VIDEO FORMATS UPDATE

With the development of improved home video equipment in the last few years, there's been a confusing expansion in the variety of video formats you're likely to come across — especially with DVD players and recorders, camcorders, digital TV set-top boxes, computers and so on. Here's an update on the various formats, what they're used for and how they relate to each other. We also give details of the cables and connectors they need.

AROUND THE BACK of most older VCRs and laserdisc players, there was just one video output socket. Like the direct video input connector on most older TVs, it was generally an RCA ('phono') socket with yellow colour coding. So if you wanted to watch videotape movies on your TV set with a picture that was clearer and 'cleaner' than was possible by tuning to the VCR's VHF or UHF modulated output, all you had to do was connect the two together with a matching RCA-RCA video cable. End of story!

Now virtually all modern DVD players do have the same kind of yellow RCA video output socket on the back, so they too can be hooked up to a TV in the same way. And when you do this, you get quite a good picture — noticeably better than from a VCR, in fact. But you're no doubt aware that most DVD players also provide *extra* video outputs, like a small four-pin DIN socket marked 'S-video', and three more RCA sockets marked 'Y', 'Cb' (or Pb) and 'Cr' (or Pr). And many modern TV sets are provided with the same kinds of extra video inputs, to match.

Modern digital camcorders and DVD recorders also sport some of these extra video inputs and outputs, plus a few more digital video connectors like 'Firewire' and USB2. The latest personal computers also have many of the same 'fancy analog' and digital video connectors.

In short, there are now quite a few different video formats being used with home theatre equipment and computers, and you wouldn't be alone if you find it a bit confusing. The aim of this data sheet is to explain what it's all about, so you can connect up your systems with confidence to get the best performance.

Analog video formats

First of all, let's look at the way standard video signals — the type you've been watching on your TV and recording on your VCR for years — are produced and used. Then we'll explain how the newer video formats have evolved.

Video information starts off from the camera or film scanner as three primary colour signals: red (R), green (G) and blue (B). For normal analog TV broadcasting, and for recording on videotape or laserdiscs, these colour signals are first processed to produce a *luminance* or black and white (Y) signal and a pair of *chrominance* (C) signals which contain the colour information. This is shown in Fig.1. As you can see the luminance or 'Y' signal contains all three original colour signals from the camera, combined in the proportions shown to produce a clear black and white (strictly 'shades of grey') display on a B&W monitor or TV set. The two chrominance signals consist of this Y signal subtracted from two of the original colour signals: the R signal and the B signal.

Composite video

These three signals are then all combined with the horizontal (line) and vertical (field) synchronising ('sync') signals into a single **composite video** signal, and it's this signal that is recorded on the tape or laserdisc — or broadcast by the TV station. If you're curious, the way the composite video signal is produced is shown in Fig.2. As you can see there's a fair bit of processing involved in arriving at this 'all in one' composite video signal for broadcasting or recording. There's even a 'colour burst' signal added in. This is because the subcarrier signal used to modulate the two colour difference signals is 'suppressed' and removed from the final composite signal to prevent it interfering with the luminance signal. The colour bursts are tiny samples of the colour subcarrier, slotted into the rear of each horizontal sync pulse so they can be used to

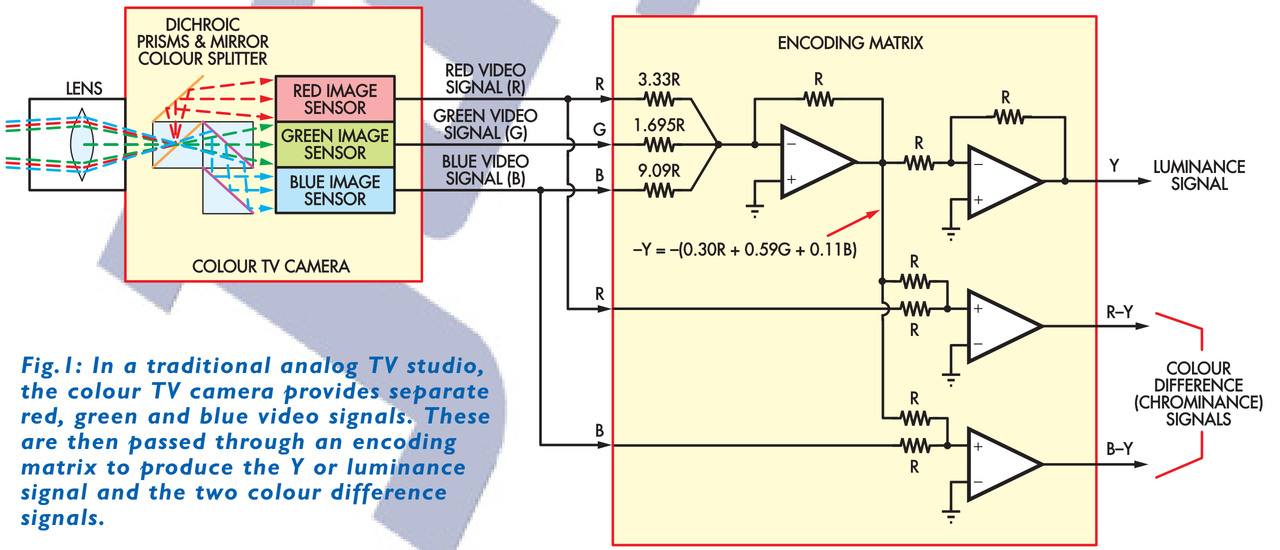


Fig.1: In a traditional analog TV studio, the colour TV camera provides separate red, green and blue video signals. These are then passed through an encoding matrix to produce the Y or luminance signal and the two colour difference signals.

