



## The Saga of the SCART and how to make it digital!

*We are all familiar with the funny connector we plug in the back of our TV and video recorder, but how many of us know the details? Wouldn't it be great to use a standard TV receiver and feed it with digital video? We are grateful to Dr John Emmett of Broadcast Projects Research for the following explanations...*

**The 1960's:** The French had a problem. They had started their post-war television service with old German equipment that employed 441 lines. After a major fire in the Paris studio centre, the French manufacturers looked outwards at the blossoming European television industry with envy, but where could they go from there?

The British 405 line system was of course unthinkable, (as well as being distinctly antique), and 625 lines would mean competition with the neighbours, so would 819 lines do? (Line numbers had to be odd in order to interlace between the two fields that make up one TV frame or picture), and the frequencies involved had to be dividable by simple valve circuits, so factors such as 3, 5 or 7 seem to always be involved.)

For a start, the European radio frequency allocations had to be stretched to accommodate the bandwidth needed, and it is quite possible that the cameras and receivers never made the best of the 14 MHz that they were eventually allocated. However, on the up side the sets were certainly impressive; uncannily silent in operation (the line frequency was just over 20kHz, so only the poodles could hear it) and they cost so much that only the bars in the typical small village could afford one. That made the bar owners supportive, for a start!

Even in the early 1950's, the 525 line US television system had adopted FM audio, although there was a nasty tendency for the typical receiver audio to whistle until the harmonics of the line frequency were lined up with the 4.5 MHz sound carrier. To do this change, the Americans simply moved the field rate down 0.1% from 60 Hz to 59.94 Hz, and in doing so they instantly built a fantastic millstone around their own necks ready for when time-code arrived. Regardless of this, they pushed on towards adopting colour with the aid of a genuinely intelligent and powerful, National Television System Committee (NTSC).

The BBC toyed with the NTSC colour system adapted to our then current 405 lines, but ABC television, at that time occupying Teddington Studios, were very keen to generate as many overseas programme sales opportunities as possible, and so were not keen on any short sighted solution. They experimented with a colour system called SECAM (SequENTIAL Colour Avec Memoire), invented by Henri de France (who wasn't, I believe, actually French). SECAM used an FM sub-carrier to carry the colour information, which made the receiver easy to manufacture. However, in the studio it was impossible to fade a picture to black, as the FM sub-carrier remained stubbornly fixed as the luminance (black and white) information faded down.

Eventually, the advantages of the German PAL (Phase Alternating Lines) system were recognised by nearly everyone, and 625 lines was adopted throughout Europe. Not to be snubbed by this, the French went for SECAM colour with AM sound, whilst the Russians went for FM sound and another version of SECAM colour.

**The early 1980's:** The home video recorder came to Europe largely from Japan. The French dug in, waiting for a European videocassette format to catch on, but they waited in vain. Somewhere in France, someone must have suggested leapfrogging the commercial battles of the previous years, and this time they intended to make French televisions future proof. After all, the Mintel system genuinely introduced the French public to using an internet type of service, long before any other national government even knew what the internet was about.

The main result of this work was the SCART connector (Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs). This was intended to interconnect a home television system much in the same way that hi-fi systems were interconnected. You could then update items one by one, and your TV could become a high quality RGB monitor, independent of the television system originally used. At that time in the US and the UK, the best we could do for interconnection were dreadful RF modulators. Today the SCART connector is also known as Pertitel connector or Euroconnector, and if you are really keen, a formal description can be found in the CENELEC EN 50 049-1:1989 standard or in the IEC 60933-1 standard.

**The SCART in the 21st century:** Different pin-configurations exist today, and which configuration or configurations are appropriate for you depends on the video device used. Sometimes you can choose between configurations by changing a software setting or a switch. (Such as choosing composite or S-video outputs on a DVD.) Two status signals on pins 8 and 16 can be used to define electrically which video signals are active, and a video device can use these status signals to automatically switch between internal or external audio/video signals. The actual voltage levels on these pins have been enhanced over the years for extra functions such as for carrying low-level data. There are tables at [www.bpr.org.uk](http://www.bpr.org.uk) which, hopefully, represent the latest connection versions.

**Yes, but what use is a SCART plug within professional systems?** A professional Serial Digital Interface (SDI) monitor costs upwards of £1000. It consists of a high-quality CRT and driver circuit, along with a digital decoder that provides red, green and blue signals from the digital video input. The SDI signal in turn arrives on an ordinary looking piece of video coax cable, terminated in an ordinary looking BNC connector. Indeed it is just this ordinariness that makes the Serial Digital Interface so useful, as you can use old analogue cables, and changing cables in studio centres often costs more than changing the technical equipment.

Now the modern telly is a remarkably good device, slight chromaticity (colour rendering) errors being the only obvious outward differences to those professional monitors. So why not use the SCART connection to turn it into a high quality RGB monitor? All you need is a digital SCART adapter. Once you have one of those, and the reverse one to turn your DVD or Video into a SDI digital video source, you have the core of an affordable professional TV Studio

**Broadcast Projects Research "JEM"** is just such a SDI to SCART adapter, constructed in a metal case with integral SCART plug. A BNC connector is used to connect the incoming SDI signal and power is provided by an external plug-top power supply. The **"MEJ"** is the companion to the JEM, and generates SDI signals from the output of say a VCR, TV or set-top box. Both devices are available from Canford (see page 317 of the 2002-2003 catalogue) as are most of the BPR products.

OK, so what is this SDI? To see where the SDI came from, we need to look back to the 1980's when all those different TV systems were starting to prove a headache to the professional programme makers and the (newly international) professional equipment manufacturers as well. The US television system had a line scan frequency which had been altered to be a sub multiple of 4.5 MHz, (or 2.25 MHz) whilst the 625 line system already had a line frequency related to 2.25 MHz. Digital sampling of the high-resolution luminance part of either signal at 13.5MHz would then give an excellent luminance resolution for both systems, and the two derived colour parts of the picture could be sampled separately at a lesser rate, as the colour part is not perceived as sharply as the luminance. The result was independent of colour system, as it used the fundamental colour components (and is therefore called a component television system, rather than a combined (composite) system such as NTSC, PAL, or SECAM), and it became known internationally as "CCIR 601" (now known as ITU-R BT601) standard, although only the sampling and filtering was really covered in this standard. The sample rates given, were quite near to four times the NTSC sub-carrier sample rate which had previously been used for composite signal encoding. As a result this sampling structure (13.5, 6.75, 6.75) became known as "4.2.2" sampling.

As first proposed, the digital component standard used a parallel cable and connector system using nine twisted-pairs (an example being BBC type "PSN18/1", Canford type "DVC" 36-391). Eight signal bits and a clock line were used, so when 10-bit video coding was proposed, it was time to look at a serial connection format. The serial format became the ITU-R 656 Standard, and it could use existing 75ohm video coaxial cable and BNC connectors

**What else can I do with SDI?** Because the 601/656 SDI system maintain the timings of the analogue system, the time gaps between lines and fields are still in place. These had been allowed for in the 1930's for cathode ray tube (CRT) scan "flyback". That spare time amounts to around 25% of the entire data rate, so would it surprise you to learn that you could carry 16 tracks of "embedded" audio in this spare space? And as well you can have it in 24-bit 48kHz sampled form along with lots of data. That makes quite a handsome 16-track distribution system using simple video coax, doesn't it? Forget the pictures, and take a look at BPR's multichannel embedders and de-embedders!