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PAL
Abbreviation for Phase Alternation by Line

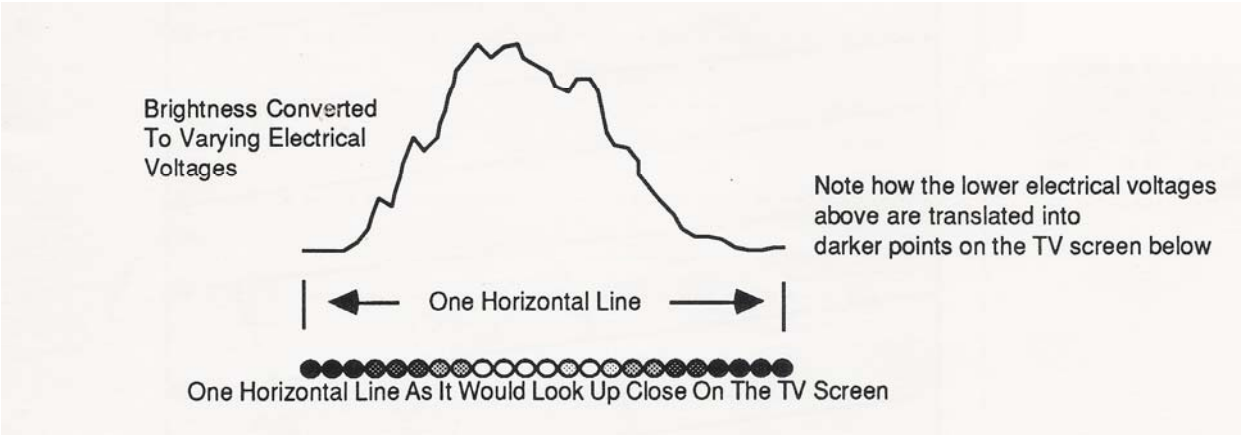
VIDEO TIMING BASICS

Video Acquisition:

Light from a scene enters the camera through the lens and create a pattern of electrical charges on the pickup tube's target. An electron beam scans across the target and completes an electrical circuit with the pattern off electrical charges on the target. Electrons representing the scene in lightness or darkness flow from the target and become the video signal. In this way, the pickup tube inside the camera changes the varying brightnesses of light that it sees into varying electrical voltages called the video **luminance** signal.

LUMINANCE

The brightness of the picture or area of the television screen being considered, as expressed by a voltage level.



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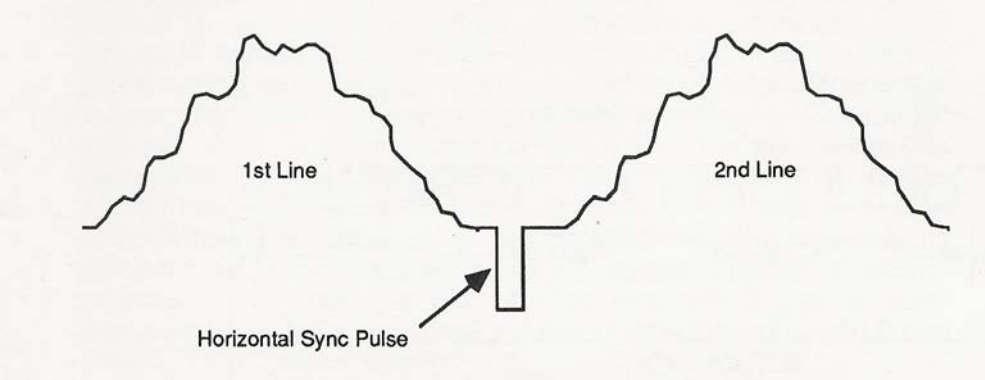
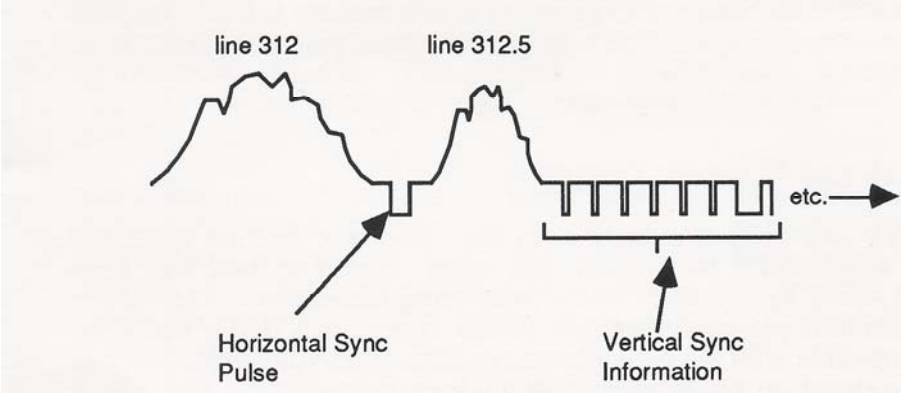
HORIZONTAL AND VERTICAL SYNC

For accurate reproduction, both the camera and the television receiver must be synchronized to scan the same part of the scene at the same time. At the end of each horizontal line the beam must return to the left side of the scene. This is called **horizontal retrace.** Coordination of the horizontal retrace is handled by the **horizontal sync pulse.**



Horizontal Sync Pulse. The synchronizing pulse at the end of each line that determines the start of horizontal retrace

At the bottom of the scene, when 312,5 horizontal lines have been scanned, it is time for the beam to return to the top of the scene. The start of vertical retrace is signalled by the **vertical sync pulse** which is different in width than horizontal sync pulses. Since the vertical retrace takes much longer than horizontal retrace, a longer vertical synchronizing interval is employed.



Vertical Sync Pulse . The synchronizing pulse at the end of each field which signals the start of vertical retrace

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SCANNING

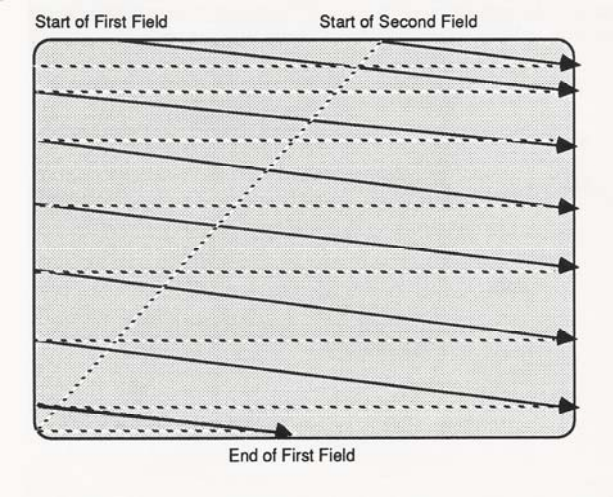
In order to accurately reproduce a scene, the scanning must be done in an organized way. In both the camera and the television receiver, the scanning of the target or screen is done by an electron beam moving in horizontal lines across the target plate or screen. At the same time, the electron beam gradually moves down the scene. Between horizontal scans, the beam returns to the left side of the viewer's screen (called **line flyback** or **horizontal retrace**). When the beam reaches the bottom of the scene, the beam is sent back to the top (called **vertical retrace**). There are **625** horizontal lines in a complete picture.

FIELDS and FRAME

Each scan of the scene is called a **field** and only involves half of the total **625** lines, or **312,5** lines. Two complete scans of the scene (625 lines) is called **frame**. Because the fields are scanned in rapid sequence (50 per second), the viewer only perceives the complete picture.

Field one is scanned as the beam moves from the top to the bottom of screen. The beam is then quickly returned to the top of the screen and **field two** is scanned. The lines of the second field are **interleaved** between the lines of the first field. This is called **interlaced scanning**.

By the way, field flyback (vertical retrace) takes a finite amount of time – up to **25 lines in PAL** – so the actual number of line displayed on the screen **is less than 625**.



Field

Half of the horizontal lines (312,5) needed to create a complete picture

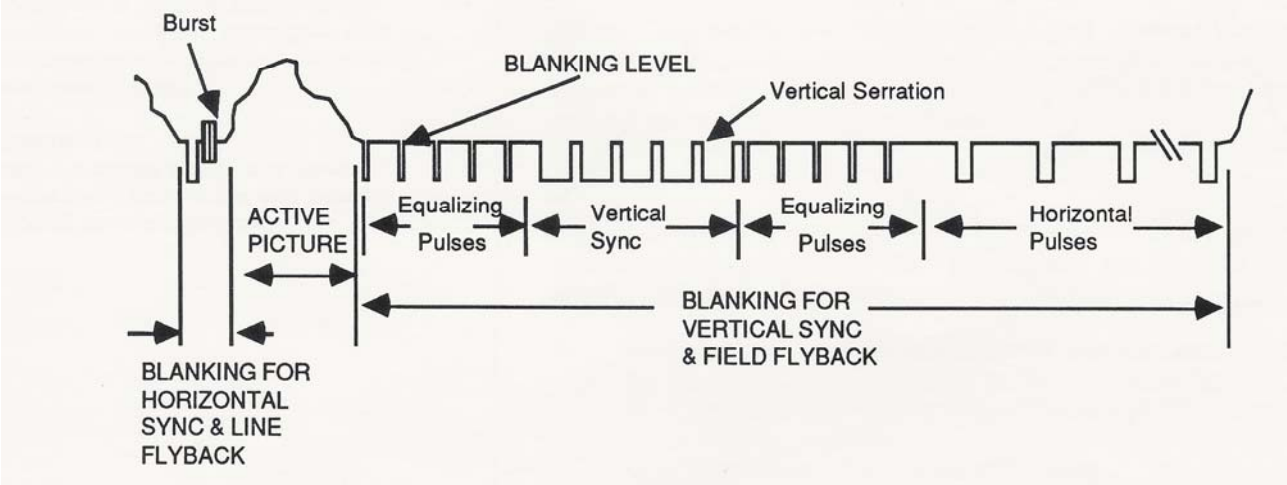
Two interlaced fields create a complete frame.