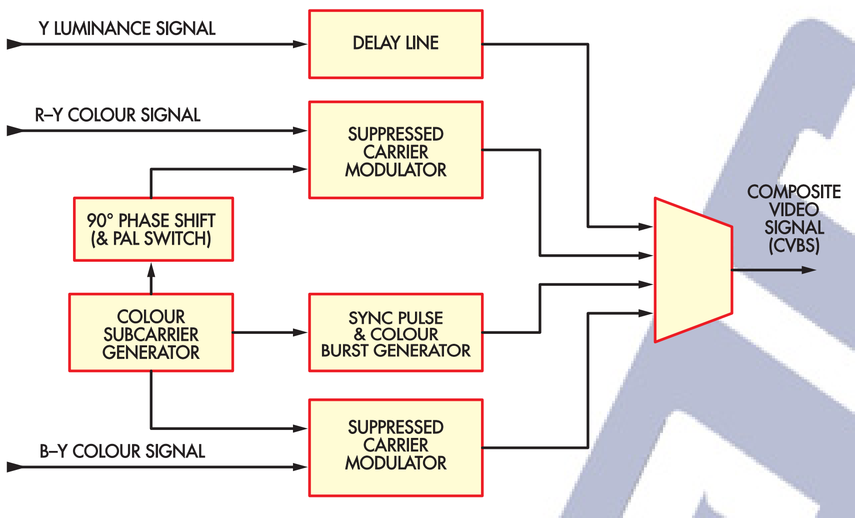


Fig.2: To produce a traditional 'composite' analog video signal, the luminance and colour difference signals are combined with sync and colour burst signals as shown here — quite a lot of processing.

recreate the subcarrier when the composite video signal is finally demodulated and displayed.

One way of visualising a composite video signal is shown in Fig.3, which shows the main luminance and modulated colour signals plotted against frequency. As you can see the luminance signals extend from DC (zero frequency) up to about 5.5MHz (megahertz), while the modulated colour signals are concentrated in two narrower bands on either side of the suppressed colour subcarrier at 4.433MHz. Because of the exact frequency used for the sub-carrier and its mathematical relationship to the line and field frequencies, the modulated colour information fits into frequency 'slots' between the clumps of luminance information.

To demodulate and display this composite signal, your TV set or monitor or video projector has to break it back down into the three original colour signals, in order to display them to you. And this again involves a fair bit of processing: first separating the luminance and chrominance information again, demodulating the two colour signals and the sync pulses and then using them all to recreate the original red, green and blue information.

So when we use a composite video signal to carry pictures, there is quite a lot of processing at each end — and the more any signals are processed, the more they tend to be degraded. Not only that, but recording the signals and playing them back in this 'all mixed up together' composite form also tends to run the risk of them interfering with each other. An example of this is the Moire patterns that you often see when an actor on TV is wearing a coat or shirt with a fine check pattern. The high luminance frequencies generated by the fine pattern tend to 'beat' with the colour information, to produce that moving purplish pattern.

S-video

To try and avoid the picture degradation that could occur with composite video, makers of high end VCRs, S-VHS and Video Super-8 camcorders and some laserdisc players (which are now obsolete) started providing them with a different type of video output and input format. In this ***S-video*** format (sometimes called S-VHS), the colour information is kept separate from the luminance and sync information, to reduce the possibility of interaction.

S-video signals are transferred via *twin* coaxial or shielded cables, which are usually fitted with miniature 4-pin DIN plugs. Sometimes they are fitted with two RCA-type plugs, though, marked 'Y' (for luminance plus

