HAMLET
EXCELLENCE IN VISION

DigiGen MultiGen

RACK MOUNTABLE HD, SD SERIAL DIGITAL AND ANALOG MULTI FORMAT WAVEFORM GENERATOR

OPERATOR'S HANDBOOK
ISSUE A1 (HD SD SDI & CST)

Hamlet Video International Limited
Maple House 11 Corinium Business Centre Raans Road Amersham Bucks HP6 6FB England
Main Line: +44 (0)1494 729 728 Fax Line: +44 (0)1494 723 237 Free phone (UK) 0500 625 525
E-mail: sales@hamlet.co.uk Web site: www.hamlet.co.uk

Hamlet Video International USA service center , Tecads Inc, 23 Del Padre St, Foothill Ranch, CA 92610, U.S.A. Tel: +1 (949) 597 1053, Fax: +1 (949) 597 1094. Toll Free Tel number: (866) 4 HAMLET
E-mail: service@hamlet.us.com Web site: www.hamlet.us.com

IN CORRESPONDENCE CONCERNING THIS INSTRUMENT
PLEASE QUOTE THE SERIAL NUMBER PRINTED ON THE
LABEL AT THE REAR OF THE UNIT

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GENERAL INFORMATION

WARRANTY

This product is manufactured by Hamlet Video International Ltd and is warranted to be free from defects in components and factory workmanship under normal use and service for a period of one year from the date of purchase.

FREE EXTENDED WARRANTY

The warranty period can be extended to two years by registering the instrument on the Hamlet web site
http://www.hamlet.co.uk/serv.html

TERMS AND CONDITIONS

During the warranty period, Hamlet Video International Ltd will undertake to repair or at its option, replace this product at no charge to its owner when failing to perform as specified, provided the unit is returned shipping prepaid, to the factory or authorised service facility.

No other warranty is expressed or implied. Warranty shall not be applicable and be void when this product is subjected to:

1. Repair work or alteration by persons other than those authorised by Hamlet Video International Ltd in such a manner as to injure the performance, stability, reliability or safety of this product.

2. Misuse, negligence, accident, act of God, war or civil insurrection.

3. Connection, installation, adjustment or use otherwise than in accordance with the instructions in this manual.

Hamlet Video International Ltd reserves the right to alter specifications without notice. This warranty does not affect the statutory rights of the UK customer.

GENERAL INFORMATION

SAFETY COMPLIANCE

This product is manufactured and tested to comply with:

BS EN 61010-1 : 1993

Safety requirements for electrical equipment for measurement, control and laboratory use.

CE

EMC COMPLIANCE

We: HAMLET VIDEO INTERNATIONAL LTD
MAPLE HOUSE
11 CORINIUM BUSINESS CENTRE
RAANS ROAD
AMERSHAM
BUCKS
HP6 6FB
ENGLAND

declare under our sole responsibility that the product

HAMLET DIGI GEN

to which this declaration relates are in conformity with the following standards:

EN50081-1
Generic emissions standard for light industrial applications.
EN50082-1
Generic immunity standard for light industrial applications.

following the provisions of EU EMC directives 89/336/EEC and 92/31/EEC.

NOTE. During the EMC certification of this product, shielded cables were used. We recommend that they be used in operation.

