in-one chip. Connect the following: +12 VDC to pin 14 and ground to pin 15, composite sync to pin 2, RGB to pins 3, 4, and 5, respectively. Put a 3.58 MHz xtal between pins 17 and 18. Optional Y delay pin 6 to 8. Video output at pin 9. I have made and sold many of these. If you have any more questions, you can visit the Motorol Website and search for: "MC1377".

2. You need to match the horizontal scan rate to NTSC (15.734 kHz) or PAL (15.625 kHz). Even basic VGA is roughly twice this - 31.4 kHz. If your video card can be programmed to put out interlaced NTSC or PAL rate video then this is easy. If not, it is more difficult. If you want to use any higher resolution than basic VGA (640x480) for a 60 Hz system or 800x600 for a 50 Hz system, it is a very non-trivial problem requiring a scan converter which includes a video A-D, full frame store, interpolator, readout timing, and video D-A. Unless you are an experienced digital and analog designer, you really really do not want to tackle this.

For the special case of VGA to NTSC or PAL, you may be able to get away with something less than a full blown scan converter. See the section: What is a Scan Divider?".
You can also buy little boxes to do this. Quality is general not great as you are seriously limited by NTSC/PAL and the VCR.
(From: Tomi Holger Engdahl (then@neppari.cs.hut.fi).)
There is all sorts of information relevant to video at:

- http://www.hut.fi/~then/electronics/video.html

There is collection of links to RGB to NTSC/PAL converter and other video chips at:

- http://www.hut.fi/~then/electronics/video.html#chips or
- http://www.hut.fi/Misc/Electronics/videochips.html

For more detail on this, check my circuit and related software at

- http://www.hut.fi/~then/circuits/vga2tv/

Probably the most complete VGA to TV conversion pages in the web can be found at:

- http://www.hut.fi/Misc/Electronics/circuits/vga2tv/

There you can find schematics, drivers, tips, ideas, documents, links to commercial products and much more. It does not have everything you need but it is a good start. Going to composite video or RF is more complicated as there are three composite video standard NTSC, PAL and SECAM in use in the world and there are also some small differences in modifications of those used in different countries) which is the reason why there are not much of this kind of project. VGA to TV conversion is not simple technology either (the circuit can be simple but there are quite many things to consider when designing such circuit).
Homebuilt circuit persons should take a look at:

- http://www.hut.fi/Misc/Electronics/circuits/vga2tv/

There you can find my design of VGA to TV converter which outputs RGBS signals suitable for TV SCART RGB input (I have also designed one with composite video output, but that's for a commercial application). At the same page you can find a PAL composite video output version of the circuit designed by Paulo Coelho.
For introduction to scan conversion, check

- http://www.extron.com/

Specifically:

- http://www.extron.com/product/scanconv.html

Flickering is a problems always when yu do graphics to TV systems. The graphics material must be designed so that flicker is not noticeable or the scan converter box must include some kind of filtering to do the job.
NTSC/PAL system limit the bandwidth which makes picture to loose some details. The picture is usually even worse than that, because of the cheap video encoding chips used in many converters.
(From: Bill Sloman (sloman@sci.kun.nl).)
Try the Analog Devices AD721 and AD722. When I used the AD720, I had to add a National Semiconductor LM1881 sync separator, and black-level clamps on the red, green and blue inputs to get the right DC levels.
Check them out at Analog Devices.
(From: Leon Heller (leon@lfheller.demon.co.uk).)
Raytheon has a chip which produces broadcast quality PAL/NTSC from VGA. I think that Harris does one, as well.

VGA to TV Converter Boxes, Adapters, and Boards

(From: Kevin Centanni (kpc@panix.com).)
There are a couple of VGA-to-TV converter boxes that also output an NTSC RGB signal. I own one from UMAX - I think it's called the TV-Mini. I bought it from Global Computer Supplies for about $175. I also think that MicroWarehouse sells this product. There's a model sold by AVer also that has RGB out... but it's over $300.
The UMAX TV-Mini is a small box that plugs into your VGA card... it also has a female VGA connector on it so you can display images on your computer monitor and television monitor at the same time. The TV-Mini is powered by the PC's keyboard connector. It has an RCA jack for composite NTSC, an S-Video jack for s-video output and a Mini-8-DIN for RGB output... if you go to UMAX's web page, they'll talk about how the TV-Mini comes with an RGB SCART cable (SCART is a strange looking connector that's used on many European televisions) - but it doesn't come with this cable.
I was able to build a small adapter cable with some parts from Digi-Key. The TV-Mini manual provides the Mini-9-DIN pinouts.
(From: Jerry G. (jerryg@total.net).)
I have played around with a few. The ones in the upper $300 to $400 are not too bad. You will get a reasonable picture. I found the cheap ones are extremely poor.

The best way to do it is with a video display card that has it built in. These cards are expensive because the scan rate must be changed. There is a lot of high speed ram and processing involved to do it right.
It is not a question of movement involved. It is a question of scan rate conversion that makes things complex. With this conversion there is the requirement of some complex quantizing to also convert the characters to match as well. In a lower priced card that I have seen good results is the ATI card with the NTSC output. I don't know the price of the card, but it is not cheap...! There is a Targa card that is excellent, but the price is too high unless you are in the business... But like I said, the higher the price, I found the pictures get better.
Also, the bandwidth for the fonts, and data comming through the conversion is extremely wide. It is wider than off of a conventional TV broadcast, or what comes out of a VCR. The TV set that you use must have a Video Component input, and be able to handle at least 600 lines resolution or better. If not, you will be cutting the performance of the signal right at the end! If your TV has S-VHS capability, get the card with that option. It is better than using encoded NTSC or PAL. The S-VHS mode keeps the color information separate for processing. This allows for a better signal to noise in the luminance signal, thus rendering cleaner pictures.

Please note, that you will never get the same picture out of a TV video monitor as your computer monitor. They are based on very different processing and CRT design. There are VGA Monitor projectors on the market, and I would consider renting one for the casual use. It will certainly do a much better job. This is what I recommend and do for my clients. Don't even think about buying such a projector unless you have a lot of use for it. They are extremely expensive, and require periodic maintenance.
(From: E. Abel (EugeneA1@worldnet.att.net).)
I've used an ATI 3D Expression+ PC2TV. The S-Video output is not bad, although text is really not very crisp.
Surprisingly, the TV output from the Canopus Pure 3D card is much better. Text is actually readable. (this is on a 27" Sony trinitron TV.) The Canopus card uses a Chrontel chip to do the conversion.
Of course, at $190 the card is a little pricy.

VGA to NTSC/PAL Chip

> "I am trying to build a circuit to convert the RGB output of a video game to my large screen TV."

(From: Leon Heller (Leon@lfheller.demon.co.uk).)
If the game outputs VGA, Raytheon has a chip, the TMC2360, which converts it to broadcast quality PAL/NTSC video.

Questions and Answers on VGA to NTSC Considerations

This dialog resulted from the desire to construct a VGA to NTSC converter to output PC video to a TV or VCR.
"I managed to construct a VGA to RGB converter so far, so I'm almost halfway there, all I believe I need now is an RGB to NTSC converter circuit, although i was trying to avoid the cost of buying one they sell in the PC catalogs."
Can you program your video card to output 15,734 Hz H interlaced scan? If so, you will have a lot less hassle.

> "I figure the odds are in my favor by creating one myself, and as far as I know, no harm could come to my computer by attempting it since the VGA/RGB is and output only and not and I/O. Now since I already manged to convert my VGA to RGB, hopefully you might be able to answer some specific questions for me?"

> "Is there a minimum & maximum resolution for a TV , or does that depend on the size of the TV?"

If you mean resolvable spots on the TV screen, realistically, it is about half VGA horizontally and perhaps a little more than half vertically or about 320x300 give or take.
If you mean scan lines, that is pretty much fixed at 525 total interlaced 2:1 at 60/30 Hz (625 at 50/25 Hz for PAL 50 Hz systems) with about 420 (540) actually visible on a typical TV. TV's are not auto-scan - they are designed to run at a single scan rate.
Therefore, even displaying easily viewable VGA resolution will be tough. A TV with an S-video input may do somewhat better.
(Remember when you had at most 40 characters across on a Commodore?)

> "Assuming the construction of this circuit would only allow a maximum output from my VGA card, what resolution would that be? 640x480 or 800x600? (I have no expectations of anything higher)"

As noted, for a regular TV, you can send it 640x480 but it will be somewhat fussy. 800x600 is really out of the question. A high quality TV-monitor might do VGA ok. The actual number of lines on a TV is, of course, only about 480 active with perhaps only 420 visible due to the CRT bezel. Unlike an auto-scan monitor, you don't get easy control of this and no control of the number of lines.

> "Finally, taking into consideration the limitations of such a device, I only intend for this to be used for full motion video playback, as my current video capture card, as well as all other cards currently on the market, lack the ability to output the video back to the original source (i.e. a VCR or camcorder)."

Unfortunately, even expensive solutions are still limited by NTSC. However, since your playback is often at reduced resolution (e.g., MPEG) to begin with, this may be acceptable.
(From: FoulDragon (fouldragon@aol.com).)
I'll warn you: You can get a box that will make your PC display on a TV, but it will not be worth your while. We use them at our school, they cost from US $100 and up, and the picture, even on a good TV is very poor. If you can afford one of those boxes, buy a used VGA [even monochrome] and use that as you will be much happier.
(From: Terry Lin (tlin@servtech.com).)
I find that with the ATI PC2TV, on a S-Video hookup on a Sony XBR, the image quality is pretty decent. The flicker removal makes even a full white screen easy to look at (provided you have the contrast turned down, which should be done on every set). I have seen what poor external boxes can do, they give me adaches with the flicker and blurriness. Just make sure your setup is right before evaluating the entire PC to TV monitor thing.

VGA to Composite Video

Realize that no matter what you do, the quality you get on the TV/VCR is not going to be anywhere near what you see on the computer screen. You must keep this in mind when designing layouts, selecting text fonts and font sizes, etc. The new video cards with on-board NTSC/PAL output should be better than your average cheap converter but don't expect miracles.