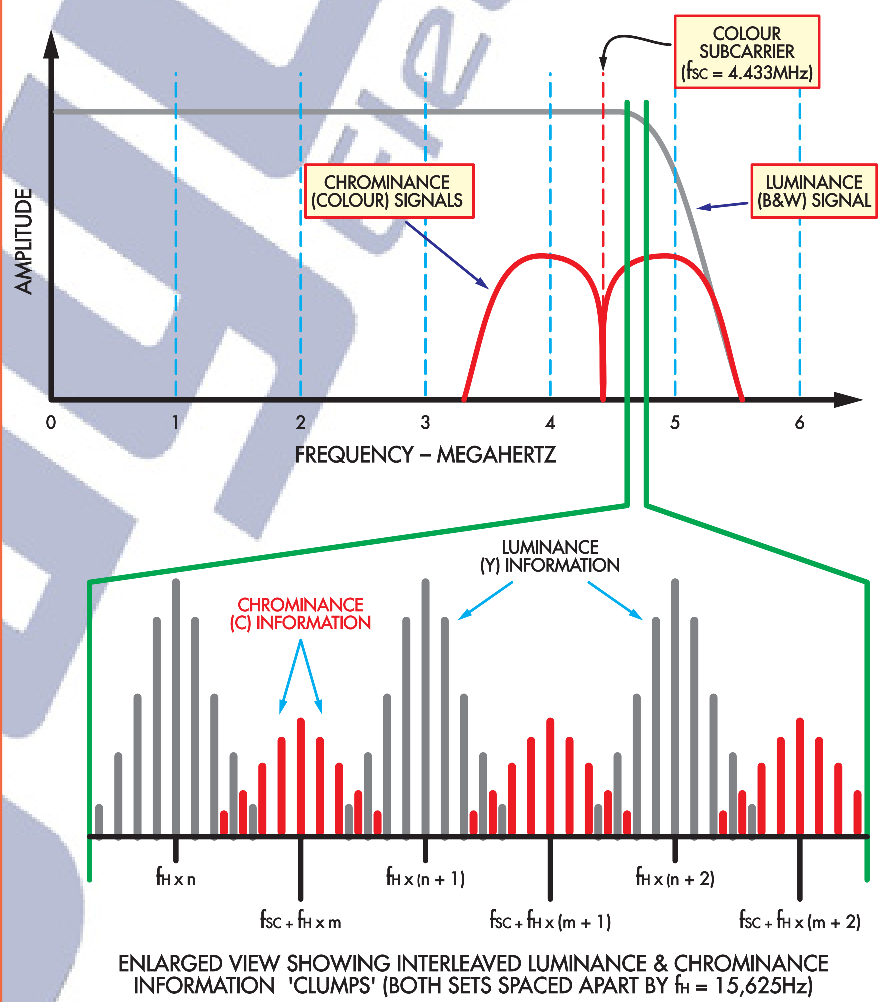


Fig.3: How luminance and colour signals fit together in composite video.

sync) and 'C' (for chrominance). The connections for S-video plugs and sockets are shown at right, in Fig.4.

Most video equipment fitted with S-video connectors is also provided with standard composite video connectors, as a 'fall back' option in case one piece of equipment can't handle S-video. However if you're using two pieces of equipment which are both able to handle S-video, it's generally better to use their S-video connectors (with a suitable cable) as this will almost always give better picture quality.

This applies particularly with VCRs and camcorders, where the video is actually recorded on tape as separate luminance and chrominance signals. It was less true with laserdisc players, where the video was actually recorded on the laserdiscs in composite format. However where a laserdisc player is provided with an S-video output, this would often still give better results than if you used the composite video output (because the Y/C separation circuitry in the player was often better than that in the TV set).

Component video

The advent of movies on DVD (digital versatile or digital video discs) brought the possibility of delivering even higher picture quality. Both the pictures and sound are recorded on DVDs in compressed digital format, which allows both to be recorded in very high quality. And in the case of the images, the video is separated into *component video* form before being digitised and subjected to MPEG2 compression.

What is component video? It's simply video where the main components are not even combined to the partial extent that they are with S-video, so there's even less chance of them interfering with one another. We simply take the luminance/sync (Y) and the two colour difference signals shown in Fig.1 — B-Y and R-Y — and handle all three separately. By the way B-Y is often called Cb or Pb, and R-Y is called Cr or Pr.

So on the latest breed of DVD players, TV receivers and video projectors, you'll find another set of video outputs or inputs: a trio of RCA/phono sockets, generally marked either Y/R-Y/B-Y or Y/Cr/Cb and often coloured yellow, red and blue respectively. Needless to say if the two items of video equipment you need to link together both have these component video connections, you'll get the best possible results by using them.

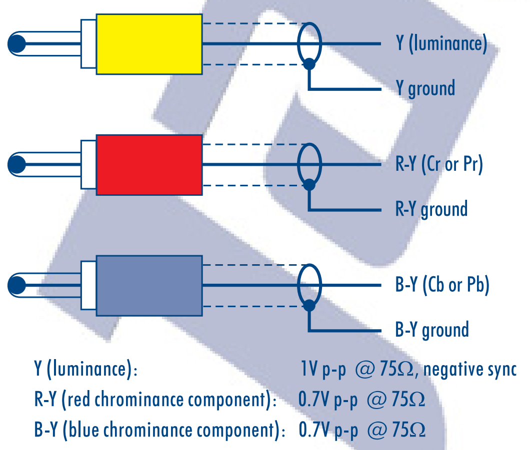


Fig.5: Component video generally uses a trio of cables, each fitted with RCA ('phono') plugs — often colour coded as shown. The signals and impedances are also shown.