FRONT AND REAR PANELS

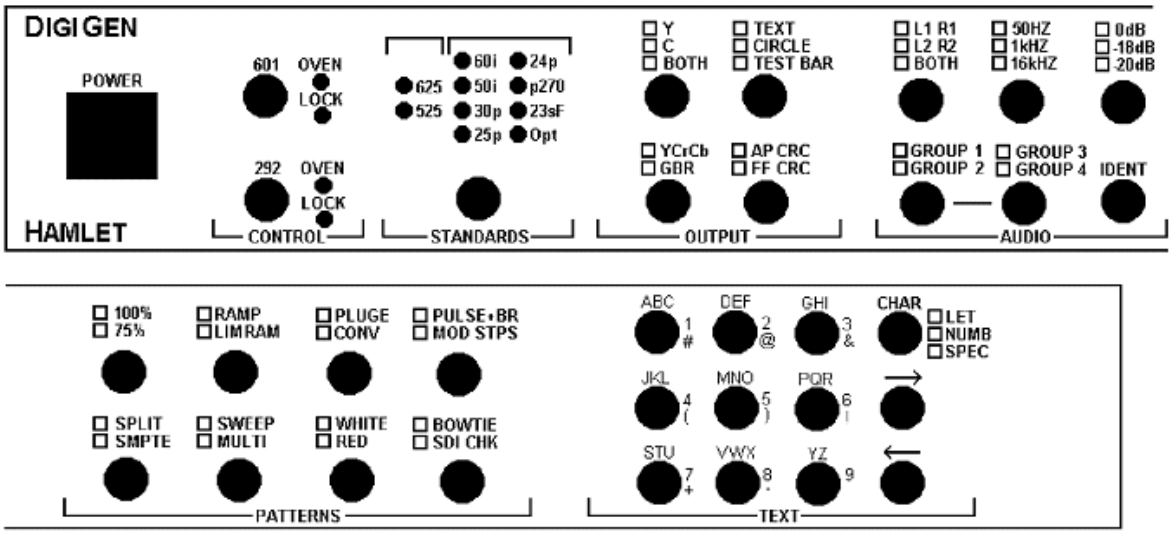


Fig 1

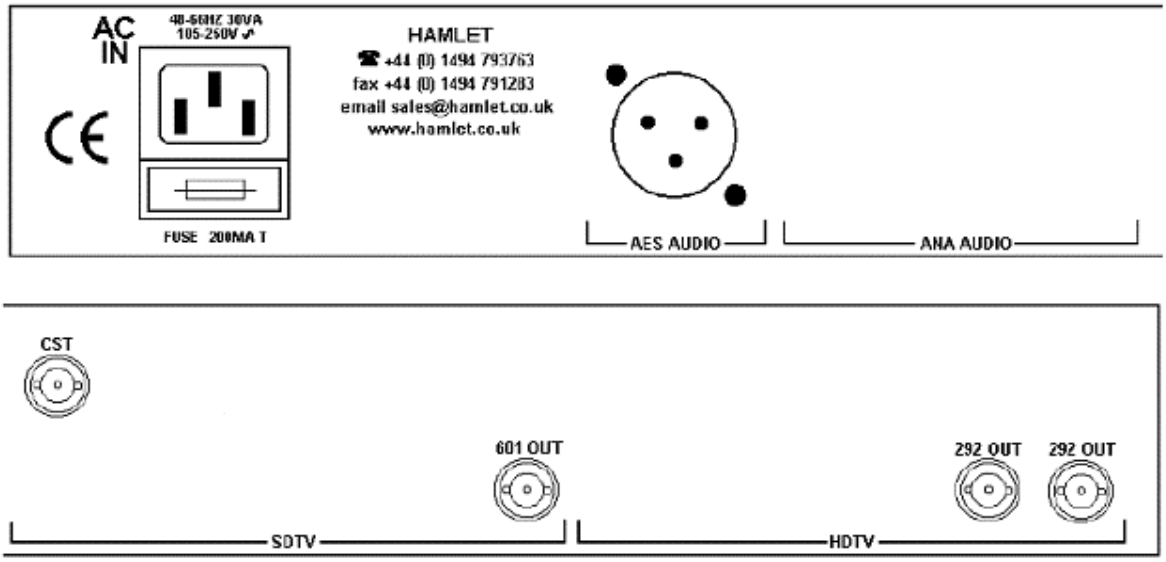


Fig 2

Note:-
Active Inputs:- Mains input
Active Outputs:- AES Audio XLR,
Out 292 BNC x2, Out 601 BNC (RH of 2),
CST out BNC

All other holes are plugged or blanked off.

OVERVIEW

The Hamlet Digi Gen Multigen is a rack mount test signal generator designed to output HD serial digital (SMPTE 292) video together with embedded audio, SD serial digital (SMPTE 259) video together with embedded audio and CRC checksums. There are additional outputs of analogue composite video, AES/EBU digital audio and analogue audio. All signals are digitally derived for accuracy and stability.

SMPTE 274M. Standard Act words P/I Clk rate

1920 x 1080/60/2:1 1920 I 74.25MHz.

1920 x 1080/50/2:1 1920 I 74.25MHz

1920 x 1080/30/1:1 1920 P 74.25MHz

1920 x 1080/25/1:1 1920 P 74.25MHz

1920 x 1080/24/1:1 1920 P 74.25MHz

1920 x 1080/30 (sf) 1920 SegForm 74.25MHz

1920 x 1080/25 (sf) 1920 SF 74.25MHz

1920 x 1080/24 (sf) 1920 SF 74.25MHz

SMPTE 296M. Standard Act words P/I Clk rate

1280 x 720/60/1:1 1280 P 74.25MHz

SMPTE 259 Both output formats can be switched to 625 (PAL) or 525 (NTSC) standards. PALM is available on request.

An ident word can be cut into the selected pattern, consisting of 16 characters selected by the front panel buttons.

The video Y and C components can be individually disabled from both outputs and the embedded audio packets can be disabled from the SDI output.

Embedded tone can be on any of the four groups. It can be on Ch1, Ch2 or both and on Left, Right or both.

16 different patterns can be selected for all standards, including colour bars, frequency sweeps and the SDI test matrix pattern. The serial digital output is generated in full ten bit specification

All settings are stored on power down

Note:-
Active Inputs:- Mains input
Active Outputs:- AES Audio XLR,
Out 292 BNC x2, Out 601 BNC (RH of 2), CST out BNC

All other holes are plugged or blanked off.

OPERATING INSTRUCTIONS

Power
Toggles power on and off.

Control Section

LEDs on	Green	292, Oven and Lock
Or		
LEDs on	Green	601, Oven and Lock

Standards Section
625 or 525 NOT Selectable in 292 mode

24/48 light on.	24Hz Progressive or 48Hz Interlaced.
25/50 light on	25Hz Progressive or 50Hz Interlaced.
30/60 light on.	30Hz Progressive or 60Hz Interlaced.
720 light on.	60Hz Progressive.

625 or 525 ONLY selectable in 601 mode

625 LED on	Green	Television standard 625 (PAL) output
525 LED on	Green	Television standard 525 (NTSC) output

Output Section
GBR not selectable
AP CRC not selectable

Y LED on	Green	Y component is on.
C LED on	Red	C component is on.
Both LED on	Yellow	Both Y and C components on.
LED off	Off	No Luminance or Chrominance on output
Text LED on	Green	Up to 16 characters of text can be superimposed on pattern To enter text:- push ident push text amend text push text again, scroll through circle, circle and bar, back to TEXT push ident (text saved into memory) push ident

Circle is not available in 292 mode

Circle LED on	Red	4:3 circle overlaid on test pattern The 625 circle display is 512 pixels high x 469 pixels wide. The 525 circle display is 426 pixels high x 469 pixels wide.
Second press	Red	16:9 circle overlaid on test pattern