> "I need a bit of advice on converting VGA or SVGA to output suitable for a color composite monitor and/or a regular NTSC standard television. I have seen add on cards or outboard boxes that will convert VGA to standard TV but I am not sure if this will have the same effect on a Color Composite Monitor. You see I am wondering if it would be more cost effective to keep my old Apple Color Composite

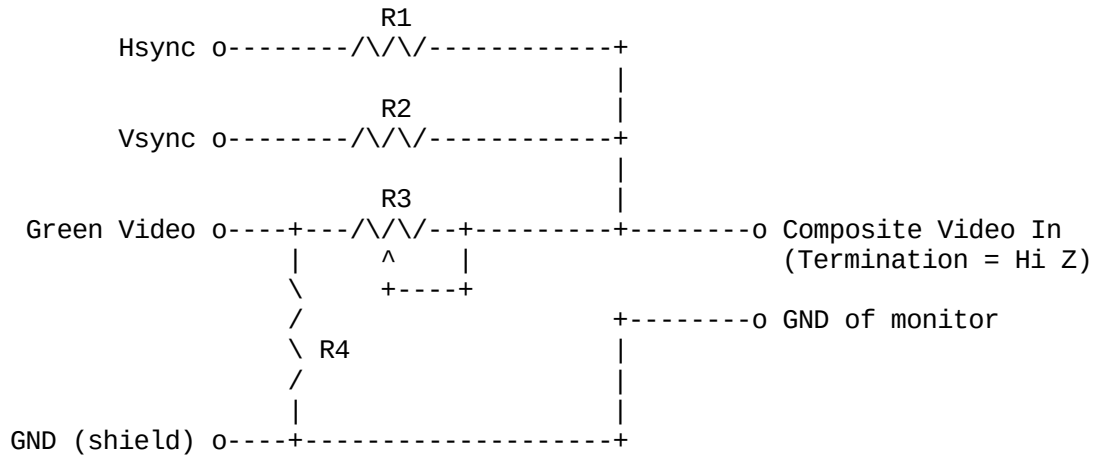
> Monitor and buy the necessary hardware to convert VGA output from my IBM clone or to just go ahead and buy a bottom end 14" VGA monitor? Can I even get true 24 bit 800 x 600 color performance out of a TV or a color composite monitor?"

A color composite monitor may be somewhat better than a good TV but it is still limited by the NTSC standard - mainly horizontal resolution but color rendition as well. There is no way to get even basic VGA performance (640 x 480) from a TV or composite monitor.
You are much better off getting a bottom-end SVGA monitor for your PC. As noted, the resolution of a TV or composite monitor is not even good enough to do justice to VGA (640x480) when using the composite video input. Direct RGB can be better but the pitch of the CRT relatively coarse dot or slot mask or aperture grill is then likely to be the limiting factor. A composite monitor or TV will give you approximately 480-490 lines vertically but 10 to 15 percent of these may be hidden by the CRT bezel due to overscan. However, horizontal resolution is much worse. You will be lucky to get half the VGA resolution (300 to 350 lines). For SVGA, there is simply no way to display 800 x 600 without expensive scan conversion on such a tube and you will not be able to read text or display clear graphics. In addition, since the composite monitor or TV is interlaced, there will be annoying flicker of graphics with thin horizontal lines.
Save your pennies - prices for basic monitors are dropping. Your Apple monitor may work fine on your VCR, however.
(From: Jerry Roush (roush_jerry@htc.honeywell.com).)
There is an "inexpensive" device available from JDR Microdevices that works fairly well, called the AVerKey (JDR part no. VGA-NTSC) They are about $100. It also has S-video output.

VGA to Grayscale Composite Monitor

This will only work if you can program the video card to produce a compatible resolution and scan rate.
If you would like to experiment, here is a really simple circuit that may work well enough for combining Hsync, Vsync, and one of the VGA color signals, say green, into a composite video.
If the monitor sense lines on the VGA connector are tied MS1 (pin 12) = GND, MS0 (pin 11) = no connect, then some programs will default to monochrome and use a reasonable color map. I don't know how you will get a reasonable mapping to monochrome for the others.
All you will need are 4 resistors.
I am calling your connector on the monitor 'Composite Video In'.

- Hsync through 500-1K ohm (R1) to Composite Video In.
- Vsync through 500-1K ohm (R2) to Composite Video In.
- Green Video through 200 ohm (R3 - variable) to Composite Video In.
- Green Video side of R3 to Ground through an 82 ohm (R4) resistor.
- Tie this ground to the BNC or RCA connector ground.



It is essential that all this be built as close to the monitor as possible for best signal quality.
Set monitor video termination for Hi-Z. R4 provides the cable termination to minimize reflections and ghosting of the green video signal.
Set your video card for negative sync polarity.
You may need to tweak these values for best results. This will depend on your actual signals. The variable R3 may provide enough range for this.

TV or Composite Video to RGB (Analog or Digital)

NTSC to CGA

> "Does anyone know how to convert a video out signal into a signal usable by a CGA monitor (RGB + H and V sync)?"

If your CGA monitor is TTL, then it may not be possible, at least not without modifications to the monitor. You need to convert from NTSC to RGB. There are single chips (with a few external components) solutions to this. Try Sony, Philips/Signetics, and Analog Devices (I think) as well as others. These take NTSC (or PAL) and output RGB and sync. CGA is not analog (continuous range of video values). It is TTL with Red, Green, and Blue signals as well as a separate Intensity signal. Unless your CGA monitor can take analog video (.7 V p-p) inputs, you will still only be able to get 8 or 16 colors - not a normal TV picture. (And even for that, you will need external circuitry to convert the analog output of the decoder chip to TTL.)
However, some CGA monitors have internal NTSC composite inputs and in that case, it is simply a matter of flipping the appropriate switch.

Composite Video (NTSC/PAL) to RGB

Several companies provide single ship solutions requiring only the addition of a few discrete components to convert NTSC or PAL to RGB and H+V or C sync. Some have options for YIQ, S-Video, and other formats at the input or output in as well.
See: Tomi Engdahl's (then@neppari.cs.hut.fi) Video chips and circuits page:

- http://www.hut.fi/Misc/Electronics/videochips.html

for an extensive list of video encoder, decoder, sync, and other chips with links to their datasheets. Also, check out the web sites or databooks of Sony, Philips, Brooktree, Motorola, Linear Technology, etc.
One example is the Motorola MC44011.

This part can be used without an external delay line (for PAL to RGB) but a delay is recommended. The chip also provides an A/D sampling clock output for video digitizing applications.
It is possible to search the Motorola site from for other parts or application notes from their Search Page.
(From: Julie Porter (Julie.Porter@efi.com).)
I was able to get my Sony PVM Monitor to successfully take a YC input on the RGB port. I used the MC44011 and it worked! However be advised. The MC44011 has just been announced for last buy this month! March of 1999. There are no other non digital solutions. The TDA3330 has been unavailable for some time. There is some additional information on my Video Animation Web site. I urge people to call Motorola and ask that this component, not be discontinued as there are many web references designs that use it. There are no substitutes. It should also be noted that if people are considering these designs then they should get the parts soon. The part will go out of production this fall (1999).
(From: Jeremy Todd (bulb@cix.compulink.co.uk).)
Sony makes at least two PAL decoder chips - CXA1621S and V7021.
It looks like you'd need a separate sync stripper (LM1881 or EL4581CN)
Brooktree's Bt812KHF is a much fancier thing for video processing and multimedia stuff.
From RS(UK) both the Sony chips are 10UKP each for 1 off's. The Bt812KHF is 107UKP!!
(From: Sam).
Also, some questions are along the lines of the following:

> "I looked at several chip manufacturers. Most have extensive documentation on their chips in PDF format. Again, most of the chips currently available convert Y/C to digital RGB, and have a lot of extra brightness/sharpness control built in. Too complex- the simplest chip I came across was 18 pins and still required two dozen external components."

(From: Eugene (eugenek@istar.ca).)
The answer is: MC44011 by Motorola, cost $28(Can). It requires some sort of a micro to program it (PIC or the like will do).
There is no external critical components except for a 14.318MHz crystal (found on any PC motherboard).
About the old TV single-chip decoders. This is not true, I've been working with those things for 15 years, and in 70-80s the decoders were much more complicated than they are now (each decoder, actually, requires a delay line (sometimes more than one) and a bunch of various filters). Yes, you had one chip and half a dozen of coils, trim-caps to tune (that required some equipment and knowledge).
Sorry, the chip I suggest has 44pins :-(but little hassle :-)

Watching TV on a PC Monitor - NTSC/PAL to VGA

Questions are along the lines of the following:

> "I'm wondering whether I could use my NEC Multisync as a TV. Long ago I had a Mitsubishi Colour Monitor which could also be directly connected to the videorecorder. Sure, I could use cards in my PC like "WIN/TV", but then every time I want to look TV I have to switch on the PC as well.
>
> Is there the possibility to convert a video to a VGA signal? My NEC has only a VGA input. Or: Are there any monitors available which have both inputs (like my old Mitsubishi)?"

"I have a VGA monitor That I want to use to watch TV. I want to be able to maybe build a box that will let me plug a vcr video out into the monitor. I do not want to spend tons of $$$$$. Can anyone tell me if there is a way to do this??"

"I have a HI-FI VHS that is attached to my stereo. Therefore, my audio needs are well taken care of. I now need the video. I had to sell my TV a little while ago so I do not have a T.V. at this point. I have recently acquired a 20" monitor for my PC (DFI brand.) It has the RGB (red-green-blue) connectors on the back along with a Horizontal and Vertical cable connections. So I have a cable that plugs into my video board on my PC that turns into 5 connectors at the end that connects to the monitor."

"Does anyone have any information on viewing composite video on SVGA type monitors. I have a MAGNAVOX SVGA monitor and if possible I'd like to feed composite video from my VCR and Sony PSX and PANASONIC 3D0 to it. Rather than getting a Toshiba TIMM monitor there has to be some kind of blackbox that will allow someone to do this...Please send info to the address provided or post here."

It depends on your monitor:

1. The monitor needs to support the NTSC scan rate - 15,734 H, 60 V. Some NECs do (like the 3D) but others do not (like the 2A).
2. You need to convert NTSC to RGB. There are boxes on the market for this or if you are handy with electronics, single chips to do this. Check out Sony, Philips, Analog Devices, Motorola, and others for NTSC/PAL to RGB decoder chips.