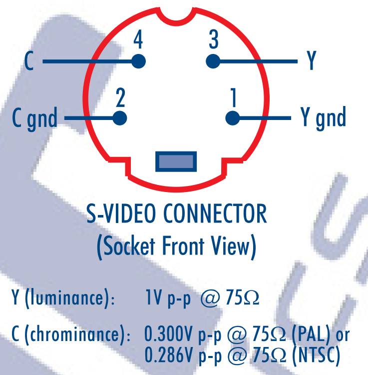


Fig.4: The pin connections for the 4-pin mini DIN connector used for most S-video cables. The signal levels and impedances are also shown.

Component video connections are made using a trio of coaxial cables fitted with RCA/phono plugs. Ideally they'll be colour coded to make it easier to avoid transpositions. The two Y sockets need to be linked, and similarly the two R-Y and the two B-Y sockets. You'll get some weird effects if you mix them up!

RGB video

A different kind of component video is found in many of the countries in Europe, where video connections between equipment are often made using multi-way cables fitted with 21-pin SCART connectors (also called Euroconnectors). This type of component video is known as *RGB*, because it consists of the three original colour signal components: red, green and blue. Sometimes the sync information is combined with the green video, and sometimes it's separate again.

Like Y/R-Y/B-Y component video, RGB offers the potential of very high image quality because the signals have undergone less processing. However the two types of component video are not interchangeable; you can't feed one type directly into equipment inputs designed for the other. Conversion circuitry is needed to change from one to the other. This is the circuitry provided in Component/RGB and RGB/Component video converter boxes.

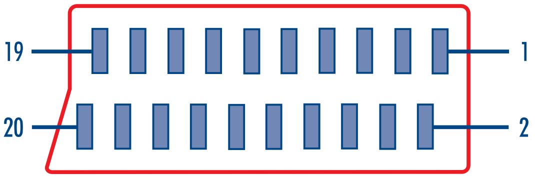
Note also that just because video equipment may be fitted with SCART connectors, this doesn't necessarily mean it's capable of handling RGB component video. SCART connectors are actually used to convey all three types of video — composite, S-video and RGB component. To discover which of these formats a piece of equipment can actually handle you'll generally need to refer to its manual.

The connections for a standard SCART/Euroconnector plug are shown in Fig.6.

PAL and NTSC

Most of the video formats we've discussed so far are equally possible with both the PAL video system used in Australia, New Zealand and Europe, and the NTSC system used in North America and Japan. The only real exception is RGB component video, which is found almost exclusively in Europe and using the PAL system.

Needless to say the fact that there's two main video systems introduces a further risk of incompatibility, when you need to connect two pieces of video equipment. Not only do they both need to be capable of handling the same video format, but they also need to be compatible in terms of TV system.



SCART PLUG
(VIEWED FROM PINS)

PIN	SIGNAL	LEVEL, IMPEDANCE
1	Audio Out (R)	500mV @ 1kΩ
2	Audio In (R)	500mV @ 10kΩ
3	Audio Out (L)	500mV @ 1kΩ
4	Audio ground	
5	RGB blue video ground	
6	Audio In (L)	500mV @ 10kΩ
7	RGB Blue Video (B)	700mV p-p @ 75Ω
8	Composite video select	0V/10V @ 10kΩ
9	RGB green ground	
10	Data/Control	
11	RGB Green Video (G)	700mV p-p @ 75Ω
12	Data/Control	
13	RGB red ground	
14	Control ground	
15	RGB Red video (R) / S-video C	700mV p-p @ 75Ω
16	RGB/Composite blanking	<0.4V = comp; >1.0V = RGB
17	Composite video ground	
18	Blanking signal ground	
19	Composite Video out	1.0V p-p @ 75Ω
20	Composite Video in / S-video Y	1.0V p-p @ 75Ω
21	Connector chassis/shield	

Fig.6: The pin connections and signal details for SCART connectors, which can be used for composite, S-video or RGB component video.

For example although PAL laserdiscs and players were made and sold in both Europe and Australia, they were never as popular as NTSC discs and players sourced directly from the USA. So most of the laserdiscs and players you'll find use the NTSC system.

Although most of the TV sets and video projectors sold in countries like Australia and New Zealand in recent years are 'multi standard' and capable of automatically handling either PAL or NTSC, this doesn't apply to many older sets. With these you have to pass NTSC video from a laserdisc player through a *standards converter* (to convert it into PAL) before they'll display it properly.

Most DVD players can play discs that were originally in either PAL or NTSC format, providing the discs are compatible in terms of region coding. In some cases they can even play NTSC material in true PAL, or in a hybrid format known as PAL 60 — which has the field and line scanning rates of NTSC, but with PAL colour encoding.

Digital video

Until now, we've been talking about analog video signals and their use in home theatre and PC situations. But in recent years the digital revolution has resulted in the appearance of still more kinds of video signal in our homes. These are of course *digital* video signals, which will now be explained.

