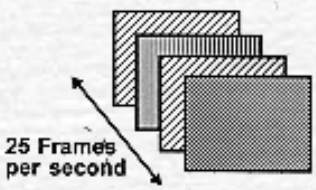
# WORLD TV STANDARDS

A number of TV standards now co-exist worldwide. This article takes a look at how and why they originated, as well as a comparison. It also offers detail listings of standards prevalent in various countries.

Television broadcast commenced approximately 50 years ago. The knowledge gained over the years has helped evolve better standards. As a result of this, the US which saw the birth of wide spread commercial television broadcasts, evolved the first system which predictably, is also the most primitive. Subsequent television systems have learnt from earlier mistakes.

## FRAMES :




Before we consider different television systems, we need to take a look at the basics of television transmissions. A television transmission consist of a series of rapidly changing pictures which convey to the viewer, an illusion of continuous motion. The pictures need to flash at a rate of more than 16 pictures per second, to fool the eye into seeing continuous motion. Each of these rapidly changing pictures is termed as a "frame". Typically a television transmission consists of either 25 or 30 frames per second. This is shown in figure 1.

## LINES :

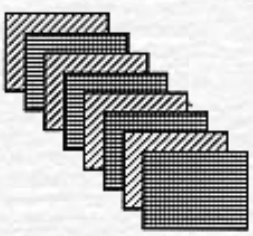


*Fig. 2 : Interleaving of Odds & Even Frames*

Each picture consists of several closely spaced lines. The lines are scanned (written) from left to right and from the top of the screen to the bottom of the screen. Typically a TV picture consists of 525 or 625 lines. In view of the large number of lines, if all lines were written one after the other on the screen, the picture would begin to fade at the top of the screen by the time the last few lines at the bottom of the screen are written. To avoid this, the first frame carries only the odd numbered lines e.g. line numbers 1, 3, 5 etc. The next frame carries only even numbered lines e.g. line numbers 2, 4, 6 etc. In this manner, successive frames carry the odd and even numbered lines. This provides a uniform intensity to the picture, and is called "interlacing", and indicated in figure - 2.

## TIMING :

TV receivers require a source to time the rapid succession of frames on the screen. Designers decided to use the Mains power supply frequency as this source for two good reasons. The first was that with the older type of power supply, (non SMPS) you would get rolling hum bars on the TV picture if the mains supply and power source were not at exactly the same frequency. The second was that the TV studio lights or for that matter all florescent, non incandescent lights flicker at the mains frequency. Since this flicker is much higher than 16 times per second the eye does not detect it. However this flicker could evolve into an extremely pronounced low frequency flicker on TV screens due to a "beat" frequency generated between the light flicker and the mains frequency. This would have made programmes unviewable particularly in the early days of development of TV receivers.

There are two Mains power frequencies widely used around the World, 50Hz and 60Hz. This immediately divided the worlds TV systems into two distinct camps, the 25 frames per second camp (50Hz) and the 30 frames per second camp (60Hz). Later the 60Hz camp made a small adjustment and changed the field rate to 59.94Hz when they added colour to the signals. The issue of field frequency remained sufficiently deep rooted in both TV standards that the vested interest remained long after the original technical justification had gone.

The biggest compatibility problems between TV standards remain related to the field rate; these are also the hardest problems to solve.
NTSC : Beyond the initial divide between 50 and 60Hz based systems, further sub-divisions have appeared within both camps since the inception of Colour broadcasting. The majority of 60Hz based countries use a technique known as NTSC originally developed in the United States by a

committee called the National Television Standards Committee. NTSC (often scurrilously referred to as Never Twice the Same Colour) works perfectly in a video or closed circuit environment but can exhibit problems of varying hue when used in a broadcast environment.