For PAL (625/50) the relevant resolution is closer to 800x600.
If your PC monitor scans down to 15.734 kHz, then all you need to do is convert the line level NTSC composite to RGB and sync. Some older auto-scan monitors like the Mitsubishi AUM1381 even have a composite NTSC input jack. Conversion requires a single chip and a few discrete components. Commercial converter boxes are also available.
However, if it is a modern SVGA/auto-scan that does not go below 31.4 kHz, then it is a non-trivial problem requiring a video A/D, frame memory, readout electronics, video D/A, etc. This is called a scan converter and is not an afternoon project even for an experienced design engineer.
You can of course buy PC cards that will enable you to watch TV in a window on you PC.
There are also external boxes that will accept antenna/cable or NTSC/PAL composite input and drive a VGA monitor. One such unit is the 'Proview' (Proview Technology, Garden Grove, CA). This is reviewed in Popular Electronics, June, 1997. It appears to be quite capable with its own internal 181 channel tuner and IR remote control. It accepts both RF (antenna or cable) and composite inputs and can select between the video source or computer to drive the monitor (but does no processing of the computer's VGA signal - full screen only). With a suggested list price of $119, the Proview could represent a cost effective alternative to a new TV if you have a VGA monitor sitting around collecting dust. Some others can be found at:

- http://www.aver.com/lite/products/avertvgenie.html
- http://www.aimslab.com/home.htm

(I have no personal experience with any of the above products --- sam).
In any case, a $150 TV may actually produce a better picture. This is because the CRT/electronics in a computer monitor is optimized for focus at the expense of brightness. Therefore, sharpness may actually be excessive and brightness may be inadequate except under subdued lighting conditions (especially on a well worn monitor!).
(From: Helmut Weber (Helmut.Weber@hamburg.sc.philips.com).)
There are some companies that have boards ready, which you only have to buy and plug into your PC. Try:

- http://www.como.com
- http://www.miro.com
- http://www.2fast4u.com

(From someone else. --- sam).

> "I want to display output of VCR on my computer monitor. Is there a video card that has Video In (such as RCA in)? Would you tell me which video cards they are? Or does anyone know any other way to display VCR out on a computer monitor? Or Is there a PC monitor exist that has RCA input jacks?"

(From: Todd McCormick (todd@galstar.com).)
There are lots of video cards that have video capture and real time display from RCA phono and S-Video inputs, Matrox Rainbow Runner (which requires a Matrox Millenium/Mystique 220/G200) or the upcoming Marvel, the ATI All-In-Wonder and it's decendents.....
There are several other cards that fill this bill. There are external devices that attach to your parallel ports, or USB port, or Firewire port which can also do this. Some of the older Diamond monitors also had video input as well as a computer input but they were quite expensive.

Comments on TV to VGA/SVGA Conversion

You need a lot more than cables. Here are some comments:

1. Your SVGA monitor must be able to sync down to 15,735 Hz Horizontal - the NTSC scan rate - this is CGA speed and few modern monitors go this low. You thus need a scan converter - not cheap.
2. You need to convert the composite video or S-video out from your VCR into separate RGB and possibly H and V sync. This means electronics not just wires.
3. You will need a good switchbox to select between the sources, you cannot just hook them together.
4. The quality of the TV video on your expensive SVGA monitor will likely be worse than on a $150 TV due to the fine focus of the monitor and the possibly lower brightness. To put it simply, the monitor is too good for NTSC video.
5. Why tie up your computer system watching TV? The other alternative is to get one of those TV tuner and/or frame grabber cards for the PC.

Video Standards Conversion

NTSC to PAL

> "Does anyone know of a simple way to convert NTSC signals produced by American video equipment to UK PAL signals."

If you simply mean the color conversion, then a couple of chips will do it.
There are chips to do RGB to NTSC or PAL color encoding but not, as far as I know, scan conversion. For your needs, look into Sony, Philips, and Analog Devices, Motorola, and others.
See: Tomi Engdahl's (then@neppari.cs.hut.fi) Video chips and circuits page:

- http://www.hut.fi/Misc/Electronics/videochips.html

for an extensive list of video encoder, decoder, sync, and other chips with links to their datasheets.
As has been pointed out, using the strict definition of NTSC to PAL as referring only to the color encoding, all you need is a couple of chips for NTSC to RGB and then RGB to PAL, maybe even a single chip. However, for the very common interpretation of NTSC to PAL (IMHO, maybe a little

USA-biased) is with respect to US NTSC 525 line 60 Hz systems to PAL 625 50 Hz systems which is where the non-trivial part comes in.
If what you really mean is NTSC 525/60Hz to PAL 625/50 Hz, it's not trivial.

- The horizontal and vertical scan rates differ 15734 vs. 15625.
- The number of lines/frame differ 525 vs. 625.
- The color encoding differs.

If you simply want to watch an NTSC tape on a PAL TV it may work but not with proper color if the vertical has a wide enough range to sync or you have a vertical hold control with enough range. If your intent is to put it into a VCR, you can safely forget it.
The usual way is to use a scan converter. Essentially, an NTSC color decoder/A-D feeds a frame buffer (approximately VGA size). The frame buffer is then read out at PAL rates and the necessary interpolation is performed using digital processing to go from 525 (480 or so active) to 625 (580 or so active) lines. The output is sent to a video DAC and then color encoded for the PAL system. Everything all happens in real-time.
Needless to say, this is not your basic hobbiest afternoon project.
Here are some additional comments:
(From: Clive Tobin (tobin@nwus.com).)
Conversion is not a trivial matter, involving interpolating scanning lines, changing the field rate, and changing the color encoding scheme. I am not aware of a simple chip set that will do it. There are several ways of doing it with bought equipment, listed in order of increasing price:

1. If you can stand to look at it on your computer instead of your TV, you can buy TV tuner cards with video input jacks, that will display NTSC on your VGA computer screen. I think I have seen these for around $100.
2. Buy a multistandard TV, which are becoming increasingly popular and don't cost much more than single-standard ones. You would not need an NTSC tuner if it has a video input jack. (I don't know if your camera has an RF modulator as well as a video output.)
3. Buy a standards converting VCR, such as Aiwa HV-MX1, Samsung SV-4000W, or similar. These can be used as a stand-alone converter, or to convert the video to record tapes in a different standard. These sell for around $600 and up. I think they all have RF modulators to feed your TV set if it is lacking a video input jack. If you get one of these you could go into the standards conversion business, converting home tapes of overseas relatives.
   Editor's note: Not all multi-standard VCRs do what you want. Some/many simply convert the color encoding between NTSC and PAL without affecting the scan rate (which is much more difficult/expensive). A wide vertical range TV or monitor might produce a viewable picture with these but at the wrong speed (off by 5/6 or 6/5 including the sound)! Unless the product specifications clearly state 'full conversion' or 'scan rate conversion' or something similar, you can probably assume they take the cheap way out! Make sure you can return the VCR if it doesn't meet your needs! --- sam.

The cheapest of all, if you can stand to see the image in black and white with the vertical size off, would be to plug it into the video input jack of a PAL monitor that has a wide-range vertical hold control. Don't use the RF (antenna) input of a regular TV as it may not work at all because of the different carrier frequencies. (You did buy one with video and audio jacks, didn't you?)
(From: Geoffrey S. Mendelson (geoffm@pita.cs.huji.ac.il).)
There are digital converters that do this "on the fly". Akai (and Radio Shack in the US) sell a VCR for $500-600 (US) that works well. Panasonic sells the AG-W1 (NV-W1) that is an excellent VCR and a much better converter for about $1800.
You can also buy just the converters.
Avoid VCR's that claim to play PAL tapes on NTSC TVs. They convert the color signal from PAL to NTSC (well enough for the kiddies to watch tapes), but assume you can "stretch" the sync of your tv to work with 50Hz video.
(From: Tim Jacobs (timothy.jacobs@gecm.com).)

The output from these PAL VCRs won't always record properly, because they take advantage of the fact that the TV can put up with some signal variations that a low-bandwidth VCR (such as an ordinary VHS machine) can't.
The other big problem is the higher frame rate of NTSC as opposed to PAL. In NTSC you have 30 frames per second against PAL's 25. PAL frames have 100 more lines than NTSC frames. So to convert, you have to drop 5 frames each second, add 100 lines every frame, and then you have to worry about the Colour!
This is very complicated if you want good quality.
Here in the UK, there is a VCR available from, IIRC, Panasonic, that will convert between PAL, NTSC, and SECAM (French system). You chose your input system which is either from socket inputs or the tape play-back, and your output system which is to socket outputs or tape record. The machine then does the conversion for you.
The only problems I see with this VCR are, no TV Tuner, and they cost around 1000 UKPounds. (From: Chris Hall christopher.hall@bbc.co.uk).)
At a broadcast level, probably the best known TV standards converters are made by Snell and Wilcox. I have also used a Barco unit. At a PC level, Vine Micros made a number of boxes for much less money than broadcast kit which do the conversions between PC (and Mac) video standards and broadcast ones. (From: Steve Darsey, N5PMB (sdarsey@yahoo.com).)
We use a Sony DSC1024G everyday, does what you ask. Up to 1024x768 to NTSC or PAL video in composite, component (RGB or Y,RY,BY) and S. It will also go the other way. NTSC or PAL to a computer monitor. Also does NTSC to/from PAL. It will also do aspect ratio conversion. Did a letter box from a 16x9 source, no sweat. I have also seen it used to down-convert HD to SD TV.
The Hyperconverter is very comparable, at the time of our purchase, it did not do much more than pure scan conversion from the PC to video. I have no knowledge of their current model.
If price is no object, look for the Fulsom 9000 series boxes. Those machines can deal with much larger (over 1600x1200) pixel rates and will probably walk your dog and water the plants. :)
Find an AV rental or convention show production facility and see if they rent one. We use Alford Media, they have a few locations around the country.

What is a Scan Converter?

A scan converter accepts video of one format - say SVGA - and outputs it to some other format - say NTSC. Some are designed for fixed input format while others can adapt - possibly automatically like an auto-scan monitor - to a wide range of input scan rates and resolutions. Output format is most often selectable between NTSC and PAL scan rates (or those of other TV formats) with a variety of output options such as composite, RGB, SCART, and S-VHS.
The typical scan converter must implement the following functions. (This example applies to a unit designed to convert from SVGA or workstation video format to NTSC):

1. Analog to digital converter (A-D or ADC). In the case of VGA/SVGA or workstation video, there will be 3 video signals - R, G, and B - and each of these must be digitized separately. The A-Ds used are generally single chip 'flash' types using a bank of voltage comparators (e.g., 255 compares for 8 bits of output precision) or similar technique to achieve the high speed conversion needed in modern video applications. These may be able to convert up to 135 M samples per second or more as they must run at the dot clock rate of the RAMDAC of the input video source. A filter (input anti-aliasing) may be needed to limit the bandwidth of the input signal. Ideally, the sampling will be adjusted to occur at the center of each pixel but this is not always possible.
2. Full frame store. The resulting digitized data - usually 6 to 8 bits for each color - is stored in a frame buffer generally constructed from DRAM or VRAM. This memory must be capable of being written to and read out effectively at the same time - dual port or pseudo-dual port. In some special cases, less memory is needed but these are the exceptions. With VRAM, the input may use the serial port since it is strictly sequential (and very high speed) and the

readout can use the random access port for interpolation (since its rate is lower but multiple pixels and lines may need to be accessed, see below).