Frame

A complete picture composed of two fields (625 interlaced horizontal lines of picture information.

BLANKING

During the time when horizontal and vertical retrace are taking place, the electron beams in the camera and home TV are cut off. This time period is called blanking. **Blanking** means that nothing will be written on the television screen.



Blanking – The time period when picture information is shut off. Blanking is the same voltage levels the black picture level. Synchronizing signals which control invisible retrace of scanning are active during the blanking period

During horizontal blanking, sync and burst occur. During vertical blanking, vertical sync ,vertical equalizing **pulses**, and vertical serrations occur. The equalizing pulses are inserted to ensure that the video fields begin at the proper points to achieve interlace. The vertical serrations keep the television receiver's horizontal sync circuitry from drifting off frequency during the time when no horizontal picture information is present.

BLACK and WHITE Vs. COLOUR

Black and white (monochrome) television was the first system to be successfully transmitted and many television sets had been purchased by the time colour was being considered. One of the constraints placed on the new colour system was that it had to be compatible with the monochrome system. Everything that we have considered so far is applicable to both monochrome and colour television systems. Both systems use interlace scanning, synchronizing, and blanking pulses.

In the picture above you will recognize the sync pulses and the active video that we have already discussed. You will also see a small segment identified as **burst**. We will be looking into the colour system, along with the concept of burst, in the next few pages of the Video Basics section.

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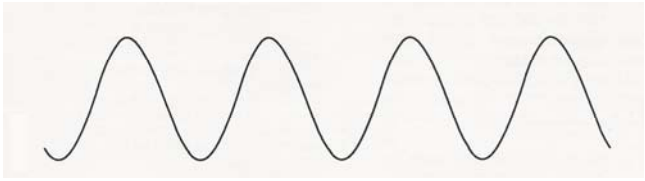
CARRIERS WAWES

Ever since radio was invented a **carrier** wave has been used to **carry** electrical information through the atmosphere . a carrier wave is a signal that goes up and down in voltage very rapidly and evenly . One complete up and down is a **cycle**.

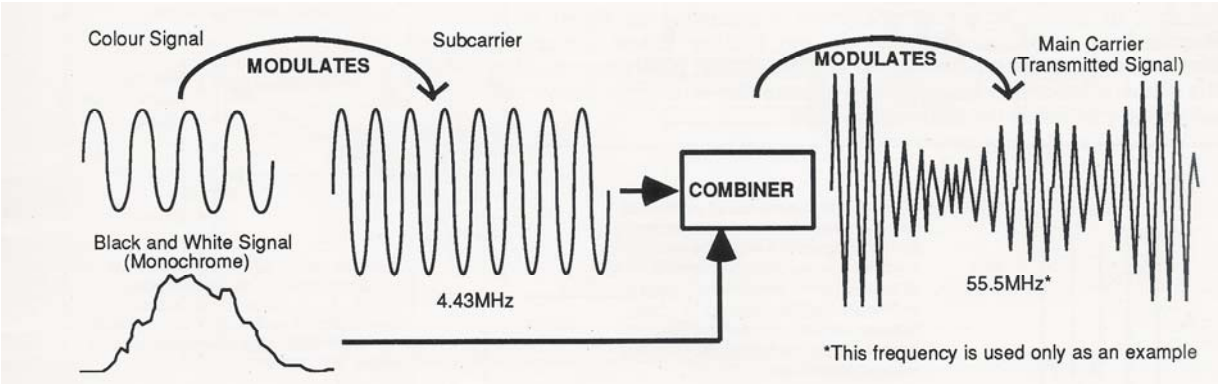
The carrier wave can be sent through the air for considerable distance and it can be easily picked up by a receiver like a radio or TV.



The carrier wave is somewhat like a rapid and exaggerated ocean wave

SUBCARRIER

In the video signal, a subcarrier wave is included to carry the colour information. The subcarrier, with its colour information, is combined with the black and white information and together they modulate the main carrier. Subcarrier **SC** is a continually cycling waveform at **4.43 MHz** on which colour information is added or encoded. SC is added to the monochrome information to make colour available.
The subcarrier has a particular frequency and that frequency is abbreviated as **4.43MHz** (Mega Hertz).
Mega means a million times and **Hertz** means per second.



Frequency: the number of cycles of a waveform in a given length of time.
Hertz: the number of cycles of a waveform in one second.

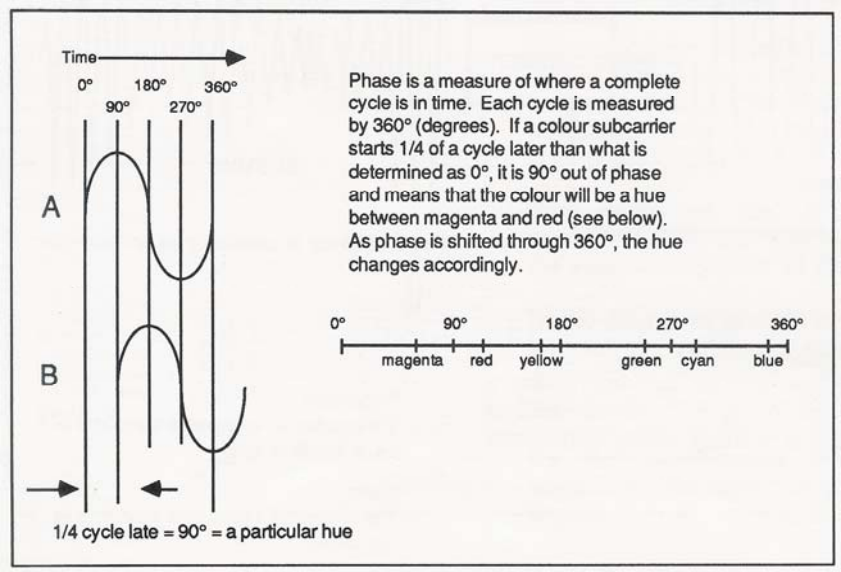
ENCODING COLOUR ONTO SUBCARRIER

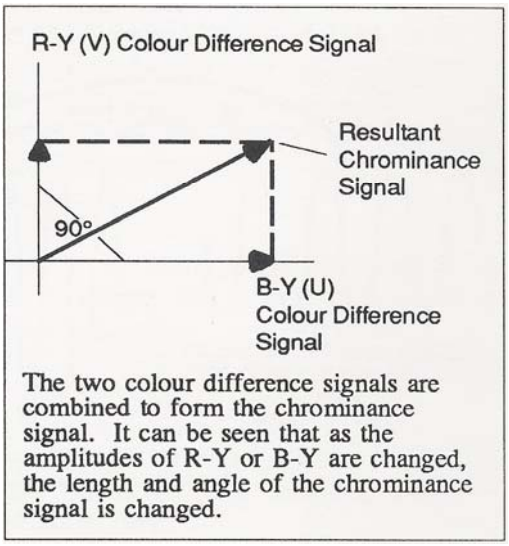
The colour signal is composed of luminance (Y), red (R), green (G), and blue (B). To make the total video signal more compact for broadcasting purposes, the Y,R,G and B components of the colour signal are combined as Y an two **colour difference** signals called R-Y (**V**) and B -Y (**U**). Each colour difference signal contain the information for hue (colour) and saturation (brightness of the colour). The amplitude values of the two colour difference signals are modulated onto two subcarriers which have the same frequency but are **90° apart in phase** These two modulated subcarriers are then further combined to form one Chrominance signal that changes in amplitude and phase. The final transmitted signal contains both a luminance (Y) and a chrominance component. The original in amplitude and phase. The final transmitted signal contains both a luminance (Y) and a chrominance component. The original Y,R,G, and B components of the scene are decoded by the television receiver from the transmitted signals.

In PAL, the R-Y component is inverted in phase on alternate lines, to compensate for phase errors caused by equipment or the transmitting medium.

PHASE

For our purposes, phase relates to a time comparison between two signals. For example, signal A starts at zero microseconds and signal B begins several microseconds later. Both signals are in sinewave like the carrier wave on the previous page. A sinewave travels through a path that is described as 360 degrees. Signal A's starting point is 0 degrees and, depending on the time lag for the start of signal B, signal A's phase relationship to signal B is described in terms of degrees. In the sidebar below the phase relationship between the first signal and the second is 90 degrees. It is this phase relationship between two signals that is used to derive the colour information in the television system.





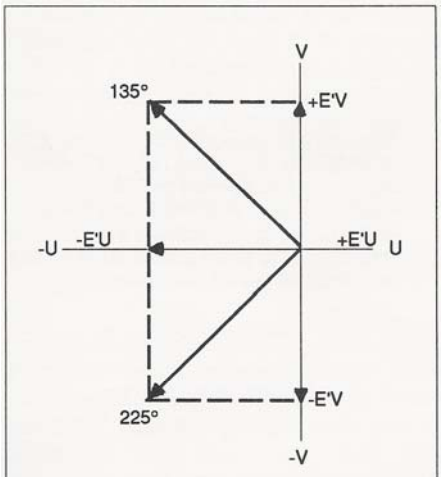
COLOUR BURST

Burst or colour burst is produced from a small section of the 4.43MHz subcarrier wave and is transmitted separately as the reference for the colour information (hue). The subcarrier is first subjected to a process called **phase splitting** which splits it into two signals, E'V and –E'U, that have a 90 degrees phase difference but an equal amplitude. E'U is permanently inverted to –E'U. E'V is inverted on alternate lines producing E'V and –E'V, respectively. Components –E'U and E' (or –E'V) are summed to form burst. In PAL, burst has a resultant degree position of 135° or 225° on alternate lines.

