> "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: Epanorama Video chips and circuits page:

- Epanorama Video Chips

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 525/60 Hz 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-Video.

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-Video, 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:

- Scan Conversion: Making the Video Connection

(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.

Inexpensive scan doublers do exist. For example:

(From: Jeffrey Kessler (kessler@fas.harvard.edu).)

I picked up a device called the "Video Cheese Box" from a company called TVOne. This is a $70 box that acts as a rudimentary line doubler. It takes a composite or S-Video input and outputs a 640 X 480 60 Hz VGA signal.

The picture is dramatically better than on a regular TV.

I'm in no way affiliated with this company except for having purchased one of their products.

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 or NTSC 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 (AD720/721) 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 (now part of Intersil makes excellent such chips.

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.

- Back to Video Conversion FAQ Table of Contents.

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).

CGA to VGA

This requires both converting the signal levels from TTL to analog as well as doubling the scan rate since modern VGA monitors will not go down below 31 kHz H. CGA is around 15.7 kHz. If you aren't fussy about how the colors map, the signal level conversion may be just some resistors.

However, the scan rate conversion requires capturing the data on each line and spitting it out twice in one line time, and providing the proper H sync to match. This would consist of a double buffer digital line memory (for the CGA TTL bits) and timing logic to store line n while reading out line n-1 twice at double the rate. It's all doable but not a project for a digital novice.

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.

S-Video to Composite

The basic requirement is to sum the luma (Y) and chroma (C) signals. A low pass filter may also be included.

One trivial implementation that should always work (if not optimal) is to have the chroma signal (C) pass through a 470 pF capacitor tied directly to the luma signal (Y). However, there may be excessive color noise in areas of fine detail. There is a tradeoff between color noise and smearing of the fine detail in the picture as the capacitor value is increased. Bypassing the capacitor with a 10 to 50 ohm resistor may help as well. On one DVD player, 15 or 20 ohms (with or without a capacitor) was best. Some experimentation may result in better performance but to get a decent picture. Nothing is critical.

Or save the hassle and just buy a $3 S-video to RCA adapter cable with the capacitor built in on eBay. :) The parts to make one will cost more than this. But some of these adapters appear to simply tie Y and C together at the connector with no electronic parts inside. At least that's what it looks like based on testing one with an ohmmeter. This does work with some sources but may result in inability to even sync with others.

However, on my tests of a single type of S-video source (a Cyperhome CH-DVD 300S DVD player, the only one I have with an S-video output), the best performance with both a high-end composite-only input TV (RCA ColorTrak 2000 from 1984 and a small LCD monitor) in terms of minimum color noise was with the composite output, slightly worse with the direct Y to C connection. The capacitor between Y and C had the highest level of color noise. The composite output had almost none. I do not know if this was because there is some low pass filtering of the signals inside the DVD player, but the resolution didn't seem noticeably affected.

I would be interested in knowing what an optimal implementation of an S-video to composite converter would be using discrete components. There are chips to do this such as the Intersel ISL59114. But they require a separate power supply and come in itty-bitty SMT packages that are generally difficult to impossible to wire. If anyone knows, please contact me via the Sci.Electronics.Repair FAQ Email Links Page.

S-Video Converter Circuit (Christian Tavernier) is a more complex implementation. I have not tested this circuit.

Composite to S-Video

Basically, all that is needed is to separate the Y and C signals. It would probably be best if the C were put through a high pass filter to remove the Y and Y were put through a low pass filter to remove the C but the following appears to work with just a cable and a small capacitor.

- Tomi Engdahl's S-Video to Composite Video Page.

RGB Sync-On-Green to VGA

There are all sorts of video widgets available, or if you're inclined to build something yourself, ICs to do it.

Do a Web search for "video sync stripper" and "RGBHV to VGA". There should be plenty of options.

One of these would be by far the easiest, though not the cheapest (at least in parts cost). But if you have a MAC-compatible monitor which uses composite sync, then it's just a matter of using a high speed voltage comparator to get the sync-on-green to TTL. Putting the green video into the VGA green may work without any conversion since the sync will hopefully be blacker than black.

- Back to Video Conversion FAQ Table of Contents.