**PAL**

This hue change problem is caused by shifts in the colour sub-carrier phase of the signal. A modified version of NTSC soon appeared which differed mainly in that the sub-carrier phase was reversed on each second line; this is known as PAL, standing for Phase Alternate Lines (it has a wide range of facetious acronyms including Pictures At Last, Pay for Added Luxury (re: cost of delay line), and People Are Lavender). PAL has been adopted by a few 60Hz countries, most notably Brazil.

**SECAM :**

Amongst the countries based on 50Hz systems, PAL has been the most widely adopted. PAL is not the only colour system in widespread use with 50Hz; the French designed a system of their own - primarily for political reasons to protect their domestic manufacturing companies - which is known as SECAM, standing for Sequential Couleur Avec Memoire. The most common facetious acronym is System Essentially Contrary to American Method, SECAM was widely adopted in Eastern Block countries to encourage incompatibility with Western transmissions - again a political motive.

**SECAM ON PAL :**

Some Satellite TV transmissions (usually Russian) that are available over India, are in SECAM Since the field (25 frames /sec) and scan rates are identical, a SECAM signal will replay in B&W on a PAL TV and vice versa. However, transmission frequencies and encoding differences make equipment incompatible from a broadcast viewpoint. For the same reason, system converters between PAL and SECAM, while often difficult to find, are reasonably cheap. In Europe, a few Direct Satellite Broadcasting services use a system called D-MAC. It's use is not wide-spread at present and it is transcoded to PAL or SECAM to permit video recording of it's signals. It includes features for 16:9 (widescreen) aspect ratio transmissions and an eventual migration path to Europe's proposed HDTV standard. There are other MAC-based standards in use around the world including B-MAC in Australia and B-MAC60 on some private networks in the USA. There is also a second European variant called D2-MAC which supports additional audio channels making transmitted signals incompatible, but not baseband signals.

**FREQUENCY STANDARDS:**

In addition to the incompatibilities of 50 and 60Hz systems, and the different Colour systems, there is a further barrier to compatibility. Fortunately, video recordings themselves are not affected by this, only the TV signal reception equipment. For various reasons of number of stations and terrain, TV pictures can be transmitted in any of three main frequency ranges, VHF, UHF and Microwave (Satellite Direct Broadcasting). Equipment designed to receive signals in only one of these bands cannot receive transmissions in any of the other bands.
Further, there are differences between the encoding of the sound between countries using the same frequency bands. Within 50Hz PAL UHF transmissions, audio signals can be at 5.5Mhz offset (system G), or at 6MHz offset (system I). Similar differences exist between the Middle Eastern versions of SECAM (MESECAM) and the Eastern Bloc (OIRT) version.

**RELATIVE MERITS OF TV SYSTEMS**

The differences between each of the main TV systems are not quite as clear cut as one might at first imagine. While NTSC has a reputation for poor colour accuracy, this is only really true of broadcast television and as a video format it has some distinct advantages over the other systems. All these systems are a compromise and many efforts have been made over the years to address the shortcomings in each of the systems.

**NTSC/525 Advantages**

Higher Frame Rate - Use of 30 frames per second (really 29.97) reduces visible flicker. Atomic Colour Edits - With NTSC it is possible to edit at any 4 field boundary point without disturbing the colour signal. Less inherent picture noise - Almost all pieces of video equipment achieve better signal to noise characteristics in their NTSC/525 form than in their PAL/625.

**NTSC/525 Disadvantages**

Lower Number of Scan Lines - Reduced clarity on large screen TVs, line structure more visible. Smaller Luminance Signal Bandwidth - Due to the placing of the colour sub-carrier at 3.58MHz, picture defects such as moire, cross-colour, and dot interference become more pronounced. This is because of the greater likelihood of interaction with the monochrome picture signal at the lower sub-carrier frequency.

Susceptibility to Hue Fluctuation - Variations in the colour subcarrier phase cause shifts in the displayed colour, requiring that the TV receivers be equipped with a Hue adjustment to compensate.  Lower Gamma Ratio - The gamma value for NTSC/525 is set at 2.2 as opposed to

the slightly higher 2.8 defined for PAL/625. This means that PAL/625 can produce pictures of greater contrast.