Burst then acts as a constant reference. The chrominance signal is compared to burst to determine the exact colour that is being transmitted. The colour is determined by the number of degrees the hue information is shifted in relation to reference burst.

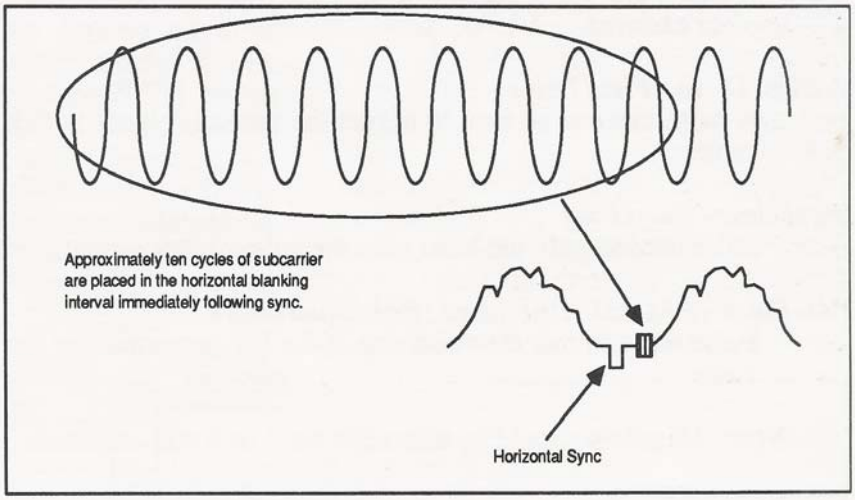
Burst is placed, as we've seen before, in the horizontal blanking interval following sync. When a video signal contains burst and horizontal and vertical sync, it is said to be **composite video (CV)**

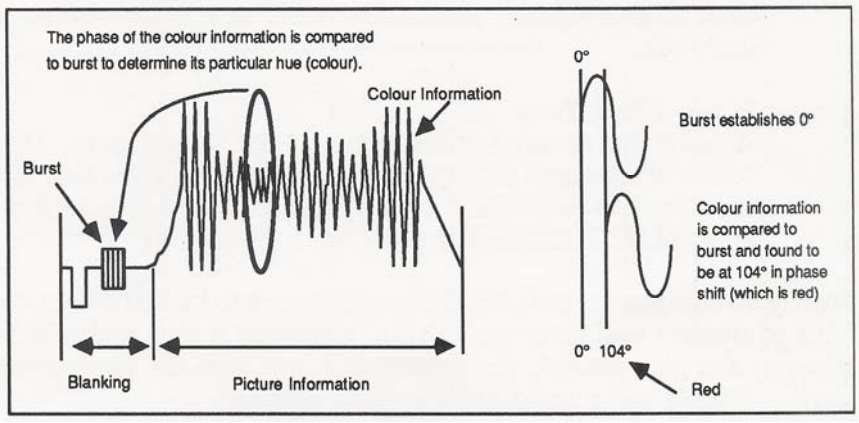
Burst
Ten cycles of 4.43MHz subcarrier, placed near the end of horizontal blanking, which is the colour reference for the colour signal. Colour timing refers to adjustment of the phase of the subcarrier.



E'_V and E'_U are the two continuous wave subcarriers, 90° apart.

In the generation of burst, the E'_V component is inverted on alternate lines, just as the R-Y colour difference signal is inverted in the encoding process described on the previous page. This keeps the reference burst and the R-Y component in phase during inversions on alternating lines.





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SUMMARY

All you have learned so far has stressed the point that all the equipment used in a television system must be **synchronized together**. This is achieved by feeding each item one or more reference signals from a sync pulse generator (SPG). When used as a master timing reference, the SPG must meet the performance specifications as required by the governing body. (**International Radio Consultative Committee** and the **European Broadcasting Union)**. Many studios will use two SPGs combined with an automatic changeover switch that will switch to backup SPG if the master should fail.

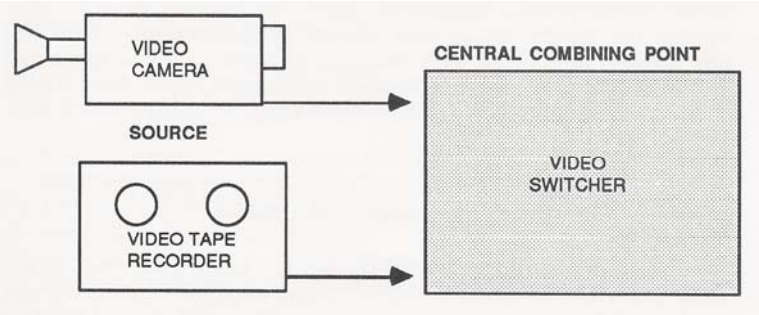
The output of sync pulse generators are as follows:

- Mixed Sync or Composit Sync or just Sync. (combined horizontal and vertical blanking pulse).
- Mixed Blanking or Comp. Blanking or Blanking. (combined horizontal and vertical blanking pulses).
- Horizontal Drive or Line Drive. (signal used to trigger the horizontal flyback in older camera).
- Vertical Drive or Field Drive. (signal used to trigger the vertical flayback in older camera).
- Burst Gate or Burst Flag. (signal used to gate the burst onto the colour black output).
- PAL Pulse or PAL I.D. or PAL Identity. (used to control the switching of E'V component of the burst).
- Subcarrier or SC. (A 4.43MHz sine wave used as phasing reference for chrominance signals).
- Colour Black or Black Burst. (a signal that contains mixed sync (H&V) plus Burst and white flag that indicate line one of field one.

Nearly all equipment designed today are designed to lock to **colour black**. This equipment will have controls for horizontal timing and subcarrier phasing.

SISTEM TIMING

It is imperative that all video signals arrive at video switcher (central combining point) in synchronization . This means that the scanning sequence of every source must start and stay in time. Without this, the picture on the television receiver or studio monitor will roll, jump, tear and/or have incorrect colours when the source video signals are combined. Careful system design is necessary to assure synchronization at the point of input to a video switcher.



The degree of accuracy with which these events must occur requires a precision reference. In all television facilities, this timing reference is provided by a Synchronizing pulse generator.

ADVANCE AND DELAY

Defining advance or delay between two video signals is dependent on which signal is defined as the **reference**. Advance on camera nr.1 means its output occur earlier in time than camera nr.2's output. If viewed from the other perspective, camera 2 is delayed when referenced to camera 1. It must be understood that advance is not really possible. Advance or negative time delay does not exist. Video signals take time to move just as you and I do. Video **frame synchronizer** make video advance appear possible, but in reality they introduce delay to achieve the apparent advance. This is proven by the fact that audio associated with the video going through a frame synchronizer must also be delayed to avoid **lip-sync** errors.

Reference Video Signal – A composite video signal used to compare all other video signals to, for timing purposes.

Frame Synchronizer – A digital buffer, that by storage, comparison of sync information to a reference, and timed release of video signals, can continuously adjust the signal for any timing errors.

STUDIO PLANNING

Most newer source equipment locks to **colour black** . This implies the device has its own internal sync generator. Typically this source equipment will have adjustment to allow the video output timing to be adjusted relative to the reference colour black. You should verify that adjustments range is sufficient for your requirements.

PLANNING FOR TIMING ADVANCES

Until now, most character generators have required pulse drivers and external adjustments of timing. This is often done by dedicating a **source synchronizer generator** to the character generator. Newer character generator models, like other devices, are locked to colour black. Also Digital Video Device such as digital effect generators, time base correctors and frame synchronizers work on the basis of storing digital video data. This allows timing to be easily adjusted and as such, digital video device are inherently able to time internally. Colour black is very common also in production switchers.

PLANNING FOR TIMING DELAYS

Coaxial cable is necessary for the proper distribution of video, pulse and subcarrier signals. Coax has an inherent **delay** of up to 5 nanoseconds per meter. This is cumulative and must be considered in system design. Very long runs can introduce significant delay. Coaxial cable can be used for delay but it should be remembered that coax introduce frequency response loss that increases with frequency and length.

DISTRIBUTION AMPLIFIERS (DAs)

Das introduce delay that will need to be planned for. This can vary from 25 to 70 nanoseconds depending on the model. Variable cable equalization adjustment will also affect electrical delay. Equalization should be adjusted prior to final system timing. Special purpose video distribution amplifiers are available to provide delay beyond 1 microsecond. These should be used because they have frequency response compensation that is superior to coax and passive video delay lines .Pulse DAs are available to allow for adjustment of pulse delay up to 4 microseconds and regenerate the pulse to eliminate distortion.

Phasing – Adjusting the delay of video signal to a reference video signal to ensure synchronization.
Path Length or Propagation Delay – The time it takes for a signal to travel through a an equipment.
Frequency Response – The maintenance of uniform video signal level over a range of frequencies.
DA – Device used to multiply a video signal. May also include cable equalization and / or delay.
Equalization – Process to altering the freq. response of a video amp. to compensate for HF losses.