In a modern digital video production studio, the original video signals generated by cameras, digital VTRs (video tape recorders) and film scanners are immediately sampled to produce very high bit-rate digital bitstreams: continuous streams of binary 1's and 0's, consisting of interleaved samples of the luminance and colour difference signals. The reason why these bit-streams have a very high bit rate is simply because the samples themselves have to be taken at a very high rate, to capture enough of the signal changes.

The most common sampling scheme used is 4:2:2, where the luminance signal is sampled at a rate nominally four times the colour subcarrier frequency, and the lower-bandwidth colour difference signals are each sampled at half this rate. This means that the luminance samples are taken at 13.5MHz and the chrominance signals are each sampled at 6.75MHz. So for each second of video there are 13.5 million luminance samples, 6.75 million R-Y samples and another 6.75 million B-Y samples — 27 million samples in all. And since each sample needs to have at least 8 bits of resolution, to capture at least 255 different signal levels, this translates to a serial bitstream of around 216Mb/s (millions of bits per second).

Now although this type of high speed bitsream is fine for capturing and editing high quality video, it is very greedy in terms of bandwidth (when it comes to transmission or broadcasting) and also the storage capacity needed for recording. For example a standard CD-ROM with its capacity of around 700MB (megabytes) could only store about 25 seconds of this raw digital video, while even a DVD-ROM with a capacity of 4.7GB could only store about three minutes!

To store movie-length video programs on practical media, then, the raw digital video information must be ***compressed***. This means that the raw video (and accompanying audio) signals are digitally processed in a variety of ways, to remove as much as possible of the *redundant* information in them (i.e., the information that keeps on being repeated over and over), which allows them to be compressed or 'squeezed down' into a much lower bit rate. The trick is to perform this digital compression without sacrificing picture or sound quality to an unacceptable extent, and luckily techniques have been developed to do just that.

DV compressed video

The 'DV' digital compression system was developed by professional digital camcorder manufacturers for use in ENG (electronic news gathering) equipment, but is now also used widely in consumer-level digital camcorders. It uses 4:1:1 sampling (i.e., the colour difference signals are sampled at only one quarter of the luminance rate), and uses only intra-frame compression encoding — removal of redundancy only within the individual picture frames, not frame-to-frame redundancy. It achieves a compression ratio of better than 5:1, resulting in a fixed 25Mb/s bitstream, with a picture resolution of 720 x 576 pixels (H x V) in PAL and 720 x 480 pixels in NTSC.

As used in consumer level digital camcorders ('Mini-DV' and 'Digital 8'), DV is recorded on small tape cartridges. When these are played back the DV signals can be fed into a PC via either IEEE-1394 cables and ports, or via USB 2.0 cables and ports.

When fed into a PC and captured on a hard disk, DV video is generally stored in AVI or 'Audio Video Interleaved' format files (.avi); on Apple computers it's stored in QuickTime files.

MPEG1 and MPEG2

There are two other main types of video compression which are used for newer recording media such as video CDs and DVDs. These are MPEG1 and MPEG2, where 'MPEG' stands for Moving Picture Experts Group (the international standards body responsible for developing, agreeing on and approving the digital encoding technology). Both MPEG1 and MPEG2 use a combination of intra- and inter-frame digital compression techniques, to achieve a much higher compression ratio than DV.

MPEG1 was the first type of compression encoding developed, which compresses the video and audio into a bitstream at a relatively low fixed rate of 1.5Mb/s (megabits per second). This is the type of encoding used for video CDs, where it delivers a horizontal image resolution of 352 pixels and a vertical resolution of either 288 pixels (PAL) or 240 pixels (NTSC). This is roughly equivalent to VHS videotape, although some 'blocking' pixelation may be evident when there is a lot of independent fast-moving changes to the image.

MPEG2 is a further development of the compression technology embodied in MPEG1, with additional enhancements and extensions. It is capable of encoding a video-plus-multichannel-audio bitstream at variable rates up to 15Mb/s, with the video occupying up to 9.8Mb/s. This is capable of delivering very high image quality. MPEG2 encoding is used on DVDs, where it delivers an image resolution of 720 x 576 pixels (H x V) in PAL and 720 x 480 pixels in NTSC — roughly double that of MPEG1 in both directions, and significantly better than the analog video from laserdiscs.

Most DVD players can decode both MPEG1 and MPEG2, and can therefore play either DVDs or video CDs (as well as audio CDs). However early dedicated video CD players can generally only decode MPEG1.

IEEE-1394

Sometimes called *FireWire* (although this term is copyright by Apple Computer) or 'iLink' (a Sony copyright term), IEEE-1394 is a high speed serial digital interfacing standard used to transfer digital video signals or other data from one piece of equipment to another. It can transmit at data rates of up to 400Mb/s, although interfaces on current digital video camcorders and VCRs are only capable of rates up to 200Mb/s. This is clearly more than enough to handle DV, MPEG1 or MPEG2 compressed digital bitstreams, and even sufficient for some uncompressed digital video formats.