Test Bar LED on	Yellow	MPEG pattern. A moving horizontal bar is provided to identify frame interpolation errors in MPEG systems or stuck frames in field stores.
LED off	Off	No overlaid
FF CRC LED on	Red	When no overlay or audio selected FF CRC inserted in data stream
LED off	Off	FF CRC not inserted

NB. When TEXT is selected the (Green) IDENT LED also comes on and the (Red) L audio bars on the RH and LH embedded audio displays pulse up and down. To restore full audio bars then switch IDENT off (TEXT LED also goes off) and select L1R1, L2R2, BOTH buttons in sequence.
N.B There is no 0 on key pad for text entry should use O instead

Audio Section
50Hz/1KHz/15KHz not selectable – red LED on permanently
0dB/-18dB/-20dB not selectable – red LED on permanently

L1R1 LED on	Green	The embedded audio on CH1 ONLY
L2R2 LED on	Red	The embedded audio on CH2 ONLY
Both LED on	Yellow	The embedded audio on CH1 and CH2
LED off	Off	No embedded audio inserted

Group 1,2 LED on Green	Selects the embedded audio group: GP 1
Group 1,2 LED on Red	Selects the embedded audio group: GP 2
Or	
Group 3,4 LED on Green	Selects the embedded audio group: GP 3
Group 3,4 LED on Red	Selects the embedded audio group: GP 4

Pattern Section
Pressing any of the pattern keys selects that set of patterns in a cyclic sequence
See below for pattern explanations

Text Section

Char LED on	Green	Keyboard used to enter the required letters
Char LED on	Red	Keyboard used to enter the required numbers
Char LED on	Yellow	Keyboard used to enter the required special characters

N.B There is no 0 on key pad for text entry should use O instead

Arrow buttons to move to required character location

ADDITIONAL FUNCTIONS

STEREO AUDIO IDENT
NB. When TEXT is selected the (Green) IDENT LED also comes on and the (Red) L audio bars on the RH and LH embedded audio displays pulse up and down. To restore full audio bars then switch IDENT off (TEXT LED also goes off) and select L1R1, L2R2, BOTH buttons in sequence.
N.B There is no 0 on key pad for text entry should use O instead

PATTERNS

100% BARS LED Green
100% full colour bars. Composite video 1V p/p.
Digital levels are Yblack =64, Ywhite = 940, Cr and Cb are 512 +/- 448 max.
NTSC/525 option set has SMPTE bars in this position.

75% BARS LED Red
White as 100% bars. Colours reduced to 75% level.

SPLIT LED Green
Top half of screen is 100% colour bars, bottom half is red.
NTSC/525 option set has 75% colours in this position

BOWTIE
Y channel is 500KHz. Cr,Cb channels are 502KHz phase adjusted so equal to Y in mid line. Suitable monitoring equipment, e.g. the Hamlet LCDScope 292WVA, produce (Y-Cr) and (Y-Cb) displays to accurately check system gains and timings, with the traditional bowtie displays.
Y Waveform is 438 bits (350mV) p/p centred on 502 bits (350mV).
C Waveform is 448 bits (350mV) p/p centred on 512 bits (350mV).
Timing markers at +/-5nSec and at every 20nSec.

SWEEP
Sweeps from 1MHz to 30MHz over the line period, with markers at 5,10,15,20,25 MHz.
Waveform is 600bits (480mV) p/p centred on 502 bits (350mV).

PLUGE
Grey scale block for colour monitor gain tracking adjustment and grey/superblack stripes for brightness setting.
Block is 940 bits (700mV), 502 bits (350mV), 239 bits (140mV).
Stripes are at 64 +/- 18bits (+/- 14mV).

MULTI LED Red
White bar at 765 bits (560mV) followed by six frequency bursts at 500KHz, 1MHz, 2MHz, 3MHz, 4MHz, 5MHz at 526 bits (370mV) p/p centred on 502 bits (350mV).
When using the composite output, disable the C component to avoid Y/C beating.
NTSC option set is 500KHz, 1.25MHz, 2MHz, 3MHz, 3.58MHz, 4.2MHz.

PULSE+BR
2T luma pulse at 940 bits (700mV), 10T chroma pulse at 502 bits (350mV), 20 uSec bar at 940 bits (700mV).

PATTERNS

MOD STPS
5-step ascending staircase, equal steps of 175 bits (140mV) each.
Added chroma of Cr at 638 bits and Cb at 652 bits.

WHITE
Plain full white screen.
Y waveform 940 bits (700mV), Cr is 512 bits, Cb is 512 bits.

RED
Plain full red screen.
Y waveform is 250 bits (149mV), Cr is 960 bits, Cb is 409 bits.

CONVERGE
Crosshatch pattern for colour monitor convergence adjustment.

DIG CHK
Top half of the screen is the equaliser test and contains several examples of 19 "0"s followed by 2 "1"s per frame.
Bottom half of the screen is the phase locked loop test and contains several examples of 20 "0"s followed by one "1" per frame.

RAMP
Y waveform is an ascending ramp, running from 64 bits (0mV) to 940 bits (700mV).
Cr and Cb waveforms are ascending ramps, running from 64 (-350mV) to 960 (+350mV)

LIM RAMP
Y waveform is an ascending ramp, running from 1 bit (50 mV below black) to 1022 bits (66 mV above peak white).

OPTION
Future or optional patterns, e.g. SMPTE colour bars.
In HD and PAL/625 mode set to SMPTE color bars
In NTSC/525 mode set to 100% color bars

TECHNICAL SPECIFICATION

OUTPUTS

292 mode

Serial digital	2 x BNC connectors. Output impedance 75 ohms. SMPTE 292, serial component. 800mV pp Full 10 bit pattern generation. Embedded audio tone is a 1KHz asynchronous sine wave at a level of -18dBFS.