3. Readout and interpolation. Hardware must be able to access the frame store without conflict at the desired output scan rate. Since the output video format has a different (generally fewer) number of pixels per line and total scan lines, some means must be provided to combine multiple pixels and lines into the output video stream. For interlaced output (as used by most TV standards), some amount of interpolation between lines (in the vertical direction) is desirable to reduce the flicker of fine horizontal lines (in graphical material) which would otherwise fall in a single output video field. For RGB full color, there is a separate interpolator for each color channel.
    - Nearest neighbor interpolation simply uses the closest sample from the stored data. This is very easy to implement since it is just a matter of computing a memory address - often by just truncating bits. However, quality is poor - pixelly - and usually unacceptable for all but the least critical and cheapest applications.
    - Bi-Linear interpolation takes pairs of input pixels in the horizontal and vertical direction and combines them to form an output pixel that is their weighted sum. This results in a much smoother and more pleasing display. Since two pixels on each line and and two lines are required for the computation of each output pixel, the bandwidth requirements of the frame store and processing complexity are greater resulting in a more expensive system. However, this is the minimum level of interpolation required to produce decent quality output video.
    - Cubic or higher order interpolation uses more than two points in each direction resulting in somewhat better results at greatly increased cost. This is likely to be found mostly in the high performance professional equipment used in television studios and production houses.

    The output of the interpolator is typically 6 to 10 bits of data for each color channel.
4. Video digital-to-analog (D-A or DAC) converter. A high speed DAC (three for RGB) converts the each of the interpolated data streams to an analog signal. A filter (output anti-aliasing) may be needed to smooth edge transitions.
    - For driving RGB monitors, this is the final output.
    - For NTSC or PAL, RGB along with H and V sync are further processed by an RGB-to-NTSC/PAL encoder. It may output be composite video as well as separate Y and C to provide for various output connector options: RCA or BNC, S-VHS, SCART, etc.
5. Microprocessor control. Most modern scan converters use sophisticated computer control to provide for advanced levels of auto-scan, many user conveniences, stored setups, and so forth. Features may includes various amounts of user or RS232 (PC) controlled pan, scroll, and zoom; control of sampling times and speeds; and selectable levels of interpolation to control smoothness or sharpness.

However, in the end, no matter how the scan converter is implemented, if the ultimate destination is an NTSC or PAL TV, the resulting picture quality will be very limited. Even a $20,000 professional scan converter may not be able to display fully legible VGA on an NTSC or PAL TV.
For more information on features and selections of scan converters, try:

- http://www.extron.com/scancon.htm

(I have no affiliations with this company and am in no way necessarily endorsing any of their products or claims.)
Implementing a system of this type is a challenging task even for an experienced engineer with extensive design experience with both analog and digital systems.
(From: Derek Roberts (der@cam-orl.co.uk).)

If you really want to do this properly, check out the Genesis Microchip gmVLD8 which uses DSP techniques to do the un-interlacing. Of course you need to add an A-D, field or frame store and some control, But this is the basis of a decent quality scan converter.

What is a Scan Doubler?

This is a special case of a scan converter where the output format has roughly twice the number of lines as the input format and runs at twice the horizontal scan rate. Various scan doubler boxes are available commercially. For example, check out the offerings from Harmonic Reseach. (I have no idea of whether they are any good - just an example.)
The following is described for NTSC; A similar approach can be taken with PAL 625/50 to SVGA at 800x600, 50 Hz.
To convert NTSC interlaced at 30 frames/second 60 fields per second to VGA which is at 60 complete non-interlaced frames per second requires a simple scan converter. This is basically an NTSC color decoder and video A/D feeding a full frame memory storing RGB (probably at 24 bits), and VGA video D/A. I say simple to compare it to the general case where in addition to frame store, you need a high speed interpolator to convert between resolutions. VGA is close enough to NTSC resolution (at least in terms of the number of active video lines) that no interpolation is needed. See the section: What is a Scan Converter?. In either case, this is a non-trivial project. IMHO, this is a poor use of an expensive monitor. A $200 TV will likely look better.
An even simpler approach is possible as well which only requires a one or two line buffers instead of a full frame store. Each input line is read in and reformatted to the appropriate VGA line (even or odd) depending on which field is being displayed. The other lines are blanked (i.e., display even lines and blank the odd lines during the even field display). This would only require enough buffer memory for one or two scan lines (depending on whether the implementation uses a double buffer or more sophisticated write and read timing) which would be a significant cost and complexity savings compared to a full frame store. The disadvantage is that since half the lines are by necessity left blank, the maximum possible brightness of the display will be reduced. It is not possible to use the blank lines as the interleaving of the even and odd fields will be incorrect and result in a poor display.

Scan Doubler Chips

Several companies now provide single chip (or minimal chip) solutions to a major part or all of this problem. For example, Siemans has just announced the SDA9400 Scan Rate Converter which appears to includes nearly everything required - even the buffer memory - to convert from interlaced to progressive (i.e., non-interlaced) scan in Y-U/V format.
(From: Richard Birchall (birchallr@aecl.ca).)

AverLogic has a chip that makes the task of implementing a scan doubler almost trivial. From their product description: "The AL250 is a 64 pin single chip scan doubler/de-interlacer. It converts interlaced TV signals (e.g., NTSC or PAL) into non-interlaced RGB format for output to a PC monitor or LCD panel. The single device also corrects color accuracy on different types of CRT and removes jagged edge artifacts from motion pictures. To allow a regular PC monitor to display television or video input you just need to add a de-coder and the AL250."

What is a Scan Divider?

For the special case of converting from VGA at 640x480 (31.4 kHz H, 60 Hz V) to NTSC or SVGA at 800x600 (31.4 kHz H, 50 Hz V) to PAL, something simpler than a full blown scan converter may be satisfactory. In this case, it is only necessary to provide storage for a single scan line (rather than an entire frame store) since the input horizontal frequency is (almost) exactly twice that of NTSC (15.734 kHz) or PAL (15.625 kHz). A double buffer where one buffer is storing while the other is reading out at approximately half the VGA pixel rate should work. With appropriate timing, even

lines become the even field and odd lines become the odd field (I may have this backwards). It is still not a trivial undertaking. Keep in mind that the quality you will get on NTSC or PAL will be poorer than the VGA due to fundamental NTSC or PAL bandwidth limitations. Also, flicker for line graphics will be significant due to the interlacing at 30 Hz.

RGB to PAL Converter Chips

(From: Gary L. Sanders (75052.2665@CompuServe.COM).)
Philips has chips, as does Raytheon, these would take digital RGB and convert to oversampled PAL output.
(From: Mike Diack (moby@kcbbs.gen.nz).)
Analog devices does a chip (AD720) which has the delay & filter elements on the chip itself.

Digital Video Conversion Chips

> "I'd appreciate on an Integrated Circuit (IC) made by a Hong Kong company called Display Research Laboratory."

(From: Philip Decker (pdecker@lds.loral.com).)
The IC is a Video Interlace Processor (VIP), part number VIP-01033. It converts 16-bit digital VGA video (5:6:5, R:G:B) to similarly formatted NTSC/PAL compatible video.
The IC can also be bought as part of a circuit board with additional components, producing composite, Y/C, and SCART analog RGB outputs, in three different configurations:

- piggy-back to VGA, via feature connector ($55)
- external VGA to TV converter ($90)
- ISA bus card with VGA included ($180)

Black Level Clamp

> "I'm looking for a simple GOOD black level clamp circuit for clamping a video signal."

(From: Joseph H Allen (jhallen@world.std.com).)
This is actually a very interesting subject. Assuming you have a constant video level (or AGC), a simple diode clamp on the horizontal sync tips (diode clamp the sync so that the black level is where you want it) is actually a high quality black level clamp. The sync level is constant after all. I use this method in accurate video digitizers for DC restoring the video before putting it into an A/D converter. The cool thing about simple diode DC restorers is that the capacitance is usually much less than that of the analog switches needed in other types. For example one of the best analog switches is the readily available 74HC4316, but even this has 40pF (if memory serves) on its pins.
The really hard part is finding a high quality large-signal linear video amplifier. If the video is capacitor coupled to the video amp, then the average brightness level will change the voltage of the black and sync levels seen by the amplifier. This is ok if the video amp is linear, but most aren't so the sync amplitude ends up changing depending on brightness. I.e., the black level will change depending on the brightness of the image (this is completely unacceptable for medical image capturing devices, for example).
The way linearity is measured for video amplifiers is the term "differential gain". It gives the largest difference in percent between a constant small amplitude signal (traditionally the color carrier is used for this) measured at different voltage levels (hopefully which sweep the entire output swing of the video amplifier).
Now you have to be very careful about manufactures differential gain measurements. Many of them play games to get even a mediocre 3% - 1% differential gain. Typically they specify this parameter with a reduced output range (when you really want the parameter to apply to rail-to-rail output swings so you can get a 2V signal needed for most A/D converters) or limit the input range, the gain

or flat out lie (I have no idea where comLinear got the specs for their clc520/522 variable gain amplifier, for example. It says .5% in the datasheet, but I measure it to be more like 5%).
All older video amplifier ICs (like the uA722 and NE592) are really lousy. Discrete transistor amplifiers also suck (many monitors use a cascode amplifier which is very bad). Most new ICs suck too- especially those which are labeled as video amplifiers. The only ones which I have been satisfied with are the newest current feedback OP-amps (the + side is high-impedance, but the - side is zero ohms. Usual op-amps are linear, but have a limited bandwidth because the - input is high impedance). These have enough open-loop gain so that they really are linear. One that I really like is the AD9617: .01% differential gain (!), 160MHz bandwidth, immense slew rate (settles to less than 1% of final value within 10ns or so) and only costs about $10.
If you need variable gain (for AGC perhaps), the best chip to use the AD834 500MHz multiplier. This little 8-pin chip is expensive (like $40) but it is the only thing that even approaches being linear (and even it is quite a bit worse than the AD9617).
(From: Brian Campanotti (bcampano@toronto.cbc.ca).)
Look at the Clamping ICs from Gennum Corp (part numbers GB4550 and GB4551). They do input buffering and clamping. They are a good front end to any video project.
(From: Mika Iisakkila (iisakkil@alpha.hut.fi).)
Since your application probably needs some kind of an input/output buffer anyway, you might consider some integrated DC restored video amplifier. Elantec makes excellent such chips; data sheets are available on their web site<HTTP: www.elantec.com under "application specific: video". EL2090 is really good as far as video quality goes, but a bit expensive for applications that don't need 100 MHz bandwidth and near-zero droop. EL4089 is simpler and cheaper, but not quite "broadcast" quality. There's also some new chip, but I haven't looked into it yet.
For both chips, you'll need to get the sample pulse from somewhere, so you can't lose the LM1881. I've used the burst gate output from it to control 2090's sample input, and quality of the result far surpasses my measuring instruments.