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SISTEM DESIGN USING SOURCE SYNCHRONIZING GENERATORS

Most of the difficulties encountered in system design can be avoided with a master/source sync generator system. This system provide maximum flexibility and the best SC/H phase stability. The approach below will be used with the same equipment employed in the previous delay system.

This time, rather than using the camera as the reference at the switcher input, the master synchronizing generator's **colour bars** will be used. These colour bars are fixed in their time relationship to the other outputs of master sync generator and thus make a rock solid, SC/H phase-correct reference. All the source still need to be in exact time at the switcher input. This time SC/H phased pulse drivers will be provided to the camera and character generator by their own dedicated source sync generators.

The source synchronizing generator has the convenience of a single line locking signal and output advance or delay relative to the lock reference provided. This results in a much simpler system to design and maintain that users far less cabling. There is also redundancy in the system since the source sync generator will continue to freerun if the master should fail

Final system timing is now a matter of looking at the switcher output and comparing each of the sources to the master sync generator's colour bars. Each source sync generator is adjusted to time the source it is driving. If the source device has a sucarrier phase control built in, you should adjust horizontal phase using the source sync generator and subcarrier with the source device's SC phase control. This will establish correct SC/H phase and afterwards only the source sync generator should need adjustement.
An SC/H phase meter will allow the source to be SC/H phased prior to adjustment of the source synchronizing generator for final timing.

Colour Frame

In PAL, colour television it takes **eight fields** to complete **one colour frame**. For a detailed definition, see the SC/H PHASE section.

Group Delay

A defect in a video signal caused by different frequencies having differing propagation delays (delay at 1MHz is different than delay at 5 MHz) In the television picture, group delay will cause an object's colour to shift outside the object's outline.

MULTIPLE STUDIO TIMING

The illustration on the next page shows a three studio system in which the timing of entire source cluster and studio can be changed. This will allow one studio to feed any other studio in time. It will also allow for the priorities to change very easily.

This entire system is being driven by a dual master reference synchronizing generator with an automatic changeover switch. This provides additional security since each master sync generator is powered from a different circuit. The master sync generators can have **ovenized crystal oscillator** option for higher frequency reference stability against temperature variations. An external frequency standard to be used as frequency standard, with the internal oscillator as a backup.

Each of the three studios are similar to the one just designed. The studio have some dedicated source devices, with additional cameras and/or video tape machines that can be assigned. A routing switcher is used to assign these sources to the studios. Every studio output is fed to a routing switcher input for assignment as a timed input to another studio. Every studio is being driven by a reference synchronizing generator which will adjust the timing of that entire studio. Each source cluster is driven by a source synchronizing generator so the source cluster timing will stay together. The reference output from each studio reference synchronizing generator is sent to the routing switcher. The reference input to any source cluster synchronizing generator can be assigned to any studio. This automatically times the source cluster to the studio using it. If the reference synchronizing generator has a phase preset option, the phase setting for every configuration can be stored and recalled. A typical configuration could be Source Cluster1 timed into Studio 1, the output of studio 1 and Source Cluster 3 timed into studio 2, Source Cluster 2 timed into Studio 3, which is also a timed input to Studio 2. These timing assignment can easily be interchanged with the phase preset option and routing switcher once the initial timing is completed and stored in each reference synchronizing generator. This system provide maximum flexibility in tailoring each studio for the production it is to be used for. The cameras would be assigned to a studio doing live production and the video tape machines could be used for post production in another studio. Many more sources can be added when using this design, without causing major system design problems.

Distributed synchronizing generator systems also provide what may be an important advantage: redundancy. Should a failure occur in the master generator, the reference and source generators will freerun and thus the equipment being driven by them will continue to function.

Ovenized Crystal Oscillator - A crystal oscillator that is surrounded by a temperature regulated heater (oven) to maintain a stable frequency in spite of external temperature variations.

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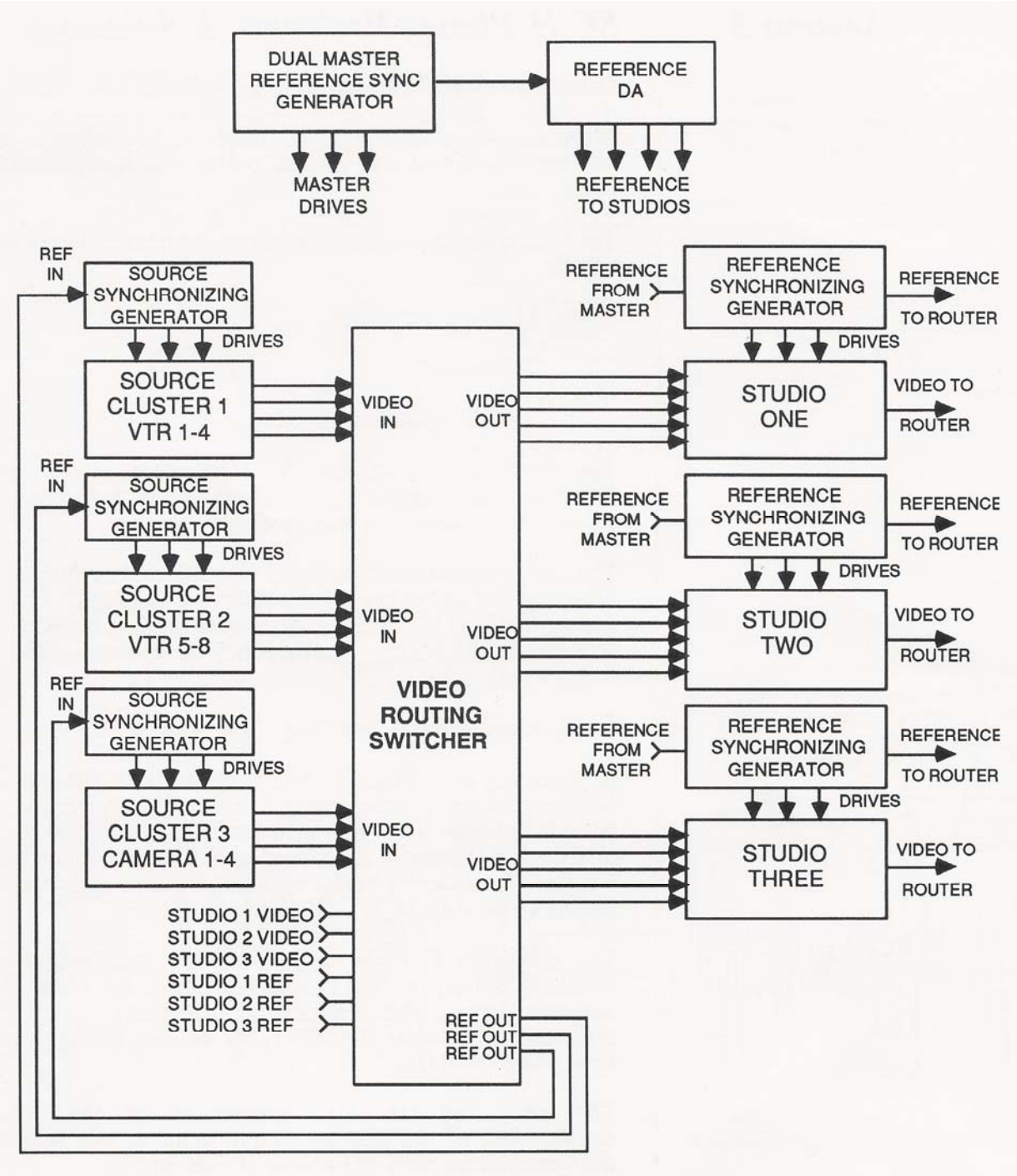
BLOCK DIAGRAM



SC/H PHASE DEFINITION

With monochrome television, there is a particular relationship between horizontal and vertical pulses that is repeated every two fields.

The PAL colour television system requires three additional reference signals:

- colour subcarrier
- burst gate
- PAL identification pulse

The phase reversal of the **V** component of the chrominance information, on alternate lines, combined with the odd number of picture lines, **produces a four field repetition** rate. The colour subcarrier frequency was selected to minimise general visibility and dot crawl on monochrome displays. The frequency used is **4.43361875 MHz** and the relationship between subcarrier frequency and horizontal frequency is shown in the following formula:

Subcarrier freq. = line freq. (284 – ¼) + ½ vertical freq.

In order that the subcarrier shall have the same phase at start of any two frames, it is necessary that there be an integral number of periods between these two instants. Because of the mathematical relationship between subcarrier and line frequency, an integral number of subcarrier cycles only occurs after eight field. This is known as the **PAL eight field sequence**.