601 mode

Serial digital	BNC connector. Output impedance 75 ohms. SMPTE 259M, ITU-R BT.601/656 serial component. 800mV pp Full 10 bit pattern generation. Addition of CRC checksum word. Addition of embedded tone at -18db.
Composite	BNC connectors. Output impedance 75 ohms. 1 volt p/p +/- 1% PAL, NTSC or PALM from 9 bit dac. Differential gain and phase +/- 1% and +/- 1 deg. Sch phase 0 +/- 5 deg.
Audio	3 pin XLR plug. Analogue: 1KHz tone 0db to +8db balanced to 600 ohms Thd <0.5%. Digital: AES/EBU encoded 1KHz tone, balanced output to 110 ohms.

POWER

Current draw is 600mA
Mains supply 220/110VAC +/-20% 50/60Hz 10VA max.

ENVIRONMENT

Indoor use, 5 to 45 deg.C. ambient to 2,000m.
Max humidity 80% to 31 deg.C decreasing to 50% at 40 deg.C.
Overvoltage category 2. Pollution degree 1.
Weight 2.2Kg.

CALIBRATION 601 section

EQUIPMENT REQUIRED

Accurately calibrated waveform monitor and audio monitor, e.g. Hamlet DigiScope 601AX. Frequency standard, e.g. off air signal from reputable tv broadcaster.

As all signals are digitally derived, the only adjustments are to the master clock frequency, the analog composite output gain and response and the analogue audio output level.

To access the adjustments, remove the four screws in the case bottom and separate the case halves. Adjustments are made through the holes provided in the upper circuit board.

All adjustments should be carried out after 30 minutes warm up.

MASTER CLOCK FREQUENCY

If not used for more than one month, run the unit for 2 hours to re-age the crystal. Compare the tv line frequency derived from either output with a known reference and adjust CV1 (FREQ) with a plastic tool for a run through of less than 2 uSec per second. Adjust R14 (DC) so it is in the centre of the range which gives stable pattern outputs.

ANALOGUE COMPOSITE OUTPUT

Select PAL, 100% BARS pattern. Connect a 75 ohm terminated waveform monitor or oscilloscope to the composite output. Adjust R3 (CST) for 1V +/- 1% p/p video and L1 (RESP) for 885mV +/- 1% p/p chroma.

ANALOGUE AUDIO OUTPUT

With an oscilloscope, adjust R23 (AUDIO) for 0db output, 2.19V p/p +/- 1%. Or with an accurate ac voltmeter, adjust for 775mV RMS +/- 5mV.