The digital bitstream transferred via an IEEE-1394 interface is combined with clock signals to form a differential non-return-to-zero (DNRZ) signal, which is sent over a shielded twisted wire pair (TWP). The DNRZ signal consists of complementary 220mV peak to peak rectangular signals superimposed on a common-mode DC voltage of 1.9V.

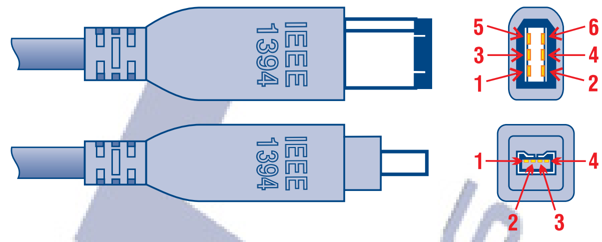
A typical IEEE-1394 interface cable may have two shielded TWP cables for bidirectional information transfer, plus two optional additional wires for supply of DC power. This type of cable can convey digital video bitstreams over distances up to about 4.5m.

Some digital camcorder manufacturers, including Sony, call the IEEE-1394 interface 'iLink DV' when it's used for digital video.

Compact six-pin (3 x 2) connectors are used for IEEE-1394 interfaces for computers, digital editing systems and hard disks used for digital video storage etc. However miniature four-pin (4 x 1) connectors are generally used for IEEE-1394 interfaces on digital camcorders.

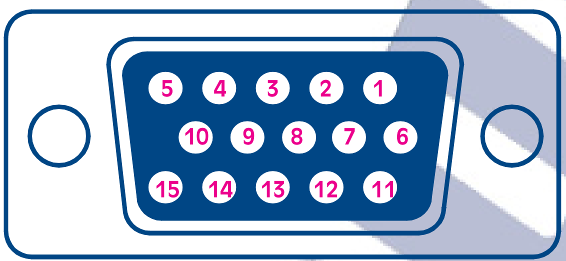
The two standard types of IEEE-1394 connector are shown in Fig.7. Note that the inserting section of the primary 6-pin plug is much larger (11.3 x 6.2mm) than that of the 4-pin plug, which is very small indeed (6.45 x 3.5mm). The larger plug is polarised by a pair of chamfers at one narrow end, while the smaller one has an indent in the centre of one longer side.

Normally all devices with IEEE 1394 ports are fitted with sockets, and the cables have plugs at each end. Adapter cables are available to allow data transfer between devices with 6-pin and 4-pin sockets, with appropriate plugs at each end. (There are also short adaptor cables with a plug and a socket, to mate with a



IEEE 1394 PLUG PINOUTS		
Signal	6-pin Plug Pin	4-pin Plug Pin
Power +	1	–
Power Gnd	2	–
TPB –	3	1
TPB +	4	2
TPA –	5	3
TPA +	6	4

Fig.7: The two different types of IEEE 1394 plug and their pin connections. The TPA and TPB connections are normally transposed from one end of the cable to the other.



STANDARD 15-PIN 'VGA' SOCKET PIN CONNECTIONS

PIN ASSIGNMENTS	
PIN	FUNCTION
1	Red Analog Video (R) or B-Y (Cr)
2	Green Analog Video (G) or Sync on Green or Y
3	Blue Analog Video (B) or B-Y (Cb)
4	Monitor ID bit 2
5	TTL ground/Monitor self test
6	Red Analog ground or Cr ground
7	Green Analog ground or Y ground
8	Blue Analog ground or Cb ground
9	Key (plugged hole – no pin)
10	Sync Signal ground
11	Monitor ID bit 0
12	Monitor ID bit 1 or Bi-directional Data (SDA)
13	Horizontal sync (TTL) or Composite sync
14	Vertical synch (TTL)
15	Monitor ID bit 3 or Bi-directional Clock (SCL)

Fig.8: Connections for the 'compact DB-15' socket used for analog computer video and by some video projectors for RGB/component video.

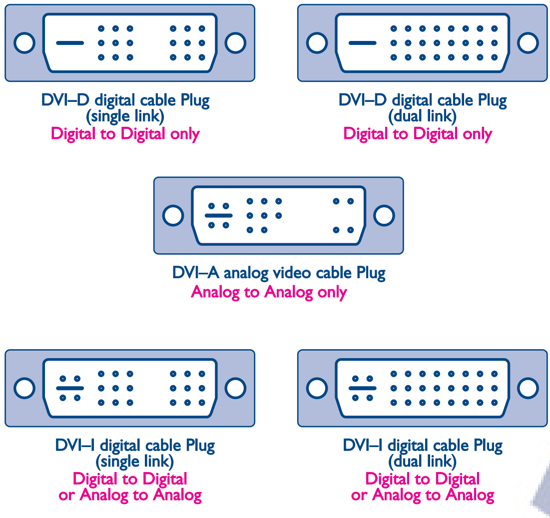


Fig.9: Connectors used for the three main types of DVI interfaces. Note that the DVI-A plug is mainly used for adaptor cables, to link analog-type VGA monitor to a DVI-I graphics card.

standard like-to-like cable.)