Undesirable Automatic Features - Many NTSC TV receivers feature an Auto-Tint circuit to make hue fluctuations less visible to uncritical viewers. This circuit changes all colours approximating to flesh tone into a "standard" flesh tone, thus hiding the effects of hue fluctuation. This does mean however that a certain range of colour shades cannot be displayed correctly by these sets. Up-market models often have this (mis)feature switchable, cheaper sets do not.

**PAL/625 Advantages**
Greater Number of Scan Lines - more picture detail.
Wider Luminance Signal Bandwidth - The placing of the colour Sub-Carrier at 4.43MHz allows a larger bandwidth of monochrome information to be reproduced than with NTSC/525. Stable Hues - Due to reversal of sub-carrier phase on alternate lines, any phase error will be corrected by an equal and opposite error on the next line, correcting the original error. In early PAL implementations it was left to the low resolution of the human eye's colour abilities to provide the averaging effect; it is now done with a delay line. Higher Gamma Ratio - The gamma value for PAL/625 is set at 2.8 as opposed to the lower 2.2 figure of NTSC/525. This permits a higher level of contrast than on NTSC/525 signals. This is particularly noticeable when using multi-standard equipment as the contrast and brightness settings need to be changed to give a similar look to signals of the two formats.

**PAL/625 Disadvantages**
More Flicker - Due to the lower frame rate, flicker is more noticeable on PAL/625 transmissions; particularly so for people used to viewing NTSC/525 signals.

Lower Signal to Noise Ratio - The higher bandwidth requirements cause PAL/625 equipment to have slightly worse signal to noise performance than it's equivalent NTSC/525 version.
Loss of Colour Editing Accuracy - Due to the alternation of the phase of the colour signal, the phase and the colour signal only reach a common point once every 8 fields/4 frames. This means that edits can only be performed to an accuracy of +/- 4 frames (8 fields).

Variable Colour Saturation - Since PAL achieves accurate colour through cancelling out phase differences between the two signals, the act of cancelling out errors can reduce the colour saturation while holding the hue stable. Fortunately, the human eye is far less sensitive to saturation variations than to hue variations, so this is very much the lesser of two evils.

**SECAM/625 Advantages**
Stable Hues and Constant Saturation - SECAM shares with PAL the ability to render images with the correct hue, and goes a step further in ensuring consistent saturation of colour as well. Higher Number of Scan Lines - SECAM shares with PAL/625, the higher number of scan lines than NTSC/525.

**SECAM/625 Disadvantages**
Greater Flicker - (See PAL/625) Mixing of two synchronous SECAM colour signals is not possible - Most TV studios in SECAM countries originate in PAL and transcode prior to broadcasting. More advanced home systems such as SuperVHS, Hi-8, and LaserDisc work internally in PAL and transcode on replay in SECAM market models.
Patterning Effects - The FM subcarrier causes patterning effects even on non-coloured objects.
Lower monochrome Bandwidth - Due to one of the two colour sub-carriers being at 4.25MHz (in the French Version), a lower bandwidth of monochrome signal can be carried.

Incompatibility between different versions of SECAM - SECAM being at least partially politically inspired, has a wide range of variants, many of which are incompatible with each other. For example between French SECAM with uses FM subcarrier, and MESECAM which uses an AM subcarrier.

## SOUND & TITLES

In addition to standard combinations of Scan Rate, Colour System and transmission frequencies, there are further complications when it comes to additional features like Stereo Sound, Sub-titling and information services. Fortunately, such differences do not effect the basic operation of equipment conforming to the same broadcast standard. In the cases of both stereo sound and additional textural information carried in the top few lines of the picture, there are three competing systems of varying technical merit.