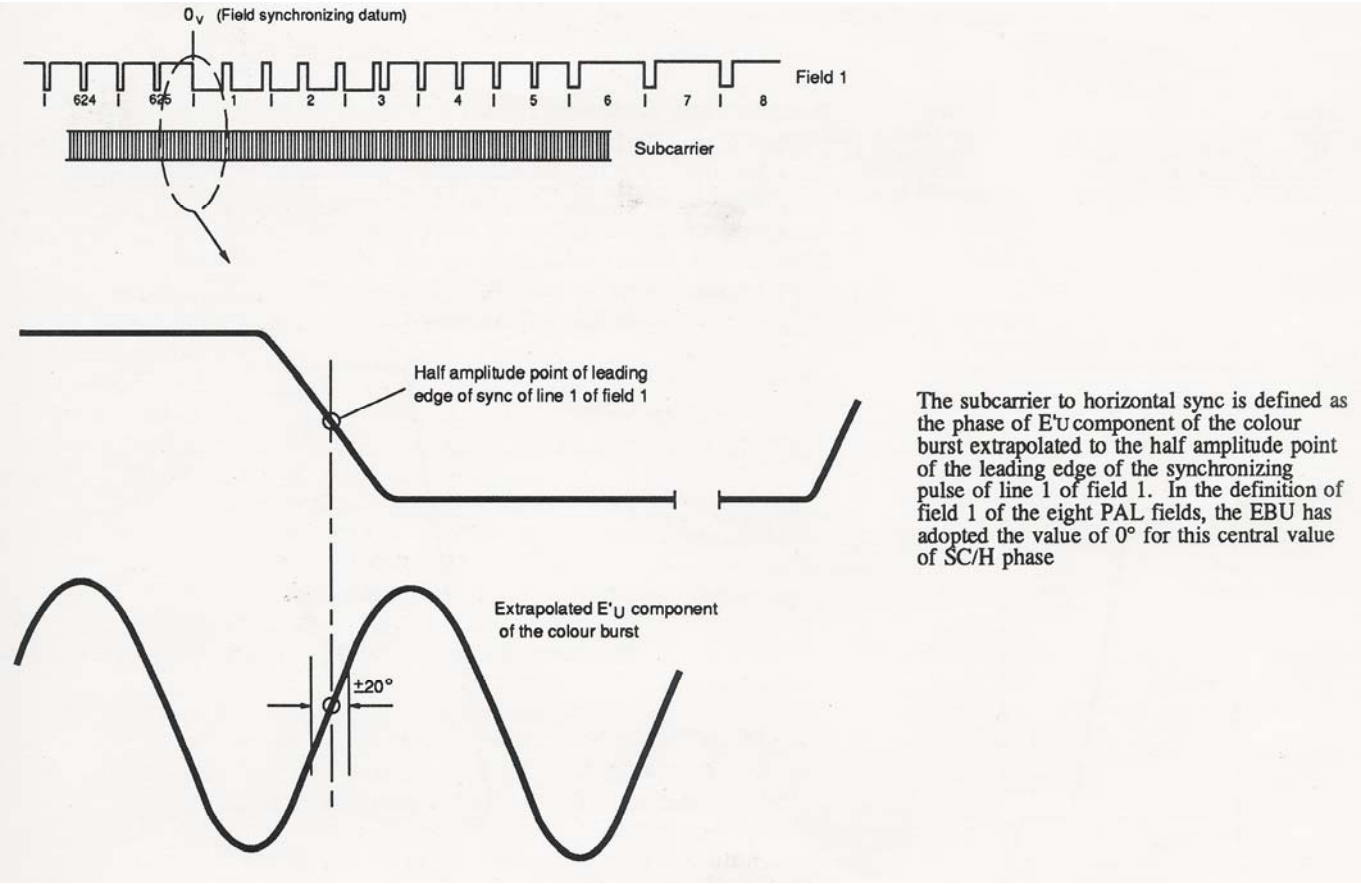
The subcarrier formula established that horizontal frequency is locked to subcarrier, but it does not define the phase relationship between them. The **European Broadcasting Union** (EBU) has produced a technical statement that defines the subcarrier to line sync phase (SC/H) as:

The phase of the E'U component of the colour burst extrapolated to the half amplitude point of the leading edge of the synchronizing pulse of line one of field one.

In the definition of field one of the eight PAL fields, the EBU has adopted the value of 0 degrees for this central value of the SC/H phase. The EBU recommends that the video on tapes to be used in sophisticated editing procedures are recorded with a value of 0 degrees +/- 20 degrees.. This definition of SC/H phase is required for the unambiguous identifications of the eight field colour sequence.

To achieve an SC/H phased plant, the timing of sync becomes as important as subcarrier, and each element should be viewed in that light. To aid video tape editing, it is important to record video with proper SC/H phase and also supply SC/H phased reference to the machine in playback.

EBU DEFINITIO OF SC/H PHASE



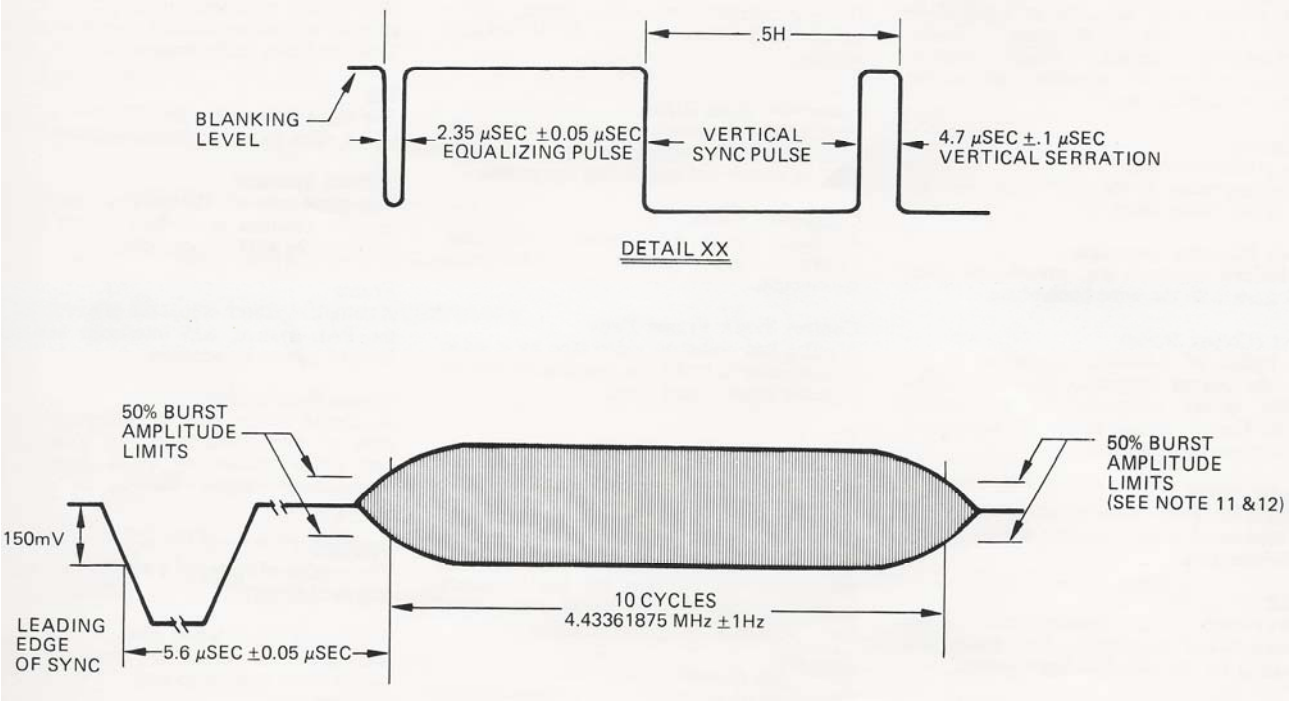
The subcarrier to horizontal sync is defined as the phase of E'U component of the colour burst extrapolated to the half amplitude point of the leading edge of the synchronizing pulse of line 1 of field 1. In the definition of field 1 of the eight PAL fields, the EBU has adopted the value of 0° for this central value of SC/H phase

NOTES

NOTES:

1. SPECIFICATIONS APPLY TO STUDIO FACILITIES. NETWORK AND TRANSMITTER CHARACTERISTICS ARE NOT INCLUDED.
2. ALL TOLERANCES AND LIMITS SHOWN IN THIS DRAWING PERMISSABLE ONLY FOR LONG TIME VARIATIONS.
3. BURST FREQUENCY SHALL BE 4.43361875 MHz ±1 Hz.
4. HORIZONTAL SCANNING FREQUENCY SHALL BE 15.625 KHz ±.01%.
5. VERTICAL SCANNING FREQUENCY SHALL BE 2/625 TIMES THE HORIZONTAL SCANNING FREQUENCY.
6. THE ZERO-CROSSINGS OF REFERENCE SUBCARRIER SHALL BE NOMINALLY COINCIDENT WITH THE 50% POINT OF THE LEADING EDGES OF HORIZONTAL SYNC PULSE OF LINE 1, FIELD 1. WHERE THE RELATIONSHIP BETWEEN SYNC AND SUBCARRIER IS CRITICAL FOR PROGRAM INTEGRATION, THE TOLERANCE OF THIS COINCIDENCE IS ±20° OF REFERENCE SUBCARRIER.
7. RISE TIMES AND FALL TIMES ARE TO BE 100 nSEC – 150 nSEC FOR ALL PULSES MEASURED FROM TEN TO NINETY PER CENT AMPLITUDE POINTS. ALL PULSE WIDTHS ARE MEASURED AT FIFTY PER CENT AMPLITUDE POINTS.
8. OVERSHOOT ON ALL PULSES DURING SYNC AND BLANKING (VERTICAL AND HORIZONTAL) SHALL NOT EXCEED 5% P P PULSE AMPLITUDES.
9. BURST ENVELOPE RISE TIME IS 0.30 μSEC MEASURED BETWEEN THE TEN AND NINETY PERCENT AMPLITUDE POINTS. IT SHALL HAVE THE GENERAL SHAPE SHOWN.
10. THE START OF BURST IS DEFINED BY THE 50% AMPLITUDE OF THE RISING EDGE OF THE BURST ENVELOP.
11. THE END OF BURST IS DEFINED BY THE 50% AMPLITUDE OF THE FALLING EDGE OF THE BURST ENVELOPE.
12. MONOCHROME SIGNALS SHALL BE IN ACCORDANCE WITH THIS DRAWING EXCEPT THAT BURST IS OMITTED.
13. REFERENCE SUBCARRIER IS A CONTINUOUS SIGNAL WHICH HAS THE SAME FREQUENCY AS BURST.
14. PROGRAM OPERATING LEVEL WHITE IS 700mV ±20mV.
15. PROGRAM OPERATING LEVEL SYNC IS 300mV ±7mV.
16. PROGRAM OPERATING LEVEL BURST IS 300mV ±7mV.