Inverting an Analog Video Signal

Inverting a video signal means doing something to both the luminance (intensity) and chrominance (assuming a color signal). This is not totally trivial (at least, it is more than just putting it through an op amp). You would have to convert to baseband, strip off the sync and invert the signal, recombine with sync, remodulate to channel 3 or 4.
If you want to also invert the colors, then you have to decode the chrominance to RGB, invert these, reencode, recombine, etc.
The assumption here is that the input is an NTSC or PAL composite video signal and that the desired output is a valid composite waveform with negative sync tips. In this case, what is required is as follows:

- Sync separation to identify and preserve the sync relationships.
- NTSC or PAL to RGB conversion.
- Inversion of the individual RGB components.
- RGB to NTSC or PAL conversion along with the sync.

Bypassing the conversions would be messy as you would be dealing the chroma phase space - I wouldn't even want to risk a wild guess as to what would be involved.
For monochrome video, the conversion steps would be replaced with a simple inverting amplifier and possibly an analog switch to merge the sync.
There may be some shortcuts one can take but you get the picture (no pun).
(From: Joel Kolstad (kolstadj@CSOS.ORST.EDU).)
Also note that straight video signal inversion will produce some... interesting... color changes, but not the same changes as you get from photographic film. For monochrome video, the end result will look like a photographic negative.

Miscellaneous Video Conversion Topics

CGA Boards with NTSC Output

Old CGA cards had RCA outputs. Usually those cards had one monochrome monitor output and other output was composite video (usually NTSC).

NTSC/PAL to RF (Channel 3/4) Output

This is called an RF modulator. Every VCR in the universe has one of these and the vast majority are in self contained modules that can be reused. It will be the silver colored metal box that has the two RF (antenna and TV) connectors.
These are also available from surplus electronics outlets for under $5 or as generic replacements for VCR servicing for $12 to $20.
The only connections required to make them work are a source of regulated power - 5 to 12 V depending on model and possible s control voltage to select output instead of pass-through mode.

SVGA Monitor on Sun Sparc

This question comes up somewhat less frequently than the opposite (Sun fixed or dual frequency monitor on PC SVGA):

- It needs to accept the single or dual fixed frequencies put out by the Sun frame buffers. This shouldn't be a problem for most modern higher-end SVGA monitors but it should be confirmed. These specs should be in the Sun user manual.
- It needs to accept composite sync. Sometimes, this is listed as a feature in the monitor specifications. Or, it may work but not be advertised where the monitor is to be connected to a PC (i.e., why manufacture more than one version of the monitor circuitry if you don't have to?). Else, you will need an adapter to separate the H and V sync.
- You will need a 13W3 to HD15 cable. Unless the adapter cable provides them, the monitor sense lines will not be present (at least not automatically), so you may have to tell the Sparc the resolution explicitly.

(From: jmz@southwind.net).
Most any multisync "VGA" style monitor will work with the GX, TX or CG3/CG6 frame buffers on a Sun Sparc. Commercial 13W3 cables and adapters are available or you could get the instructions from a couple of places on the net.
I use my ViewSonic 17s on both Macs and Suns.
You should have a copy of Birdsall's Sun FAQ and you may wish to join the Suns-at-Home mail list, for all Sun self-maintainers. Use a search engine for these and they should vector you to the cable pinouts as well.

Items of Interest

Various Video Standards

Various Standards for Analog Component Video SCART Interface Definitions S-VHS Interface Panellink (serial digital rgb interface standard for displays).

General VGA Information

(From: Tomi Holger Engdahl (then@tinasolttu.cs.hut.fi).)
VGA monitor pinout can be found at:

- http://www.hut.fi/Misc/Electronics/docs/old/vga_bd15.html

and more related links at

- http://www.hut.fi/Misc/Electronics/pc/video.html#connections

VGA signal timing details are documented at:

- http://www.hut.fi/Misc/Electronics/docs/pc/vga_timing.html

Information on how one commercial VGA to TV converter grabs a VGA signal can be found at:

- http://www.hut.fi/Misc/Electronics/circuits/vga2tv/box800.html

Information about video signals in general can be found at:

- http://www.hut.fi/Misc/Electronics/video.html

TV Capture Cards for PCs

Here are some Web sites of companies who market various video products for PCs.

- http://www.hauppauge.com/hcw/index.htm
- http://www.aimslab.com/f_products.htm
- http://www.fast-multimedia.com/fast/html/products/products.html
- http://www.tekram.com/tvcaptur.html
- http://www.miro.com/e/e2-products/products.html
- http://www.diamondmm.com/products/visualization/dtv-1100/
- http://www.matrox.com/mgaweb/mediaser.htm#mediatv

But be careful, what they say is not always the reality...
Here is an example of a homebuilt video digitizer:

- http://www.ucl.ac.uk/~ucapwas/video.html

Mixing of Independent Video Sources

If they are truly independent, then this is a non-trivial problem. You will need to either:

1. Genlock the two video signals so that they are in sync before mixing. Depending on the sources, the difficulty may range from easy to impossible. Production video equipment will probably have the necessary inputs and outputs. Consumer stuff probably will not. For mixing N signals sources, N-1 will need to have genlock inputs.
   If this is not possible then (assuming two sources):
2. You need a real time programmable video delay. This would typically consist of a video A/D, dual ported frame store, readout delay timing logic, and video D/A. Since there is no way to assure the precise phase stability needed for PAL encoding, you would probably need to separate the luminance and chrominance and deal with them separately.
   The delay would need to be anywhere up to 1/2 frame (or 1 frame if only one of the sources can be delayed). Not an afternoon project. For N sources, you would need N-1 0 to full frame delay units. Also note that commercial broadcasts will sometimes shift frame reference when cutting between remote locations which are not genlocked. If these sources are to be supported, you will need an automatic adjustment scheme to maintain synchronization.

For info on the availability of commercial devices, you may want to post to one of the video newsgroups - rec.video.production, for example.

Studio Video Recording or Filming Directly from Monitors

> "I'm designing graphics for a computer that is used on a the set of a TV show. When the camera operators shoot the screen, horizontal lines roll up and down. I assume it has something to do with the scan rates. I know there is a small program for the Macintosh that corrects this, but I know of nothing for the PC. Does anyone know?"

(From: Dic (dic@werple.mira.net.au).)

This depends on whether they are shooting on video or film. There are display cards for PC which allow you to dial up the vertical output rate, which you want to match to either 30Hz(NTSC frame rate) or 24Hz (typical film frame rate). Multiples are fine, i.e. 60 or 48Hz respectively.
But that isn't the end of it. You may have (approximately) matched the frame rate of the camera, but you have to also lock them together as there will be a certain amount of drift due to slight differences in the two scan (frame) rates. For film there are devices called a Computach or a Synclock, which attach to the movie camera and take a video input (you can just feed it sync from your PC card but you may need to fiddle the level or polarity).
On set, they roll the camera and adjust the shutter phase so the vertical blanking bars on the PC fall in between movie frames. The synclock then keeps the camera perfectly synchronized to the PC sync.
If you're shooting on video it's a bit harder. You need to genlock the video camera to the PC, which can be awkward as the PC sync may not be quite steady enough (directors HATE having to lock to ANYTHING).
The hardest thing to do is run several PC's in the same shot, because they won't be scanning in sync; you can lock your camera to only one at a time. If anyone knows of PC videocards that can be genlocked together I'd be very interested.
We do a lot of this kind of work and at the end of the day, particularly if there is more than one PC in shot, we record the computer graphics to video and use Amiga monitors, because they look like PC monitors but take video input. We use Umatic or Betacam tapes because the playback machines can be drum locked together. Obviously though, if you need a high degree of interactivity with the actor, this won't work too well.
The vertical blanking bar on a PC is quite fine so if they aren't in the foreground you can usually get away with just matching the vertical rate of the PC as close as possible to that of the video/film camera. You won't see flicker, just a fine dark line moving up or down the picture slowly.
That is about the sum total of my experience but if anyone else has better suggestions I'd be very interested. I have seen some TV/movies with multiple computers in shot with no sign of flicker or blanking bars; maybe the bars are just too fine to show up?
(From: falcon@tao.agoron.com (Tom Strano)
In the previous section, the author mentions the problem of videotaping a shot that includes a computer screen, and goes into great depths about sync problems and such this answer is too simplistic, but I've found that simply using a video mode of 640*480, any number of colors, results in an extremely stable picture, even when taped with a cheap consumer camcorder. I've even done this to tape directly off a screen in a pinch. I've done this with at least 3 different computers, all with different monitors and video cards, and it always works fine. Perhaps I'm just luckier than some technicians...

Video Controller Timing

> "I wonder if anyone could tell me a good reference on how CRT controllers operate. Specifically, how do the HSYNC, VSYNC, BLANK, and dot clocks interact. Or, would some kind soul like to explain it? Thanks."

I am not exactly sure what you really want but here are some simple descriptions:

- DOT Clock: the pixel clock. 1/(Pixel period).
- Hactive: the time during which video on a line is actually displayed.
    - Hactive*DOTclk=#Pixels.
- Hblank: the time during which no video is displayed and the beam is being retraced.
- Hsync: positive or negative pulse during Hblank which synchronizes the horizontal deflection circuits of the monitor.
- Htotal: Hactive+Hblank.
- Vactive: the number of lines during which video in a frame is visible.