Because of their complex construction and the small size and precision of their connectors, IEEE 1394 cables can be quite expensive. Because of this and the tiny size of the 4-pin connectors in particular, they should be treated with care to ensure that they provide reliable communication at the fast data rates involved.

Computer graphics formats

When personal computers arrived on the scene in the early 1980s, they could only display text and low-res graphics on their video monitor screens. They did this using the first type of 'display adaptor' boards: the monochrome display adaptor (MDA), the colour graphics adaptor (CGA) and later the enhanced graphics adaptor (EGA) boards. These all sent out relatively low resolution digital video signals to the CRT (cathode-ray tube) monitors used at the time. The cables used generally had modified DB-9 plugs on each end.

The next development came with the video graphics array (VGA) graphics adaptor, which provided higher resolution (640 x 480) and more colours, but in order to do this it incorporated three digital-to-analog converters (DACs), which provided the video monitor with analog RGB signals (plus separate sync signals). The same system was adopted for many of the enhanced computer graphics systems which followed on from VGA: Super VGA (SVGA) and the extended graphics array (XGA).

Most video cables used for VGA, SVGA and XGA analog computer video have compact DB-15 plugs at each end. The connections for these are shown in Fig.8.

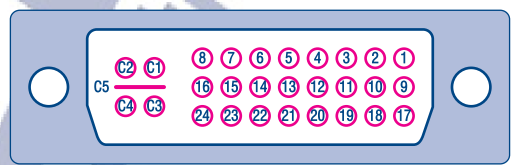
DVI-D, DVI-A and DVI-I

As the resolution and colour depth of PC video adaptors improved, and also with the development of high-speed data interfaces like IEEE 1394 and DVD-ROM burners, it became possible to use PCs to carry out many functions on traditional video signals. PCs could be used for non-linear video editing, DVD mastering and so on. Improvements in display technology also resulted in the use of high resolution LCD (liquid crystal display) and plasma display panels, which are generally more compact than CRT monitors.

The only complication about using LCD or plasma displays with computers is that both of these newer display technologies need the video to be in digital form. This means that when they are used to display analog video from VGA, SVGA or XGA graphics adaptors, they must first convert the analog video back into digital format. The video signal are thus passed through two redundant processing steps: from digital to analog in the graphics adaptor, and then from analog back to digital in the display panel circuitry.

This double conversion inevitably causes signal deterioration, and also becomes more and more of a problem when the resolution and/or colour depth is increased — increasing the bandwidth. Yet this is exactly what is happening nowadays, with the convergence of computer and video technology and the growth of digital high definition TV (HDTV).

To get around this problem, the computer and display industries came up with the Digital Visual Interface (DVI) standard. This is basically an interface which allows video graphics adaptors, HDTV set-top boxes, DVD players and other sources of high definition digital



DVI–I digital cable Plug (viewed at pins)

PIN ASSIGNMENTS				
PIN	SIGNAL	DVI-D	DVI-A	DVI-I
1	TMDS Data 2 –	✔	✔	✔
2	TMDS Data 2 +	✔	✔	✔
3	TMDS Data 2 Shield	✔		✔
4	TMDS Data 4 –	✔		✔
5	TMDS Data 4 +	✔		✔
6	DDC Serial Clock	✔	✔	✔
7	DDC Serial Data	✔	✔	✔
8	Analog Vertical Sync		✔	✔
9	TMDS Data 1 –	✔		✔
10	TMDS Data 1 +	✔		✔
11	TMDS Data 1 Shield	✔		✔
12	TMDS Data 3 –	✔		✔
13	TMDS Data 3 +	✔		✔
14	+5V Power	✔	✔	✔
15	Ground	✔	✔	✔
16	Hot Plug Detect	✔	✔	✔
17	TMDS Data 0 –	✔	✔	✔
18	TMDS Data 0 +	✔	✔	✔
19	TMDS Data 0 Shield	✔		✔
20	TMDS Data 5 –	✔		✔
21	TMDS Data 5 +	✔		✔
22	TMDS Data 5/Clock Shield	✔		✔
23	TMDS Clock +	✔	✔	✔
24	TMDS Clock –	✔	✔	✔
C1	Analog Red		✔	✔
C2	Analog Green		✔	✔
C3	Analog Blue		✔	✔
C4	Analog H Sync		✔	✔
C5	Analog Ground	✔	✔	✔

Fig.10: Connections for the three different kinds of DVI digital/analog video interface.

video to feed it directly in this form to LCD, plasma and other 'digital' display devices, without intermediate processing.

DVI uses a single cable fitted with special 29-way connectors. However because the DVI standard was designed for compatibility with existing hi-res analog monitors and display adaptors, many current DVI cables and connectors provide for analog RGB video signals as an additional alternative to the digital channels. In fact there are currently three different kinds of DVI cable: DVI-D cables, which cater for only DVI digital video; DVI-A cables, which handle only hi-res analog RGB video; and DVI-I cables, which provide conductors and connector pins for both digital and analog video.