COLOR TIMING DATA:
1° = 0.6265 nSEC
1 nSEC = 1.596°



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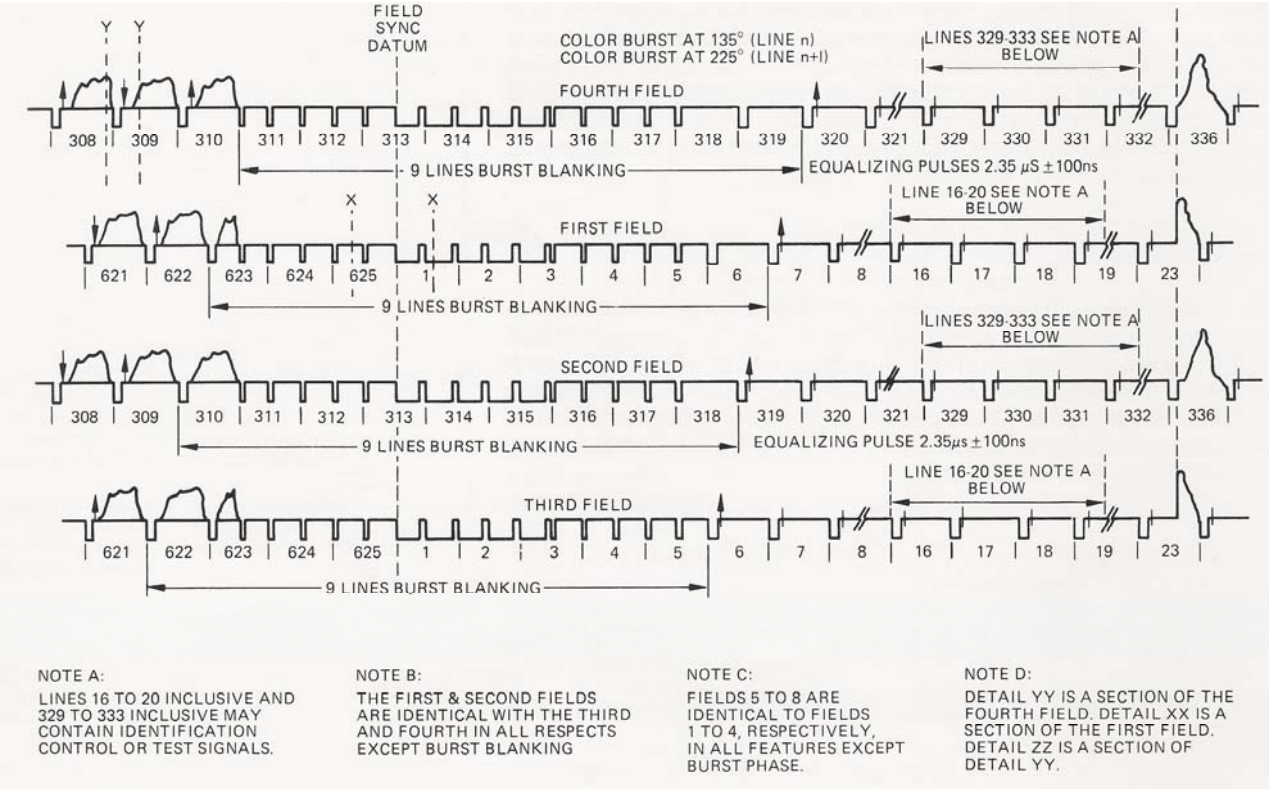
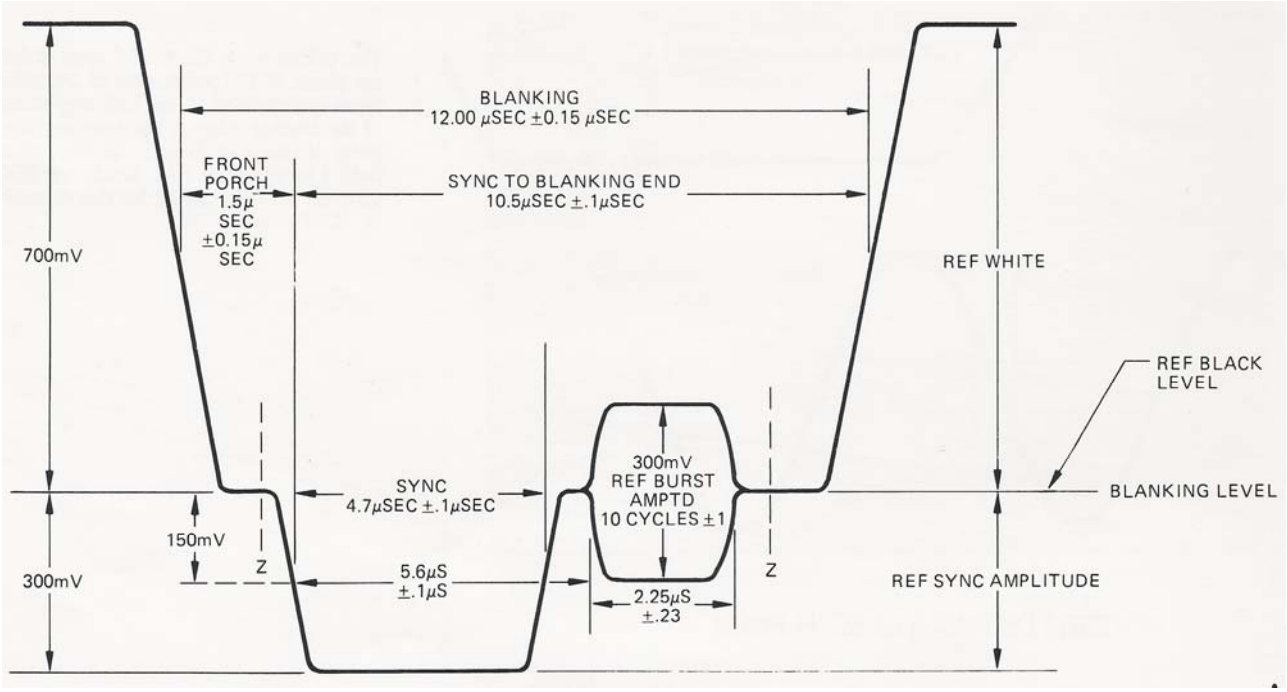
FIRST FOUR FIELDS OF PAL EIGHT FIELD SEQUENCE





PAL REFERENCE TIMING DATA

Subcarrier frequency	**4,43361875 MHz**
Subcarrier Period	**225.55nS**
Horizontal Frequency	**15,625 KHz**
Horizontal Period	**64uS**
Vertical Frequency	**50 Hz**
Vertical Period	**20mS**
Vert. Equalizing Pulse Width	**2,35uS**
Horizontal Sync Width	**4,7uS**
Horizontal Blanking Width (H)	**12,0uS**
Vertical Sync Width	**27,3uS**
Vertical Blanking Width	**25 lines + H**
Front Porch Width	**1,5uS**
Breezeway	**0,9 uS**
Burst Width	**2,25uS**

Color Timing Data	**1° = 0,627nS**	**1nS = 1,59°**
For Cable With 66% propag. Factor	**1° = 12,4cm**	**1nS = 20cm**

Introduction to VITS & ITS

The picture of a television screen (CRT) is generated by one (in color TV, three) intensity-modulated electron beam(s) to excite the phosphorous layer on the inner side of the screen. To cover the whole area of the screen, the electron beam is deflected horizontally by the line frequency and vertically by the field frequency. Picture information is only "written" on the screen during the forward scans of the beam (from left to right and from top to bottom).

Because magnetic deflection is used in most TV receivers and monitors, the retrace periods are rather long (almost 20 % of the horizontal scanning period and 10 % of the vertical period). Exact calculation shows that only 75 % of a 625-line TV signal and 76 % of a 525-line signal carry active picture information.

The horizontal blanking interval holds synchronization pulses and color burst; but still some transmission capacity is available. In the Eurovision network, the sound (mono or stereo) channel is coded into the horizontal sync pulses in the form of a digital signal (sound-in-syncs).

The vertical blanking interval (VBI) has a number of "empty" lines (25 in the 625-line system; 20 in the 525-line system). These lines are used for several purposes:

- transmitting special test signals for measuring purposes: Vertical Interval Test Signals (VITS)
- transmitting data to viewers (e.g. Teletext, VPS, closed captioning)
- transmitting data for internal use by the broadcaster (remote control, source identification, timing codes, program timing codes)

The advantages in using the empty lines in the blanking interval are:

- transmission of the information is free of charge
- the information is invisible to viewers
- additional services can be made available to viewers
- the broadcaster can do some maintenance during program time, i.e. in normal working hours

Nomenclature

Vertical Interval Test Signals (VITS) are single-line test signals inserted into the program signal at the point of origination. Since the VITS follow the program all the way to the point of destination, any distortion of the VITS is a measure for the distortion of the program signal.