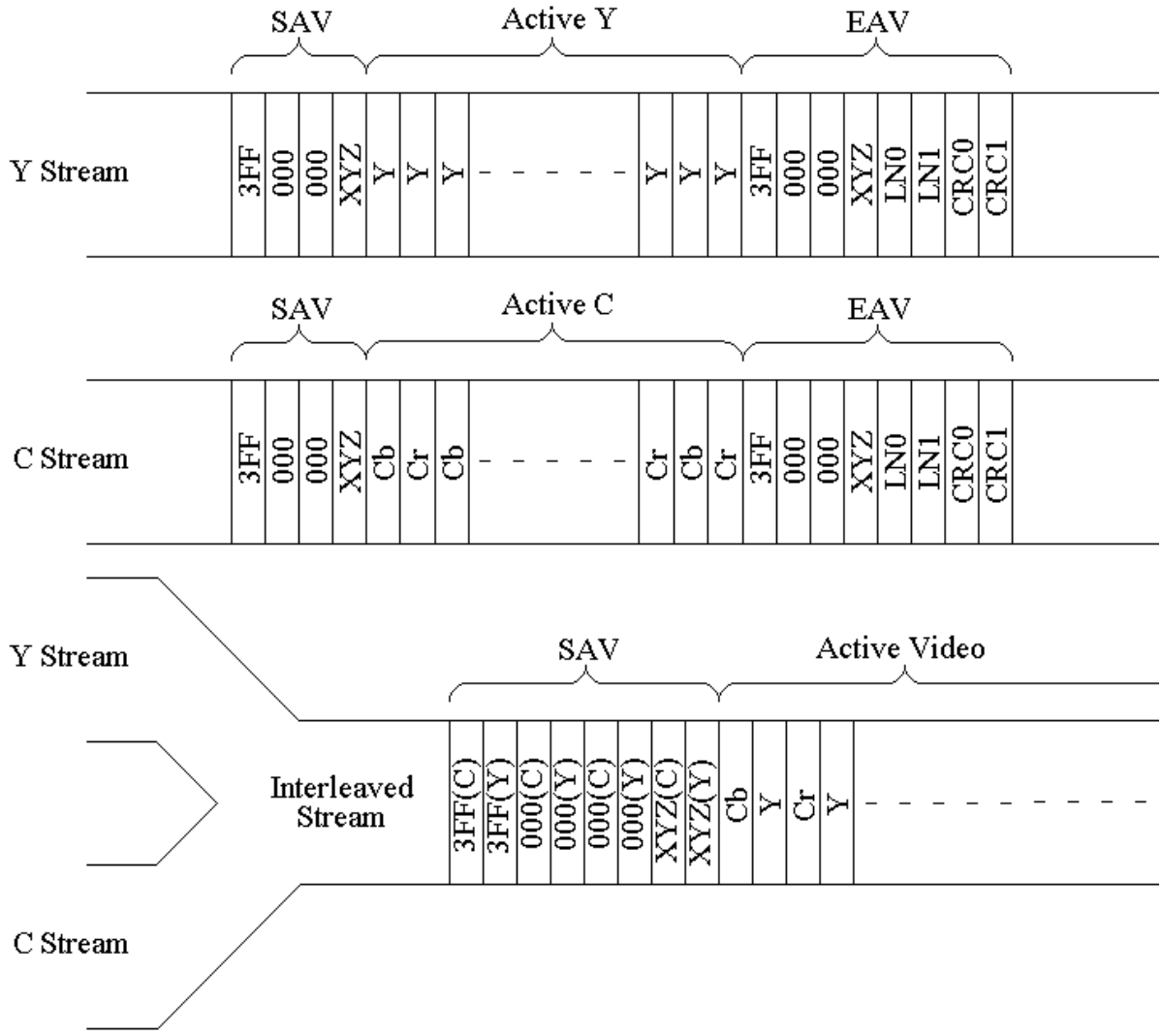

SAV
Active Y
EAV
Y Stream
3FF
000
000
XYZ
Y
Y
Y
Y
Y
Y
3FF
000
000
XYZ
LN0
LN1
CRC0
CRC1
SAV
Active C
EAV
C Stream
3FF
000
000
XYZ
Cb
Cr
Cb
Cr
Cb
Cr
3FF
000
000
XYZ
LN0
LN1
CRC0
CRC1
Y Stream
SAV
Active Video
Interleaved Stream
3FF(C)
3FF(Y)
000(C)
000(Y)
000(C)
000(Y)
XYZ(C)
XYZ(Y)
Cb
Y
Cr
Y
C Stream

Fig 3

HDTV SERIAL DIGITAL BASICS

BIT SERIAL DIGITAL INTERFACE DEFINED BY SMPTE 292M.

HDTV digital component video is produced by applying a 4:2:2 sampling structure to the analog signal. The luminance component (Y) is sampled at 74.25 MHz, the colour difference components U & V) are both sampled at 37.125 MHz.

The Y stream is quantised to 10 bits resolution and Timing Reference Signals (TRS) are added at the beginning and end of the horizontal video blanking period.

The U & V streams are also quantised to 10 bits and then interleaved to give a C stream at 74.25 MHz. TRS are added at the beginning and end of the horizontal video blanking period.

The 74.25MHz Y and C streams are then interleaved to produce a single stream at 148.5MHz.
This data is then scrambled and serialised using a None Return to Zero (NRZ) code to produce a 1.485 GHz signal.

The TRS at the end of the horizontal blanking period is called Start of Active Video (SAV) it consists of 4 words:

1) 3FF hex i.e. all '1;s
2) 000 hex i.e. all '0's
3) 000 hex i.e. all '0's
4) XYZ, which determines the type of TRS pulse, consisting of:

Bit 9: Always '1'
Bit 8: 0=frame 1, 1=frame 2
Bit 7: 0=normal 1=field blanking
Bit 6: 0=SAV 1=EAV
Bit 5: Bits used for Hamming correction.
Bit 4: Bits used for Hamming correction.
Bit 3: Bits used for Hamming correction.
Bit 2: Bits used for Hamming correction.
Bit 1: Always 0
Bit 0: Always 0

The TRS at the beginning of the horizontal blanking period is called End of Active Video (EAV) it consists of 8 words: The first 4 are the same as for SAV, followed by 2 words containing the current line number and 2 words containing a Cyclic Redundancy Check (CRC) for all the preceding words in the line. The period between EAV and SAV is not used by normal video and may be used for embedded audio or timecode data.

ILLEGAL VALUES
The values 000 and 3FF hex are used solely by TRS pulses (EAV & SAV) they must not appear anywhere in the active video area.

OUT OF GAMUT

Values apart from the illegal values which should not be used.
Luminance is defined as being between peak white, 700mV (3AC hex) and black 0 mV (040 hex) Chroma is defined as being between max positive 350mV (3C0 hex) and max negative -350mV (040 hex). Values above or below these values are termed 'Out of Gamut'.

PARALLEL DIGITAL INTERFACES
Several parallel video Standards can be used with the above serial interface. These are defined in SMPTE 274M for 1920 x 1080 scanning and SMPTE 296M for 1280 x 720 scanning.
SMPTE 274M
Several sub-standards for this are defined:

1920 x 1080/60/2:1
1920 samples/active line 1080 active line/frame 30PsF segmented format.
74.25 MHz Sample frequency 2200 total samples/line 1125 total lines/frame

1920 x 1080/59.94/2:1
1920 samples/active line 1080 active line/frame 29.97PsF segmented format.
74.176 MHz Sample frequency 2200 total samples/line 1125 total lines/frame
This standard gives an exact frame rate compatibility with NTSC.

1920 x 1080/50/2:1
1920 samples/active line 1080 active line/frame 25PsF segmented format.
74.25 MHz Sample frequency 2640 total samples/line 1125 total lines/frame

1920 x 1080/30/1:1
1920 samples/active line 1080 active line/frame 30 Hz Progressive scan.
74.25 MHz Sample frequency 2200 total samples/line 1125 total lines/frame

1920 x 1080/29.97/1:1
1920 samples/active line 1080 active line/frame 29.97 Hz Progressive scan.
74.176 MHz Sample frequency 2200 total samples/line 1125 total lines/frame
This standard gives an exact frame rate compatibility with NTSC.