- Vblank: active for the number of lines during which video is not visible and the beam is retracing to the top of the screen.
- Vsync: positive or negative pulse during Vblank which synchronizes the vertical deflection circuits of the monitor.
- Vtotal=Totaltime=(Vactive+Vblank)*Htotal.
- Csync: Hsync combined with Vsync usually be ORing or XORing.
- Cblank: Hblank Ored with Vblank.
- Composite video: Video combined with Csync usually the video is .7 V p-p positive-bright riding on top of .3 V negative Csync.

For RGB, some monitors will want 'sync on green' which is this type of signal only for the green video. R and B and just the straight video. Mono composite is this signal. NTSC/PAL: RGB color encoded and modulated. Composite video is used for the luminance (intensity) with the color information modulated on a subcarrier (which is ignored by a B/W TV).
One source for info on timing specs is the data sheet for a video DAC or RAMDAC. They will usually define all of these parameters.

Sync Generator Chips

(From: Rob-L (rob-l@mars.superlink.net).)
DigiKey lists 74ACT715PC-ND as "Video Synchronous Generator NEW!" It is a 20 pin DIP and costs $17.50 each for small quantities. The surface-mount version is SC instead of the PC in the above number. You have to pay an extra $1 for the datasheet if you want one. 1-800-DIGI-KEY is their order line. http://www.digikey.com/ is their web address.
(From: (opal@opal.co.il).)
Try philips SAA1101.

Sync Separators

(From: Myron Brookshire (harris.mbrooksh@ic1d.harrris.com).)
Try using the National Semiconductor LM1881 It's a 8 pin DIP that does exactly what you need. I think it costs @ $8.00 and you only need a couple of caps externally.
(From: Jan Arvidsson (janarv@algonet.se).)
The EL4583C from Elantec has a dedicated HSYNC output in addition to CSYNC and VSYNC outputs, available on the less expensive LM1881 (National). It is of course very easy to derive a pure HSYNC signal from the CSYNC output!

Dead VCRs and Composite Monitors

Most VCRs go to their graves not because of electronics problems but because of the death of the tape transport. Or, perhaps, because the owner was not willing to spend the money or take the time to resuscitate (or has killed it due to improper servicing). Of course, it might just need a 50 cent rubber tire (but that is for another FAQ). What this means is that the tuner and video circuitry is generally as good as the day the VCR rolled off the assembly line.
If you have a composite monitor (probably gathering dust at this point), then this in conjunction with the otherwise useless VCR will result in quite a nice TV. Many CGA monitors as well as early auto-scan or multi-scan monitors have NTSC (or possibly PAL) compatible composite inputs. Some even have built in speakers. A set of RCA patch cables and you are all set. Since they were designed for high resolution (at the time) computer applications, the quality is generally excellent. (Note: I do not make the same quality claims for modern SVGA monitors as their display is optimized for high scan rate computer video and not CGA or NTSC). In addition, controls are usually accessible to permit any desired degree of underscan or overscan.
It may even be possible to use the VCR's timer to turn your rig on and off automatically! (It just requires faking out the record/cassette interlock and locating a signal that can be used to control a power relay.

Conserve your landfills - save a VCR!

Video Cables

> "Does anyone know about the specifications of the video and sync signals for VGA monitors?"

Video: .7 V p-p, (more positive is brighter).
Sync: separate horizontal and vertical TTL signals. May be either polarity.

> "I am trying to send VGA signals over some 180 feet of cable, I'd especially be interested in the required line impedance of the cable."

Line impedance: 75 ohms terminated at both ends.

> "Is it possible to produce a Composite Sync signal (or maybe even a composite video signal) that could be fed into an off-the-shelf VGA monitor, so I could use only 3 instead of 5 coaxial wires in parallel?"

RG59U 75 ohm coax is what is normally used, but you will need a good quality cable to go 180 feet without too much signal degradation. Of course, it also depends on what resolution and thus what video bandwidth you need and how much dispersion (signal delay as a function of frequency) you can tolerate.
It is relatively easy to combine the H and V syncs together and then combine these with the video (usually the green signal for 'sync-on-green') but most low cost VGA monitors do not support this mode and you would then need to separate the signals at the far end. You could come up with alternative ways of combining the signals to save on cables but these will all complicate your circuitry at the monitor end. There are multiple coax cables inside a single sheath for just this purpose.

Building a 5 BNC Cable

This is straightforward, if time consuming and tedious.
The five coaxial cables (75 ohm, RG59 typical) are wired as shown in the table. The corresponding VGA connector pin numbers are in ().

Coax Center	Coax Shield
Red Video (1)	Red Return (6)
Green Video (2)	Green Return (7)
Blue Video (3)	Blue Return (8)
H Sync (13)	Ground (5,10)
V Sync (14)	Ground (5,10)

Tie pin 11 (ID0) to Ground to indicate a color monitor. Leave pin 12 (ID1) open.
Make sure that the lengths of the cables are fairly well matched - to within a couple of inches - to assure that the 3 color channels line up precisely. (One foot of cable is about 1.5 to 2 ns of delay which is significant for a 10 ns dot clock!).
Also note that you will lose your 'Plug-and-Play' capabilities without the direct control connections to the monitor (or for monitors without these features).
That's it!
You will wish that your fingers were about 10 times smaller than they are, however. :-)

Tweaking the Deflection Rates of a Fixed Frequency Monitor

Pulling a fixed frequency monitor by more than a few percent will likely be a problem. I know this is not the answer you were looking for but getting a new inexpensive video card, video card designed for fixed frequency monitors, or new monitor, may be a better solution.

If you insist, the adjustment would be called something like horizontal oscillator, horizontal frequency, or horizontal hold. If you do tweak, mark everything beforehand just in case you need to get back to the original settings.
WARNING: Make sure you understand the issues involved in working inside a monitor! See the document: Safety Guidelines for High Voltage and/or Line Powered Equipment. Something that looks innocent can really ruin your whole day!
There is also some risk to the monitor - changing it too far may result in damage either immediately (the horizontal output transistor or power supply may blow) or increase component stress reducing reliability and shortening its life. There is no way to know without looking at the design.

Modifying a CGA (or EGA) Monitor for NTSC or PAL Input

These are often high quality monitors and would make nice TV displays - especially as there are many no doubt gathering dust on their way to the dumpster!
However, these are digital (TTL) monitors with respect to the video inputs and proper linear video amplifiers may not even be present. Therefore, you may need to implement both the NTSC or PAL decoding as well as boosting the signal levels to the hundred volts or so needed to drive the CRT.
The scan rate of CGA is the same as NTSC so deflection is not a problem.
For PAL (625/50) instead of NTSC, the vertical rate will need to be reduced to 50 Hz but this should not be a problem. The horizontal scan rate is close enough (15.625 kHz).
Similar comments apply to EGA monitors that have a compatible scan rate. EGA represents a range of scan rates between 15.75 kHz and 21.85 kHz so this should not be a problem.

How Can I Determine Monitor Specifications or Whether It Supports SVGA?

There is no easy way to tell by just examining the monitor visually. Even those with only a 9 pin rather than a 15 pin connector are sometimes SVGA (e.g., Mitsubishi AUM1381 and NEC Multisync II which will do 800x600 at 56 Hz V non-interlaced and 1024x768 interlaced at 43 Hz V).
You cannot even safety test scan rates on all monitors - some will blow up or be damaged by being driven with incorrect video.
For a monitor that you already have, posting the model number or looking it up is really the only way to be sure of its capabilities.
Quicky tests:

1. Check the video connector. If it has a high density (VGA) 15 pin connector then there is a greater likelihood of SVGA but not always.
2. Check the manufacturing date on the back. If it has a manufacturing date of 1991 or later, the likelihood of it supporting SVGA is higher as demand for VGA-only monitors was rapidly declining by this point.
3. Check the dot pitch on the CRT by examining the screen with a magnifier. If it is really coarse, the monitor probably cannot do anything beyond VGA.
4. Become familiar with the major manufacturers and models so that you will recognize the common SVGA models.

While not conclusive, positive results on the first 3 of these tests definitely increases the likelihood that it supports at least some SVGA modes. Of course, if you recognize a model number, you have dramatically increased your odds of success - assuming it works!
The following URLs provide quick access to the general specifications of many common PC and MAC compatible video monitors:

http://www.mindspring.com/~nunez/info/monitors/ (Computer Shopper)<liGriffin Technology

- Hercules
- Monitor World
- Rasterstone

- Table of monitor specs

Low Cost VGA Hacking

Typical question:

> "I have an old mitsubishi monitor, model number C3919N, Scan rate is 15.5-23.5kHz horizontal, analog. I want to run video from my pc svga card into this monitor. I found the correct video mode, resolution, etc. in which it works, but have one problem. I get two perfect images displayed on this screen."

(From: Martin Moeller (mmoeller@delphi.com).)
I have a copy of a very detailed book on using old 19" monitors for VGA:

- The Cheap VGA book
  Self Published by a Michael Johnson, Esoteric Electronics
  35-R Derryfield Road
  Derry, NH 03038
  Night only Phone: 1-603-434-8494

This book contains a lot of good information and advice. He also sells kits for less than $50 (see comment below --- sam) to make the sometimes needed sync inversion from VGA. (VGA cards invert H and V sync depending on mode to tell the monitor what rate to go to. As far as I know only IBM ever used this.)
I have not tried his kits but the book is very good. BTW if you pay much more than $300 for a 19' surplus monter you have been moderately had. I do not have any other connection with this person, I just think his book is very good if you are even thinking of using a "non-VGA" monitor with a VGA card. (From the Editor).
A circuit to perform the automatic sync polarity correction is shown at:

- http://www.hut.fi/~then/circuits/vga2tv.html

The cost of the parts for this circuit is probably under $5 even if bought from Radio Shack.
Note: I believe there may be a problem with the use of normal or LS TTL for the sync buffers of this circuit due to their sourcing of current when the input is LOW. A gate with a Low Level Input Current of less than .2 mA should be used. (--- sam)

Real Time Multi-Screen Displays

These are the type of displays used to view multiple video inputs simultaneously on a single screen - security monitoring, for example.
You have two problems: compressing the signals to 1/4 screen and synchronizing them. The straightforward (though not simple) approach is to digitize each at 1/4 resolution into a frame buffer which is read out at NTSC rates. This overcomes the issues of genlocking and timing of the 4 quadrants.

On-Screen Display Implementation

> "I am looking for chips that do on-screen display of text and simple graphics. I've got some information about a Philips chip PCA8516 which seems to be a pretty nice complete chip for doing everything I want. Are there other chips out there that do this as well?"