WSS (Wide Screen Signalling) is becoming common together with the advent of different aspect ratios and coding of program signals.

Insertion Data Signals (IDS) are digital codes used in the Eurovision network to identify program originators and sources.

Vertical Interval Reference Signal (VIRS) is a simple VITS used in North America.

VPS is information sent to the viewers to control the recording of a home video tape recorder.

Ghost Cancelling Reference signal is a special "training" signal for the Ghost Cancelling circuitry in the receiving end.

Quiet Lines are lines that have been cleaned (erased) for the purpose of measuring noise in the transmission path.

Teletext has for many years been used for transmitting newspaper-like information to the viewers. This information is often both public-service information as well as commercial advertisements (even interactive). Also teletext can carry recording information comparable to the VPS data.

Closed Captioning is a subtitling service provided for hearing impaired. In contrast to teletext, the closed captioning can be recorded successfully on VHS recorders.

Time Codes (VITC) are digital signals usually recorded on video tape and used for editing tapes and programs.

VITS Equipment

A VITS Generator & Inserter is often a multi-function instrument. It generates all kind of test signals (incl. GCR), VPS, WSS and other data services. The inserter part controls the mixing of these signals and external sources into the program signal.

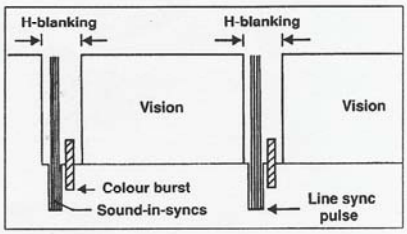
It is important that VITS inserters introduce very little distortion into the program, since several inserters may be cascaded through the network. It is also important that the program is protected against interruption by faulty VITS inserters.

VITS analyzers are measuring instruments that analyze the quality of the receiving end and either display the amount of distortions or transmit them in the form of digital measuring results to a remote monitoring center. Automatic VITS correctors measure certain distortions of the VITS and insert circuitry in the transmission path to compensate for previously introduced distortions.

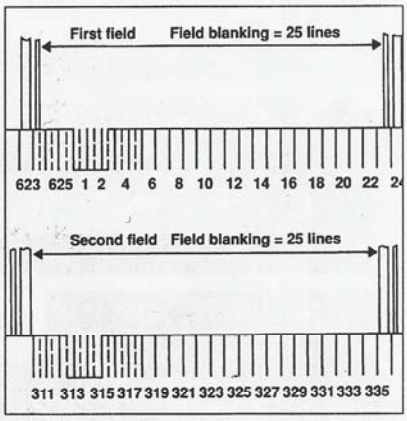
Philips VITS Instruments

The Philips PM 5655, PM 5640A and PT 5251 form a family of VITS Generators covering almost any need from the simple to the most complex operation. Especially the PM 5655 offers the most flexible solution including options for video AGC and clipping, full VPS and WSS programming, program substitution with a full test pattern, etc.

The Philips VITS generators have full program protection and introduce such minimal distortions into the program signal that several units would have to be cascaded to make these minimal distortions measurable. All VITS (internal or external) are keyed into the program lines, so that previous VITS or noise are erased before insertion. It is also possible to erase lines without inserting new VITS.



Details of the horizontal interval (PAL or NTSC). The pulses "standing" on sync bottoms are "sound-in-syncs". They are not broadcast to the viewers.



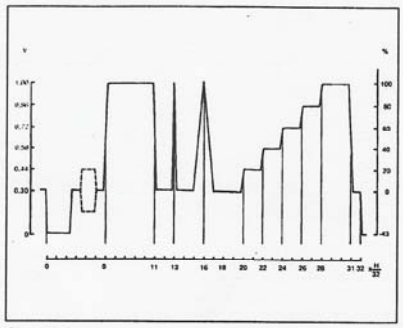
Details of the vertical interval (625-line system). In 525-line systems, the interval is 20 lines. The line numbering is also different. Line no. 1 starts after field blanking (3 lines before the vertical sync pulse) and line 263 is often called line no. 1 in field 2.

VITS & Test Signal Generators

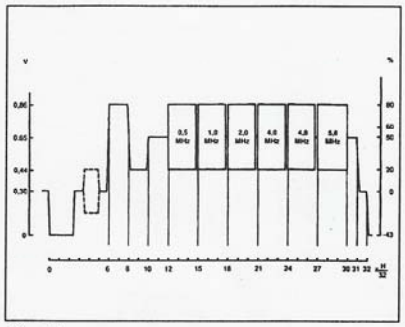
Introduction to VITS & ITS

VITS Signals

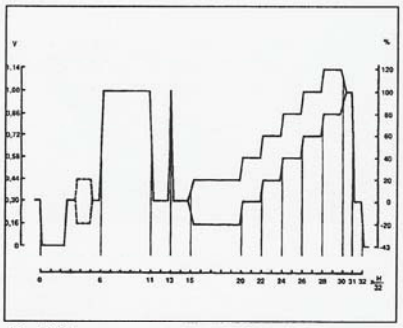
EBU/CCIR Standard



Line 17

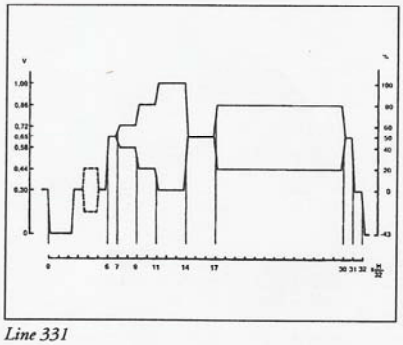


Line 18

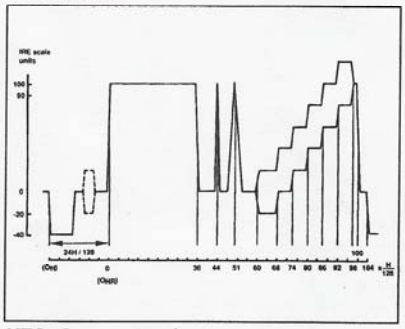


Line 330

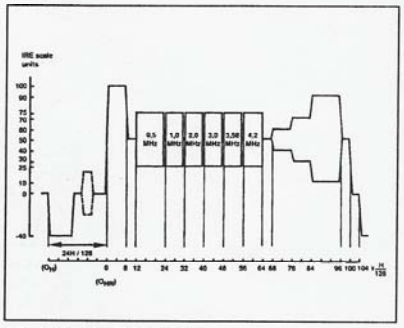
NTC Standard



Line 331

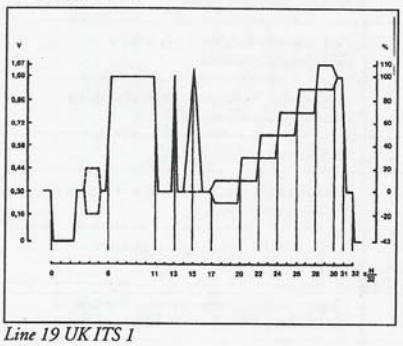


NTC7 Composite Signal

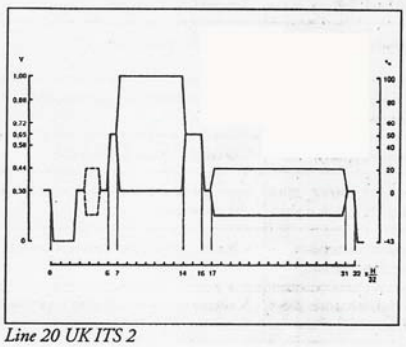


NTC7 Combination Signal

UK-ITS Standard



Line 19 UK ITS 1



Line 20 UK ITS 2

GLOSSARY OF TIMING TERMINOLOGY

APL
Abbreviation for average picture level. The average luminance level of the part of a television line between blanking pulses.

Active Picture Period
That part of the video signal that produces the television picture, as distinguished from that portion of the video signal that occurs during blanking (horizontal and vertical retrace).

Amplitude Modulation (am)
Modulation in which the amplitude of a wave is made to vary. In television, the colour video signal modulates the sub-carrier, causing its amplitude to vary.

Automatic Changeover Switch
Equipment that receives the outputs of two sync generators and automatically switches to the backup sync generator should there be a failure of the sync generator in use.

Backporch
The blanking signal portion which lies between the trailing edge of a horizontal-sync pulse and the trailing edge of the corresponding blanking pulse. The colour burst is located on the back porch.

Bandwidth
The complete range of frequencies over which the television system can function. The information carrying capability of a particular television channel.

Blanking
The time period when picture information is shut off. Blanking is a voltage level at black picture level and acts as a signal to turn off the scanning beam. Synchronizing pulses which control invisible retrace of scanning are active during the blanking period.

Breezeway
That portion of the "back porch" between the trailing edge of the sync pulse and the start of the colour burst.

Bruch Blanking Sequence
A blanking sequence that ensures that each field starts with the same burst phase.

Burst (Colour Burst)
Ten cycles of 4.43MHz subcarrier, placed near the end of horizontal blanking, which is the colour reference for the colour signal. Colour timing refers to adjustment of the phase of the subcarrier.

Carrier Wave
A single frequency wave which is transmitted and modulated by another wave which contains the information.

CCIR
Abbreviation for International Radio Consultative Committee. This group sets standards for the PAL television system.

Character Generator
A device used to generate text or captions for television broadcast.