## STEREO SOUND

The most recent system, NICAM 728, was designed by the BBC in the late 1980s using digital audio technology. MTS - The oldest still operational of the stereo sound systems is the American MTS system based on NTSC transmissions Used in conjunction with NTSC/525. Consists of two

independent carriers each carrying a discrete channel. One channel provides stereo sound by providing left/right channel difference signals relative to transmitted mono audio track. The second carrier carries the Secondary Audio Program (SAP) which is used for a second language or a descriptive commentary for the blind. Uses a technique based on the dbx noise reduction to improve the frequency response of the audio channel.

FM-FM - only slightly more recent than the MTS, is the twin channel FM-FM system used in Germany, Austria, Australia, the Netherlands and Switzerland. This system uses 2 FM carriers, one each for the left & right channels, to yield analog stereo transmissions. The same system can also be used for bi-lingual operation, but no auto-selection is available. NICAM - (full name: NICAM 728) The system provides digital two-channel audio transmissions with sub-code selection of bi-lingual operation. Stereo digital signals with specifications approaching those of Compact Disc are possible. NICAM stands for Near Instantaneously Companded Audio Multiplex and uses a 14 bit sample at a 32KHz sampling rate which produces a data stream of 728KBits/sec.

**STEREO ABSENT IN INDIA**

Unfortunately, no standard for transmission of stereo sound with the TV picture has been specified or adopted in India. While NICAM would appear to be the logical choice, keeping in mind that we follow the German TV standards, the Bureau Of Indian Standards ( BIS ) has not specified any system. Currently, no terrestrial TV transmissions or CATV networks, carry stereo sound, which is a pity since it could significantly add to the viewing pleasure of not only the (Satellite broadcast ) music channels such as Channel[V] & MTV but also for movies viewed on a Home theater system.

**SUB-TITLING TELETEXT**

The oldest of the subtitling systems is almost definitely the BBC and IBA designed TeleText system which has been is use in the UK since the mid 1970s. It is also the most widespread and the most flexible of the systems in widespread use. Doordarshan too had commenced the use of teletext, embedded in its terrestrially transmitted signals in some metros, but the service never really became popular. Some believe that the system failed to receive viewer patronage, because the contents were not updated regularly, and therefore the contents (such as arrival times of Trains) were often false & misleading.

There is now an enhanced version called Fastext which defines four links to additional pages that can be followed with one of four coloured buttons on the Teletext receiver's remote control. Closed Captioning ( CC ) The US Closed Captioning mechanism came about through political pressure from the Deaf organisations in the USA and has not been developed beyond the simple job of producing subtitles for the Deaf.

Transmitted on line 21 of NTSC/525 transmissions, ( hence widely known in technical circles as LITO = LIne Twenty-One ), contains subtitling information only. CC has no support for block graphics or multiple pages but it can support 8-colours and the use of an italic typeface. Sometimes found on US pre-recorded VHS cassettes and LDs, it is also used on US broadcasts. Sometimes it is found on European PAL/625 pre-recorded VHS cassettes in a modified version, because Teletext cannot be carried on a VHS tape.

**ANTIOPE**

The French ( as you would expect ) developed their own subtitling and information system called Antiope which has not found favour elsewhere, largely due to the existing widespread use of the BBC developed TeleText system. A few US stations have now adopted the BBC-style Teletext but few manufacturers, fit the decoders to their sets.

**CONCLUSION:**

As we have seen, TV standards have evolved over the years along with various options for including a colour burst to carry the colour as well as other features such as stereo sound and titling. The NTSC system too has its advantages and infact provides excellent reception for video transmission in a CCTV (not CATV) network where phase variations are not significant.

While the recent systems offer improvements and better fault tolerance, it is now not possible for countries to change their existing systems because of the millions of TV receivers already installed. Engineers and governments have learnt from these past mistakes and strived to make all future developments such as digital transmissions and encoding more universal. A key requirement of the MPEG-2 system was that it should accommodate all, PAL, NTSC and SECAM. Clearly this confirms the fact that there is not going to be a reversal of existing systems in any country and we will have to live with multiple systems, in the years ahead.