(From: Jack Climent (rocket5@haven.ios.com).)
When you are looking for something for the consumer marketplace, Look toward Mt. Fuji :-).
The MB88303 from fujitsu is an "NMOS Television Display Controller" And the NJM 22075 is a "Sync & Video SuperImposer". These two chips and very little else form a complete on screen text & Min graphics system. Add a uC and you are in business. Also low cost and easy to implement. Have hardware & software someplace if needed.

(From: Winfield Hill (hill@rowland.org))
This isn't an easy thing to do, as quite a bit of electronics is required. Fortunately, this function is needed for TV sets, VCRs etc and several manufacturers have created custom VLSI chips to do the task, which is called On Screen Display or OSD. For example, Phillips, SGS-Thompson, Rohm, and NEC, etc. all make OSD chips. Some, like Motorola, include the OSD function within a microprocessor.
I like the NEC uPD6464A chip.
Using an OSD chip, you can roll your own design (e.g. see Sept and Oct 1996 Electronics World, which uses a discontinued chip!), but it's still a non-trivial task! One easy solution is to purchase an OSD already on a pcb, with all the extra circuitry and C source code software. E.g. BOB-1 from Decade Engineering in Turner, Oregon (503-743-3194). It uses the Rohm BU5963AS chip and cost $169 each ($200 with the software).

SCART Site

- http://www.mindspring.com/~kjack1/scart.html

Video Resizing

> "I'm looking for a device to do resize (in horizontal direction only) of a video signal. Basically I need a fractional decimator (in this case 2:3). Harris has some stuff that might be useful, and Phillips has some devices but I think they're more geared towards NTSC/PAL (data rate here is around 20 MHz, but, then again, isn't the luminance typically sampled at a pretty high rate?). Anyway, I also know I could do it in an FPGA with bit-serial arithmetic, but I'd rather buy something."

(From: David L. Tosh (dlt@earthlink.net).)
Check out:

- http://www.gennum.com/vbprofam.htm

Gennum makes several multirate filters vor video resizing.

Video Resolution of Various VCR Formats

Luminance Specifications:

- VHS (240 lines) - FM Dev: 1 Mhz; Freq Range: 3.4-4.4 Mhz. (Sync tip - White)
- SVHS (400 lines) - FM Dev: 1.6 Mhz; Freq Range: 5.4-7 Mhz.
- BETA1 (250 lines) - FM Dev: 1.3 Mhz; Freq Range: 3.5-4.8 Mhz.
- BETA2/3 (240 lines) - FM Dev: 1.2 Mhz; Freq Range: 3.6-4.8 Mhz.
- SuperBETA (285 lines) - FM Dev: 1.2 Mhz; Freq Range: 4,4-5.6 Mhz.
- ED BETA (500 lines) - FM Dev: 2.5 Mhz; Freq Range: 6.8-9.3 Mhz.

The above refers to resolvable horizontal resolution - the maximum number of vertical lines that can be seen using an arbitrary high quality monitor to view the VCR's output. Also, this applies only to luminance - intensity, not color. The color resolution is much lower and in the particular case of SVHS vs. VHS at least, not improved over VHS since it is recorded in exactly the same way. Also, I don't know whether this is a just noticeable difference (JND) or percent response type of spec where the lines are really just resolvable.
Vertical luminance resolution in the monitor or TV is determined by the video standard (NTSC, PAL) and the quality of the monitor or TV. Specifically, for NTSC (525 total lines for NTSC) there can be a maximum of 482 or so active video lines and something like 580 for PAL (625 line). The remaining lines are for blanking and sync during retrace. These are physical scanning lines.
Vertical luminance resolution for the VCR is determined only by the number of active video scan lines for each standard.

Factors which reduce the effective vertical resolution are CRT focus (spot size) and stability of the interlace, and Kell factor. (See the section: What is Kell Factor with Respect to Interlaced Displays?.
Depending on the video standard, vertical color resolution may be less.
Depending on the video source, there will be a variety of other factors which reduce the effective resolution horizontally and vertically.

What is Kell Factor with Respect to Interlaced Displays?

(From Bob Myers (myers@fc.hp.com).)
The Kell factor - which has to do with the fact that we're often undersampling an image from the standpoint of the Gospel According to St. Nyquist - IS a factor in the reduction of vertical resolution, but interlacing plays a part as well. This comes from at least two factors:

1. The monitor or receiver usually cannot precisely interleave the two fields.
2. More importantly, there are steps taken to reduce the interline flicker which reduce the effective vertical resolution. This includes running the line width of the display somewhat larger than would otherwise be the case, and in interlaced cameras, discharging the entire screen (including the lines from the "other" field) after every field scanned.

Interlace is particularly troublesome on moving images, where you will often perceive momentarily "missing" details. There was a LOT of discussion regarding the gory details of interlacing in the recent HDTV debates within SMPTE and other groups.

Common PC Video Connector Pinouts and Assorted Monitor Info

Many of these are also available at the Sci.Electronics.Repair FAQ site (and its mirror sites) in the document: Pinouts for Various Connectors in Real Life(tm).
Also see the connector info at:

- http://oacosf.na.astro.it/rossi/hwb/hwb.html

Video Graphics Adapter (VGA)

Note that IBM called VGA 'Video Graphics Array' probably in reference to the video memory. However, we will use the more popular terminology since it agrees with the naming conventions of the other PC standards.
Original VGA (31.5 kHz - 640x480)/SVGA (35-37 kHz - 800x600) 15 pin sub D:

```
                                        6
 1 Red (Analog)   6 Red   Return    11 (ID0) GND (Color)     11. . . 1
 2 Green (Analog) 7 Green Return    12 (ID1) NC (Color)        . . .
 3 Blue (Analog)  8 Blue  Return    13 Horizontal Sync        . . .
 4 Reserved       9 No Connect      14 Vertical  Sync         . . .
 5 Ground        10 Ground          15 No Connect             . . .
                                       15  10  5
```

Note: Monitor ID Lines ID1,ID0=NC,G for color; G,NC for Mono. ID0 only may be used.
Mono VGA is similar using only the Green Video and Return.

VGA (VESA Standard)

(From: Bob Myers (myers@fc.hp.com).)
Note that many of the pins shown above as "no connects" (actually, these were sometimes used as monitor ID bits by many manufacturers) are now defined under the VESA Display Data Channel standard. This standard provides two protocols for display ID and control, including support for the full ACCESS.bus interface. The current definition of the "VGA" pinout per the DDC standard is:

```
                                                          6
 1 Red (Analog)   6 Red   Return       11 Monitor ID0 (opt.)    11. . . 1
 2 Green (Analog) 7 Green Return       12 Data (SDA)              . . .
 3 Blue (Analog)  8 Blue  Return       13 Horizontal Sync         . . .
 4 Reserved       9 +5 VDC (frm host)* 14 Vertical  Sync          . . .
 5 Return        10 Sync return        15 Data clock (SCL)*       . . .
                                                         15  10  5
```

Those signals marked with an asterisk would be supplied by the host only if the host supports the DDC2 protocol (I2C or ACCESS.bus).

VESA Display Data Channel Standard

(From: Bob Myers (myers@fc.hp.com).)
This defined several protocols for digital communications between a host system and its display. DDC provides 3 different modes:

- DDC1 - A unidirectional (display to host only) serial communications system which provides basic display ID and feature support information (including supported timings, display size, colorimetry and gamma, etc.) to the host. This uses pin 12 on the 15-pin "VGA" connector as a data line.
- DDC2B - Adds clock (pin 15) and return (pin 11, I think - I'm at home, and don't have the standard with me) to enable at least ID information to be obtained via an I2C interface. I2C is a bidirectional interface, but display control via DDC2B is not defined at this time.
- DDC2AB - Full ID and control of the monitor via ACCESS.bus. As ACCESS.bus is basically a command and protocol definition on top of the I2C hardware interface, this uses the same lines as DDC2B.

DDC was the first and only definition of the 15-pin D-subminiature video output connector which VESA has provided. No further definitions on this connector will be made, as VESA is instead concentrating on the new Enhanced Video Connector standard which is due out later this year. This will define a completely new connector which will include support for DDC and separate syncs as in the 15-pin D-sub, and will also include support for audio I/O, video input, and the USB and P1394 serial interfaces.

VGA - 9 Pin

This is pretty standard as the NEC Multisync II, Tatung CM1495, and others use the same pinout. However, there is at least one other pinout that has been used which is similar to the CGA pinout. Also see the document: Pinouts for Various Connectors in Real Life(tm).
I used a multimeter to determine this on the VGA to 9 pin adapter for a NEC Multisync II.

Pin 1: Red Video Pin 2: Green Video Pin 3: Blue Video Pin 4: H Sync Pin 5: V Sync Pin 6: Red Return Pin 7: Green Return Pin 8: Blue Return Pin 9: Ground

Note: IBM PGC assigns pin 4 to Composite Sync and pin 5 is a no-connect.
BTW, don't use an EGA 9 pin extension cable to connect it to VGA. While this will work, the wires are not shielded or the wrong wires and you will get ghosting and ringing at vertical edges. I constructed mine using proper 75 ohm coax for the RGB and H and V sync as well (though it is not needed for the sync).
(From: Carl Mueller).

If you're sure it's a VGA monitor (not CGA or EGA, which are not compatible with VGA), then there are two possible likely pinouts for the plug. I believe they are both detailed in the ibm PC hardware FAQ. One possibility is the CGA pinout, and the other is the 9-pin VGA pinout. Check the grounds to find out.

Enhanced Graphics Adapter (EGA)

p> EGA - TTL (15.74-21.85 kHz) 9 pin:

```
 1 GND                    6 Secondary Green Video/Intensity
 2 Secondary RED Video    7 Secondary Blue Video
 3 Primary RED Video      8 H Sync TTL Positive
 4 Primary GREEN Video    9 V Sync TTL Negative
 5 Primary BLUE Video
```

Color Graphics Adapter (CGA)

CGA - TTL (15.75 kHz - 320x200 or 640x200) 9 pin:

```
 1 GND                    6 Intensity
 2 Unused                 7 Unused
 3 RED Video              8 H Sync TTL Positive
 4 GREEN Video            9 V Sync TTL Positive
 5 BLUE Video
```

Dell UltraScan 17ES

This pinout may be used by a number of Dell monitors. The connector looks like a standard VGA/SVGA HD15 but is wired differently (for some unfathomable reason).
(From: Chris Lawson (lawsonc@micron.net).)