1920 x 1080/25/1:1
1920 samples/active line 1080 active line/frame 25 Hz Progressive scan.
74.25 MHz Sample frequency 2640 total samples/line 1125 total lines/frame

1920 x 1080/24/1:1
1920 samples/active line 1080 active line/frame 24 Hz Progressive scan.
74.25 MHz Sample frequency 2750 total samples/line 1125 total lines/frame

1920 x 1080/24sf
1920 samples/active line 1080 active lines/frame 24 Hz segmented frame
74.25 MHz sample frequency 2750 total samples/line 1125 total lines/frame

HDTV SERIAL DIGITAL BASICS

1920 x 1080/23.98/1:1
1920 samples/active line 1080 active line/frame 23.98 Hz Progressive scan.
74.176 MHz Sample frequency 2750 total samples/line 1125 total lines/frame

SMPTE 296M
Several substandards for this are defined:

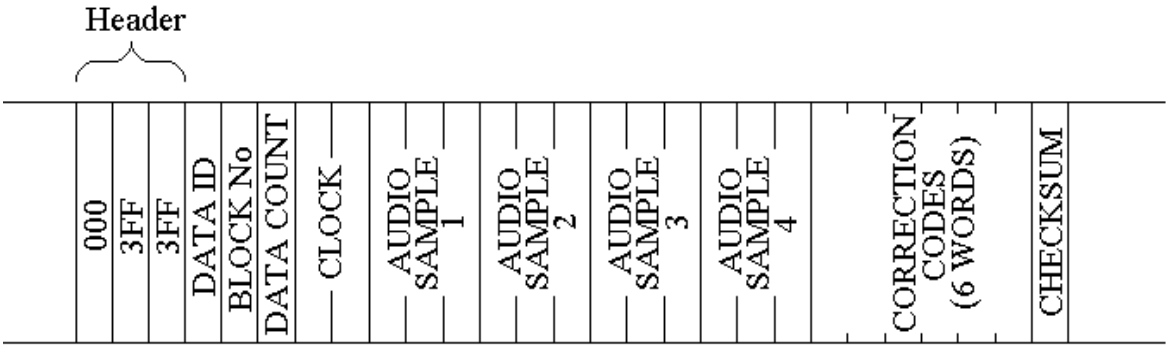
1280 x 720/60/1:1
1280 samples/active line 720 active line/frame 60 Hz Progressive scan.
74.25 MHz Sample frequency 1650 total samples/line 750 total lines/frame

1280 x 720/59.94/1:1
1280 samples/active line 720 active line/frame 59.94 Hz Progressive scan.
74.176 MHz Sample frequency 1650 total samples/line 750 total lines/frame

EMBEDDED AUDIO

The period between EAV and SAV can be used to send embedded digital audio signals. This is defined in SMPTE 299M. Up to 16 separate audio signals may be sent in a single video channel. These are organised as four GROUPS of four signals, the four signals are often two stereo pairs. Typically only one group will be used, giving two stereo pairs of audio. The audio data is quantised in the sending equipment to 24 bits of resolution, usually at 48 KHz sample rate in AES/EBU format. The digitised data is arranged in packets which are placed in the EAV-SAV space.

A packet consists of:



The Header: (000, 3FF, 3FF)

Data ID: This contains the Audio group number.

Data block number: AES frames have 192 samples of audio data

Data Count: This contains the number of words that follow, always 218 hex

Clock: 2 words containing the number of video clocks that have elapsed between the first word of EAV and the time the audio sample was made, it is used by the receiving equipment to reconstruct the audio signal with the correct phase delay.

Audio Sample 1: Consists of four words

Audio Sample 2: Consists of four words

Audio Sample 3: Consists of four words

Audio Sample 4: Consists of four words

Error Correction Codes
Consist of six words used by the receiving equipment to detect or correct errors in the 24 words from the header to the last word of audio sample 4 inclusive.

Check Sum This is the sum of all previous words in the packet except the header words.
Each audio packet contains a sample of all four audio signals
e.g.: Channel 1 left, Channel 1 right, Channel 2 left and Channel 2 right.
Each audio signal requires 3 words to hold all 24 bits, thus each audio packet has 12 words of audio data.
Typically one or two packets are sent in each EAV-SAV period.
These audio data packets are placed in the Chroma data stream only.

Audio Control Packets.
The audio control packet structure is similar to the audio data packet.
Data in the packet includes the audio sample rate e.g. 48 KHz,
the number of active channels out of the possible 4,
the delay information between Channel 1 audio and Channel 2
and delay information between Channel 3 audio and Channel 4.
Audio control packets are placed in the Luminance Stream, this is sent once per frame in the second line after the switching point.

As with the video signal words consisting of all '1's or all '0's are not allowed.

ANALOG BASICS

COMPONENT COLOUR

The colour picture can be distributed in two forms, whether in 625 or 525 line standards:

RGB

This is the basic signal produced by a camera etc and fed to a colour c.r.t. It consists of three primary signals, Red, Green and Blue. By convention, black level is at 0mV and peak brightness is at + 700mV.

YCrCb

As the human eye can see less resolution with colours, the video can be modified to take advantage of this to reduce the amount of information needed. The picture is separated into monochrome and colour components. The monochrome Y signal is formed from:

Y = (0.3 x Red) + (0.59 x Green) + (0.11 x Blue) approximately.
This signal has black level at 0mV and maximum white level at + 700mV.