Items of Interest

Various Video Standards

- Various Standards for Analog Component Video

General VGA Information

(From: Tomi Holger Engdahl.)

VGA monitor pinouts and more related links can be found at:

- Epanorama Video Connectors

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

- SkyVision BOX-800 VGA to TV converter

Information about video signals in general can be found at:

- Epanorama Video Links

Comparison of Composite, S-Video, Component Video, and RGB

(From: Dave Martindale (davem@cs.ubc.ca).)

Composite is better than using an RF modulator and feeding the signal into the TV tuner but is otherwise the worst of them all.

S-video uses two signal paths, luma and chroma. It's better than composite video, which mix both together into a single signal.

But component video is better than S-video. With component, you have three separate signals - usually Y, R-Y, and B-Y. This bypasses the subcarrier encode/decode process entirely, and gives better quality.

There's also RGB, which is potentially just a bit better than Y/R-Y/B-Y, but can also be considered a different type of "component".

TV Capture Cards for PCs

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

- Hauppauge Computer Works
- Diamond Multimedia
- Matrox

But be careful, what they say is not always the reality...

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 my personal experience, I've found that simply setting the video mode on a PC to 640*480, any color depth, and a 60 Hz refresh rate, results in a very stable picture, even when taped with a cheap consumer camcorder and no attempt at synchronization. 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

One example is the 74ACT715 programmable video sync generator. A Web search will easily find its datasheet.

(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!

Monitor World has quick access to the general specifications of many common PC and MAC compatible video monitors. (There used to be many monitor spec Web sites but most disappeared.)

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:

- VGA to TV Converter

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 September and October 1996 Electronics World, which uses a discontinued chip!), but it's still a non-trivial task! One easy solution is to purchase a BOB-4 video overlay module from Decade Engineering, which solves the disappearing OSD chip problem by using industry-standard microcontroller and FPGA chips. It accepts printer-like commands through 'TTL-232' or SPI ports. BOB-4 has text scroll and crawl, vector graphics, user-installable fonts, and other features that didn't exist in the old OSD chips. Small-quantity prices are posted on the Order page at Decade's website.

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:

- Gennum

Gennum makes several multirate filters for 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.

- Back to Video Conversion FAQ Table of Contents.

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:

- The Hardware Book
- Gamesx.com - A/V and Miscellaneous Pinouts

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)

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    Monitor Connector
                      HD DB-15 male   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 but there are several variations. See: [MonitorWorld Video Standards]

Page. Towards the bottom they have several different 13W3 pinouts. Some only accept composite sync, some have the sync pins reversed, etc.

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)
```

Sun/Sony GDM17E10

(From: Andy Cuffe (baltimora@psu.edu).)

This is a good SVGA monitor (same as Sony Multiscan GDM-17SE). The Sun version doesn't connect the H and V sync lines to the video connector. If you open it, on the the video board there will be a 3 pin connector labeled H sync, V sync, and ground. All you have to do is connect these to some unused wires in the video cable. There will be several wires going to a small board which I think is used for monitor detection, or other functions only used by a sun station. You can just cut any two of these and use them for sync. Cut off the 13W3 and attach a HD15 connector, remembering which pins are used for sync.

If you're not into soldering, I'm fairly sure there is an adapter fit this that just converts the separate sync to sync on green. If I remember correctly, the web site that was selling it incorrectly identified it as a fixed frequency monitor and said you needed one of their special video cards. It is NOT fixed frequency.

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:

- Tomi Engdahl's VGA to RGB + Composite Sync Converter

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.

S-Video

Note that this is often called S-VHS. I don't know whether this is correct. I assume that S-Video refers to the use of separate luminance (intensity) and chrominance (color) signals and that S-VHS refers to a modified recording standard for the VHS tape format to achieve higher resolution on special S-VHS tape. S-VHS may or may not use S-Video signals and vice-versa.

In any case, S-Video uses a 4 pin mini-DIN connector. Viewing from the female-end with the key at the bottom:

Pin 1 (lower right): Y Ground
Pin 2 (lower left): C Ground
Pin 3 (upper right): Y (Intensity/Luminance)
Pin 4 (upper left): C (Color/Chrominance)

- Back to Video Conversion FAQ Table of Contents.

-- end V2.01 --