Chrominance
That portion of the video signal that contains the color information (saturation and hue).

Clamping
The process that establishes a fixed reference level for the picture signal, normally keyed off the horizontal synchronizing pulses. A major benefit of a clamp is the removal of low-frequency interference, especially power line hum.

Coaxial Cable
A cable with a noise shield around a signal-carrying conductor. In television, the cable impedance is 75 ohms.

Colour Background Generator
Circuit that generates a full-field solid colour for use as a background in a video picture.

Colour Bars
A video test signal widely used for system and monitor setup.

Colour Black (Black Burst)
A composite video signal that produces a black screen when viewed on a television receiver. Composite video is a video signal that contains horizontal, vertical, and colour synchronizing information.

Colour Frame
In PAL colour television it takes eight fields to complete one colour frame. For a detailed definition, see the SC/H PHASE section.

Composite Sync (CS)
Horizontal and vertical sync pulses combined. Often referred to simply as "sync". Sync is used by source and monitoring equipment.

Composite Video
A video signal that contains horizontal, vertical, and colour synchronizing information.

Control Track Frame Pulse
A pulse laid down on video tape by a video tape recorder to enable the machine to lock up correctly when played back.

Cut
A transition between two video pictures which is nearly instant, without any gradual change.

DC Restoration
The reestablishment by a sampling process of the DC and the low-frequency components of a video signal which have been suppressed by AC transmission.

DC Signal Bounce
Overshoot of the proper DC voltage level of the blanking pulse due to multiple AC couplings in a signal path. Causes sudden brightness in picture.

Delay Distribution Amplifier
An amplifier that can introduce adjustable delay in a video signal path.

Distribution Amplifier
Device used to multiply (fan out) a video signal. May also include cable equalization and/or delay. Referred to as a DA.

Drive Pulse(s) (Pulse Drives)
A term commonly used to describe a set of signals needed by source equipment such as a camera. This signal set may be composed of any of the following: sync, blanking, subcarrier, horizontal drive, vertical drive, PAL pulse, and burst flag.

EBU
European Broadcasting Union. This group produces technical statements and recommendations for the PAL television system.

Equalization
Process of altering the frequency response of a video amplifier to compensate for high-frequency losses in coaxial cable.

Equalizing Pulses
A series of pulses occurring at twice the line frequency before and after the serrated vertical synchronizing pulse. Their purpose is to adjust the scanning sequence for proper interlace.

Fade
A gradual transition of the video picture (and signal) to black.

Field
Half of the horizontal lines (312.5 in PAL system) needed to create a complete picture. Two interlaced fields create a complete frame.

Fill
The video information that fills the "hole" cut in the video picture by the key signal.

Flyback (retrace)
The movement of the camera or television monitor electron beam back to the starting point for the next line or field.

Frame
A complete picture composed of two fields. In the PAL system, 625 interlaced horizontal lines of picture information.

Frame Synchronizer
A digital buffer that by storage, comparison of sync information to a reference, and timed release of video signals, can continuously adjust the signal for any timing errors.

Frequency
The number of cycles of a waveform in a given length of time.

Frequency Modulation (fm)
Modulation in which the frequency of a carrier wave is made to vary.

Front Porch
The blanking signal portion which lies between the end of the active video picture information and the leading edge of sync.

Frequency Response
The maintenance of a uniform video signal level (amplitude) over a range of frequencies.

Gate
A signal used to trigger the passage of other signals through a circuit.

Group Delay
A defect in a video signal caused by different frequencies having differing propagation delays (delay at 1MHz is different than delay at 5MHz). In the television picture, group delay will cause an object's colour to shift outside the object's outline.

Harmonic
A wave having a frequency that is an integral multiple of the fundamental frequency. For example, a wave with twice the frequency of the fundamental is called the second haromonic.

Hertz
Unit of measurement for the number of cycles of a waveform in one second.

Horizontal Sync Pulse
The synchronizing pulse at the end of each line that determines the start of horizontal retrace.

Hue
The actual colour that appears on the screen. Hue defines colour on the basis of its position in the spectrum – i.e., whether red, blue, green, or yellow, etc. One of the three characteristics of television colour. See Saturation and Luminance.

Impedance
The total opposition (resistance and reactance) a circuit offers to the video signal at a given frequency.

Key
A signal that can electronically "cut a hole" in the video picture to allow for insertion of other elements such as text or a smaller video picture.

Linear and Regenerative Pulse DAs
Linear pulse DA will handle up to 4V p-p signals (pulses) but is limited to amplifying and fanning out the signal. Regenerative pulse DA reconstructs the signal and allows for adjustment of delay.

Luminance (brightness)
The brightness of the picture or area of the television screen being considered. See Hue and Saturation.

Master Reference Synchronizing Generator
A synchronizing pulse generator that is the precision reference for an entire teleproduction facility.

Microsecond (μS)
One millionth of a second: 1 x 10^{-6} or 0.000001 second.

Modulator/Demodulator
Modulator is a circuit that modulates or impresses the carrier wave by amplitude and /or frequency. Demodulator is a circuit that demodulates or decodes the amplitude and/or frequency information from the carrier wave. In television, the information typically modulated and demodulated are the hue and saturation components of the colour signal.

Monochrome (black and white)
The video signal which represents the brightness values (luminance) in the picture, but not the colour (chrominance) values in the picture.

Nanosecond (nS)
One-billionth of a second: 1 x 10^{-9} or 0.000000001 second.

NTSC
National Television System Committee which worked on formulation of standards for present United States television system. Now describes the American system of colour telecasting which is used mainly in North America, Japan, and parts of South America.

Ovenized Crystal Oscillator
A crystal oscillator that is surrounded by a temperature regulated heater (oven) to maintain a stable frequency in spite of external temperature variations.

Overshoot
Amplitude of the first maximum excursion of a pulse beyond the 100% level. Pulse exceeds its defined level temporarily, before settling to the correct level. Overshoot amplitude is expressed as a percentage of the defined level.

PAL
Abbreviation for Phase Alternating Line. PAL is the name for the colour television system in which the E'_V component of burst is inverted in phase from one line to the next in order to minimise hue errors that may occur in colour transmission. PAL-B is a European colour TV system featuring 625 lines per frame, 50 fields per second, and a 4.43361875 MHz subcarrier. Used mainly in Europe, China, Malaysia, Australia, New Zealand, and parts of Africa. PAL-M is a Brazilian colour TV system with phase alternation by line, but using 525 lines per frame, 60 fields per second, and a 3.57561149 MHz subcarrier.

Phase
The relative timing of a signal in relation to another signal. If the time for one cycle of a signal is represented as 360° along a time axis, the phase position for the second signal is called phase angle, expressed in degrees.

Path Length or Propagation Delay
The time it takes for a signal to travel through a piece of equipment or a length of cable.

Phasing (Timing)
Adjusting the delay of a video signal to a reference video signal to ensure they are synchronous. This includes horizontal timing and subcarrier phasing.

Pick-Off Jitter
Jitter is a random aberration in the time period due to noise or time base instability. Pick-off means sample point.

Processing Amplifier/Proc Amp
(See Video Processing Amplifier)

Pulse Width
Measured between the 50% amplitude points of the leading and trailing edges.

Reference Video Signal
A composite video signal used to compare all other video signals to, for timing purposes.

Rise Time
Time required for a pulse edge to rise from 10% to 90% of the final value.

Return Loss
At a connecting point in a video system, the difference between the signal amplitude on the connection and the signal amplitude reflected from the connection. The difference is measured in decibels (dB).

Saturation (chroma, chroma gain)
The degree of purity of a colour. Adding white to a colour reduces its degree of saturation.

SC/H Phase
The phase relationship of the subcarrier to the leading edge of horizontal sync. Alignment of the zero degree crossing of subcarrier with the 50% point of the leading edge of sync.

SECAM
Abbreviation for *sequential couleur a'memorie* (sequential with memory). A color-tv system with 625 lines per frame and 50 fields per second developed by France and the U.S.S.R. and used in some countries that do not use either NTSC or PAL systems.

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Source
Video producing equipment such as a camera, tape recorder, or character generator.

Source Synchronizing Generator
A synchronizing pulse generator used to drive a specific piece of source equipment. It is referenced to a master reference synchronizing generator.

Spurious Signals
Any portion of the signal that is not part of the fundamental video signal and its harmonics. Spurious signals include transients and noise.

Switcher, Production Switcher, Vision Mixer
Device that allows transitions between different video pictures. May also contain special effects generators.

Subcarrier
A continually cycling waveform at 4.43MHz on which colour information is added or encoded; subcarrier is added to the monochrome signal to carry colour information.

Synchronizing Pulse Generator (SPG)
Equipment that generates synchronizing pulses needed by source equipment. Also known as a sync generator.

Time Base Corrector
Device used to stabilize the video picture on replay from a tape machine.

U
Colour difference signal (B–Y) used to modulate "U" component of subcarrier.

V
Colour difference signal (R–Y) used to modulate "V" component of subcarrier. "V" component of subcarrier is reversed in phase on alternate lines (see PAL).

Vertical Serrations
A vertical synchronizing pulse contains a number of small notches called vertical serrations. These serrations provide horizontal synchronization during the vertical interval.

Vertical Sync Pulse
The synchronizing pulse at the end of each field which signals the start of vertical retrace.

Video Processing Amplifier
A device that stabilizes the composite video signal, regenerates the synchronizing pulses, and can make other adjustments to the video signal.

Zero Timing Point
The point at which all the video signals must be in synchronization (typically the switcher input).