The colour components are two colour difference signals:

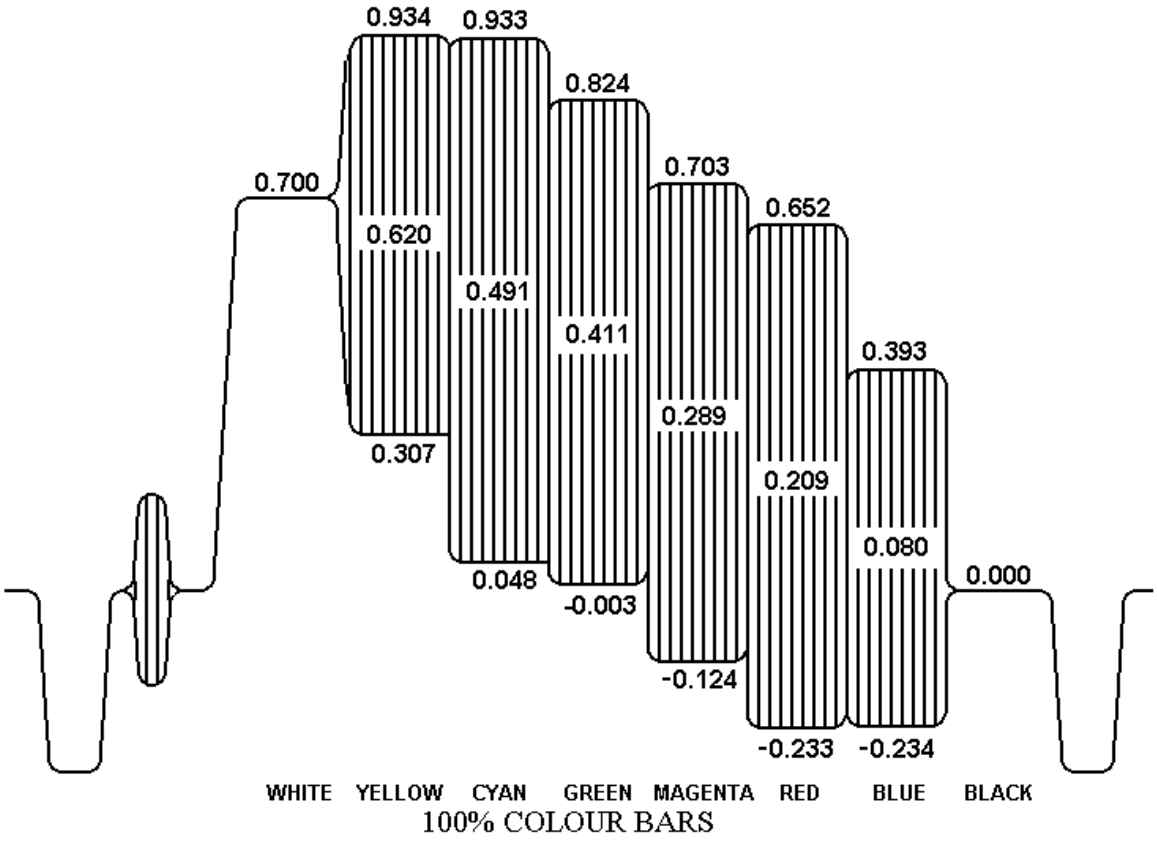
Cr = (R-Y) and Cb = (B-Y)
These are weighted to give maximum values of +/- 350mV and are bandwidth restricted to half that of the Y component.

PAL

Fig 3 shows an encoded 100% colour bar signal. The two colour components of Cr and Cb are used to amplitude modulate a 4.43361875Mhz carrier signal. The two carriers are arranged to be 90 degrees apart before they are combined with the Y luminance signal, so that they can be decoded separately. The PAL system is designed to minimise hue errors by phase reversing the Cr axis on alternate lines (Phase Alternate Line). This reversal is copied by the decoder, so that the hue error will now alternate in phase. By combining the chrominance from two adjacent lines, the error is thus cancelled out.

NTSC

Fig 4 shows an encoded SMPTE (75%) colour bar signal. The two colour components of Cr and Cb are used to amplitude modulate a 3.579545Mhz carrier signal, but they are first modified into I and Q signals to reduce the overall maximum chrominance level when combined.