Luckily the three different kinds of DVI cable can be identified by the pins on their connectors. In particular, by the presence or absence of pins on either side of the flat pin at one end. As shown in Fig.9, the connectors for a DVI-D 'digital only' cable have no pins above or below the flat pin, while the connectors for DVI-A or DVI-I cables have two additional pins above and below.

You'll also see from Fig.9 that there are actually **two** versions of both DVI-D and DVI-I cables. This is because the DVI standard allows for a second digital video channel or 'link', if needed for higher resolution and bandwidth signals (as in HDTV). As you can see the DVI-D and DVI-I 'dual link' cable connectors have all of the 3 x 8 rows of pins populated, to provide the connections for the second digital channel.

DVI transports the digital video information using a format known as 'transition minimised differential signalling', or TMDS. A single TMDS link or channel can convey 10-bit digital RGB information at up to 165MHz, which corresponds to a bandwidth of 1.65Gb/s (gigabits per second) — enough to display 1920 x 1080 pixel widescreen HDTV images at a field rate of 60Hz. When the second channel or link is added, this increases the bandwidth to over 2Gb/s and allows the display of 2048 x 1536 pixel images at 60Hz.

Most of the latest PC graphics adaptors are fitted with a DVI-I output socket, to allow direct connection to an LCD monitor or plasma panel with DVI input. However even if the graphics adaptor doesn't have an analog video 'VGA' output as well, it can still be used to drive an analog CRT monitor by using a DVI-to-VGA adaptor cable or box. This is because the analog video signals are all available on pins of the DVI-I output.

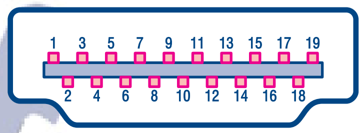
Note, though, that you can only drive an analog monitor from a graphics adaptor with a DVI-I or DVI-A output. If the graphics adaptor only has a DVI-D output this means that analog video signals are not available, and none of the DVI cables includes digital to analog conversion circuitry.

HDMI — the next step

Although DVI does a good job of interfacing high bandwidth uncompressed digital video, it doesn't handle audio signals at all. Any system using DVI to transfer the digital video over a cable must therefore use additional cables to transfer the accompanying audio, in either analog or compressed digital form.

To avoid this additional complexity for consumer electronics, industry leaders such as Panasonic, Sony, Toshiba, Philips, Thomson/RCA and Silicon Image formed a working group in 2002 to develop a more compact and integrated interface solution. This resulted in the High Definition Multimedia Interface, or HDMI.

HDMI effectively combines a digital component video interface (based on DVI) with its accompanying audio



HDMI Type A Connector (viewed at pins)

PIN ASSIGNMENTS

PIN	SIGNAL
1	TMDS Data 2 +
2	TMDS Data 2 Shield
3	TMDS Data 2 –
4	TMDS Data 1 +
5	TMDS Data 1 Shield
6	TMDS Data 1 –
7	TMDS Data 0 +
8	TMDS Data 0 Shield
9	TMDS Data 0 –
10	TMDS Clock +
11	TMDS Clock Shield
12	TMDS Clock –
13	CEC (not used)
14	Reserved (NC on device)
15	DDC Serial Clock
16	DDC Serial Data
17	DDC/CEC ground
18	+5V Power
19	Hot Plug Detect

Fig.11: Pin connections for the Type A HDMI digital video + audio interface, now beginning to be used to connect digital HDTV receivers with plasma display screens.

bitstreams. It can transfer up to eight uncompressed audio bitstreams with the video, at sampling rates up to 192kb/s depending on the video format. Alternatively it can handle a compressed multichannel audio bitstream (like Dolby Digital or DTS), again at sample rates up to 192kb/s.

Although the HDMI video interface is based on DVI, it does not handle the DVI video formats used by computers. It mainly supports the following digital HDTV formats: 704 x 480 pixels at 60Hz progressive scan (480p); 704 x 480 pixels at 30Hz interlaced scan (480i); 1280 x 720 pixels at 60Hz progressive scan (720p); 1920 x 1080 pixels at 30Hz interlaced scan (1080i); and 1920 x 1080 pixels at 60Hz progressive scan (1080p). The digital colour component formats handled are RGB, 4:4:4 Y/Cb/Cr and 4:2:2 Y/Cb/Cr.

HDMI outputs are likely to appear on the next generation of HDTV digital set-top boxes, recorders and DVD players. The next generation of HDTV receivers are also likely to have HDMI inputs. HDMI cables use a compact 19-way connector, shown above in Fig.11.

Summary

As you can see, there are now many different options when it comes to video formats and cables for home theatre and computer video displays. Hopefully this Tech Note has given you enough understanding of what's needed, what's available and their pros and cons, so that you'll be able to make the right decision for your computer system and home theatre setup.