> Pin 1: Gnd Pin 2: Red video Pin 3: Gnd Pin 4: Green video Pin 5: Gnd Pin 6: Gnd Pin 7: NC Pin 8: VSync Pin 9: HSync Pin 10: Blue video Pin 11: NC Pin 12: NC Pin 13: NC Pin 14: NC Pin 15: NC

Monochrome Graphics Adapter (MGA)

```
MGA - TTL (18.43 kHz - 720x350) 9 pin:
 1 GND                    6 Intensity
 2 Unused                 7 Video
 3 Unused                 8 H Sync TTL Positive
 4 Unused                 9 V Sync TTL Negative
 5 Unused
```

MacIntosh Video

Mac II - analog (35 kHz H, 66.67 Hz V - 640x480) 15 pin. Mac II and Quadra - analog (49.7 kHz H, 74.55 Hz V - 832x624) 15 pin.

```
 1  Red Ground             9 Blue Video
 2  Red Video             10 Sense 2
 3  Composite Sync        11 Ground
 4  Sense 0               12 Vertical Sync
 5  Green Video           13 Blue Ground
 6  Green Ground          14 Ground
 7  Sense 1               15 Horizontal Sync
 8  Reserved (+12)
```

Mac (16") Monitor Info

(From: Dale Adams (adams9@apple.com).)
Note that the Apple 16" monitor is a fixed frequency display - i.e., it only works at one resolution and scan frequency. Here are the partculars:

- Resolution: 832x624
- Pixel clock rate: 57.2832 MHz
- Vertical scan rate: 75 Hz
- Horizontal scan rate: 49.7 kHz

Here's the pinout for the Apple DB15 video connector:

Pin	Signal	Description
1	RED.GND	Red Video Ground
2	RED.VID	Red Video
3	CYSNC~	Composite Sync
4	MON.ID1	Monitor ID, Bit 1
5	GRN.VID	Green Video
6	GRN.GND	Green Video Ground
7	MON.ID2	Monitor ID, Bit 2
8	nc	(no connection)
9	BLU.VID	Blue Video
10	MON.ID3	Monitor ID, Bit 3
11	C&VSYNC.GND	CSYNC & VSYNC Ground
12	VSYNC~	Vertical Sync
13	BLU.GND	Blue Video Ground
14	HSYNC.GND	HSYNC Ground
15	HSYNC~	Horizontal Sync
Shell	CHASSIS.GND	Chassis Ground

You can pretty much ignore the ID bits. You can try the following cable pinouts to match to a VGA connector.

Mac Video DB15		VGA Connector HD15
2	Red Video	1
1	Red Ground	6
9	Blue Video	3
13	Blue Ground	8
5	Green Video	2
6	Green Ground	7
15	Hsync	13
12	Vsync	14
14	Sync Ground	10

Mitsubishi Diamond Scan Monitors

These monitors accept PC video (at least standard VGA - 640x480 at 60 Hz - but have non-standard connectors. Here are two types - there may be others.
(From: Tony Matt (tonym@world.std.com).)
Cable for Mitsubishi Diamond Scan 20M (Model HC3925ETK)

Pin Function	PC Connector	Monitor Connector
Red (Analog)	1	2
Green (Analog)	2	4
Blue (Analog)	3	10
Reserved	4	6
Return	5	6
Red Return	6	1
Green Return	7	3
Blue Return	8	5
Sync Return	10	6
Monitor ID0	11	6

Horzontal Sync	13	9
Vertical Sync	14	8

1. Both connectors are high-density DSUB-15 male (VGA).
2. Cable is marked "CABLE-FA5"; unsure if this is Mitsubishi marking.
3. Cable material is Fujikura E49075 (AWM Style 2560).
4. Color signals are carried on coax with their respective returns.
5. Two wires of the cable are connected to Pin 6 at the monitor end; one of these wires is connected to Pins 4 and 5 at the PC end, the other wire to Pins 10 and 11.
6. Ferrite cylinders are shrink-wrapped around cable near each end.

Cable for 13" Mitsubishi Diamond Scan (Model AUM1391A)

Pin Function	PC Connector HD DB-15 male	Monitor Connector DB-25 male
Red (Analog)	1	2
Green (Analog)	2	4
Blue (Analog)	3	14
Red Return	6	3
Green Return	7	5
Blue Return	8	15
Sync Return	10	1
Monitor ID0	11	1
Horzontal Sync	13	16
Vertical Sync	14	17

1. Cable is marked "Mitusbishi CAT. NO. 246C057-8".
2. Cable material is E41447 (AWM Style 2560).
3. Color signals are carried on coax with their respective returns.
4. Pins 10 and 11 use separate wires in the cable, which are connected together at Pin 1 of the DB-25.

Sun 13W3

This was introduced by Sun Microsystems and is a nice compact robust connector. Other manufacturers have copied it.

Pin 1: NC
Pin 2: NC
Pin 3: Sense 2
Pin 4: SRTN
Pin 5: CSYNC
Pin 6: NC
Pin 7: NC
Pin 8: Sense 1
Pin 9: Sense 0
Pin 10: CRTN
Pin A1: Red
Pin A2: Green
Pin A3: Blue

The following I picked off the net so I do not know the accuracy of the resolution table.

```
Analog: 13W3 connector:
        +---------------- * gnd
        |   +------------ * vertical sync
        |   |   +---------   sense 2
        |   |   |   +-----   sense common (gnd)
        |   |   |   |   +-   composite sync
        |   |   |   |   |
        |   |   |   |   |   grey
    red |   |   |   |   |   green blue
     |  1o  2o  3o  4o  5o    |     |
    (O)                       (O)   (O)
       6o  7o  8o  9o 10o
       |   |   |   |   |
       |   |   |   |   +---   composite common (gnd)
       |   |   |   +-------   sense 0
       |   |   +-----------   sense 1
       |   +--------------- * gnd
       +------------------- * horizontal sync
```

* May be NC. My spies tell me Sun considers these obsolete.

The green video input is used by grayscale monitors.
Sense table - 1=nc, 0=strap to gnd

Sense	Type/scan rate
0	TBD (?))
1	Reserved
2	1280x1024, 76Hz
3	1152x900, 66Hz
4	1152x900, 76Hz, 19"
5	Reserved
6	1152x900, 76Hz, 16 or 17"
7	Nothing (no monitor connected)

Sony PVM-2030 and PVM-2530 Profeel Pro Monitors

(From: Rob Myers (myer3812@nova.gmi.edu).)
I have the pinouts for the RGB connectors on newer Sony monitors (specifically, the PVM-2030 and PVM-2530 Profeel Pro monitors). These pinouts are directly from the owner's manual. The connector used is a DB25 female.

- High state = 5V (open)
- Low state = 0V (short to ground)

Note On Pins 3,4,5,6,11:

- If pin 9 is high/open (Analog RGB mode) then .7Vpp, 75 ohm signals must be input to these pins. Pins 1 and 25 are not used.
- If pin 9 is low (Digital RGB mode) then TTL signals must be input to these pins. Pins 1 and

- 25 are only used in this mode.

```
Pin   Signal         Descr
-------------------------------------------------------------
1     IBM Select     High: IBM mode (RGBI)
                     Low:  3 Bit TTL (RGB)

2     Audio Select   High: Audio input from pin 13
                     Low:  Audio input from LINE A/B/VTR jacks

3     HSync/CSync    Horizontal or Composite Sync, Negative Pol.

4     Blue Input     Video Inputs: Positive Pol.

5     Green Input    (Sync on green optional in analog mode)

6     Red Input

7     NC

8     NC

9     Analog/Digital High: Analog mode
                     Low:  Digital mode

10    RGB/Normal     High: RGB input selected
                     Low:  LINE A/B/VTR input selected

11    VSync          Vertical Sync, Negative Pol.

12    Blanking       High: Video input from RGB input only
                     Low:  LINE A/B/VTR signal is superimposed over
                           signal from RGB input

13    Audio Input    -5 dB / 100% mod.

14    NC

15-24 Ground

25    intensity      Positive Pol.
```

These monitors are regular NTSC monitors, but I'm sure they can be connected to computers the same way I connected the KX-2501... using a simple buffer circuit and special video drivers. Another possibility is to build a component-to-RGB converter for really high quality DVD playback (better than S-Video)... the blanking feature seems interesting but the RGB source would have to be synchronized with the composite source. I think the KX's/XBR's have the blanking input, too.
The Sony RGB Multi Input pinout is also valid for the kV-25XBR; it should also work with the kV-20XBR and KX-1901, and I know it works with a KX-2501. (The KX series monitors are the original Sony Profeel monitors from about 1983, and they are very common.)
A female 34-pin floppy connector will mate with the Sony connector just fine. I was able to use the analog RGB input on a KX-2501 to display VGA PC video using a sync level converter circuit and drivers from:

- http://www.hut.fi/Misc/Electronics/circuits/vga2rgbs.html

SGI Octane to Sony GDM-17E21 Cable

(From: Yves DELAY (yves.delay@imag.fr).)
I am trying to connect a Silicon Graphics (SGI) 17" screen display to an SGI Octane CPU. I would like to build my own HD15 to 13W3 cable.
The monitor is standard SVGA with the VESA Display Data Channel (DDC) and works fine on a PC.
SGI OCTANE CPU video pinout (13W3):

A1 Red (analog)
A2 Green (analog)
A3 Blue (analog)
1 Monitor ID bit 3 (TTL)
2 Monitor ID bit 0 (TTL)
3 Composite sync (active low), TTL
4 Horizontal drive (active high), TTL
5 Vertical drive (active high), TTL
6 Monitor ID bit 1 (TTL)
7 Monitor ID bit 2 (TTL)
8 Gnd
9 Gnd
10 Gnd

Below is the pinout of the SGI 13W3 to HD15 cable, part number: 018-0500-001, Rev. E VIST 9717, obtained after a phone call to the SGI hotline.

Signal	SGI OCTANE (13W3)	Monitor: GDM-17E21 (HD15 male)	
Red	A1	1	Red
Red Gnd	A1 Gnd	6	Red Gnd
Green	A2	2	Green (+ composite sync)
Green Gnd	A2 Gnd	7	Green Gnd
Blue	A3	3	Blue
Blue Gnd	A3 Gnd	8	Blue Gnd
		Pins 6, 7, and 8 tied together, along with both connectors metallic shell and cable shield.	

Notes:

1. ID3 (1): not used
2. ID0 (2), ID2 (7), and Gnd (8): all tied together.
3. Other pins: not used.