100% COLOUR BARS

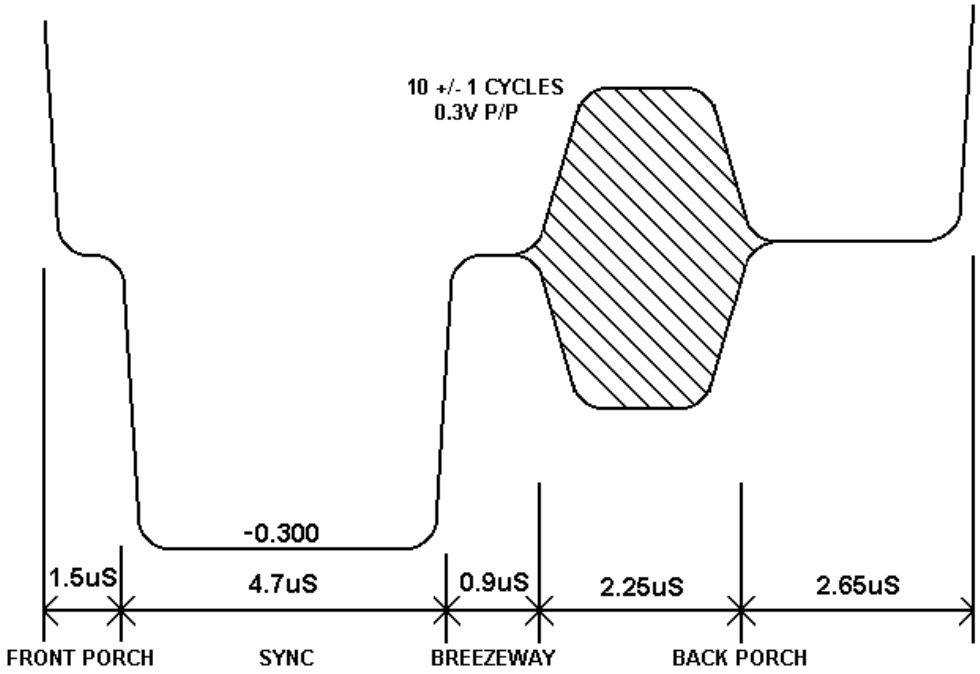
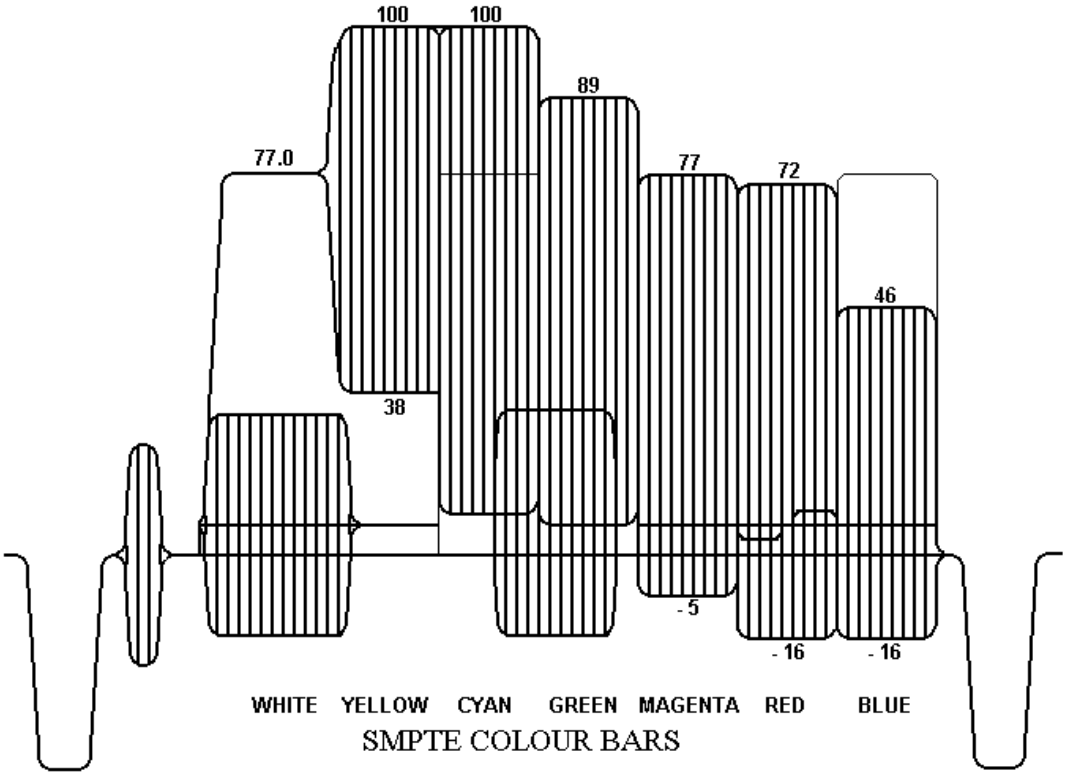


Fig 4.


100
100
89
77.0
77
72
46
38
- 5
- 16
- 16
WHITE
YELLOW
CYAN
GREEN
MAGENTA
RED
BLUE
SMPTE COLOUR BARS

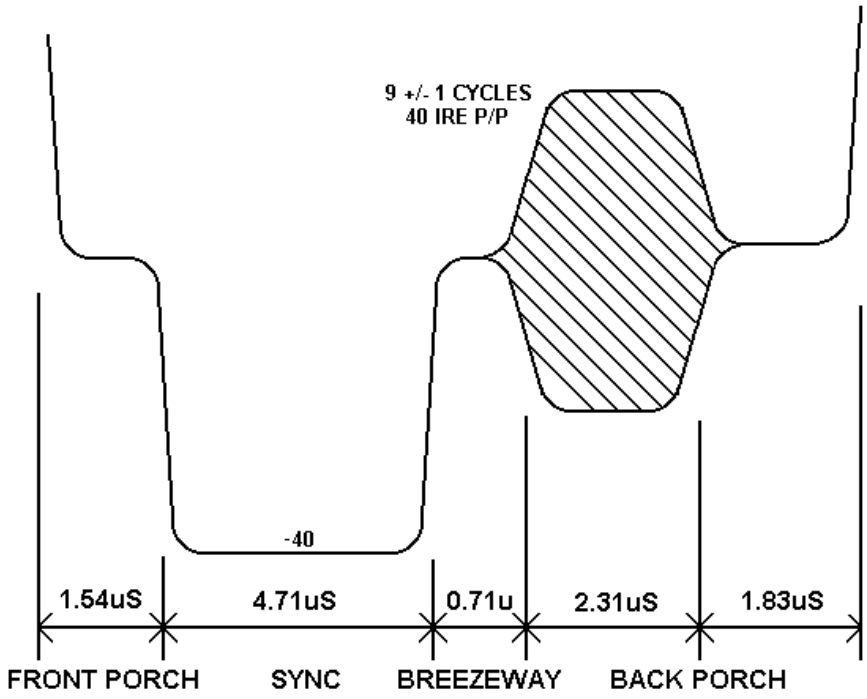

9 +/- 1 CYCLES
40 IRE P/P
-40
1.54uS
4.71uS
0.71u
2.31uS
1.83uS
FRONT PORCH
SYNC
BREEZEWAY
BACK PORCH

Fig 5.

SC-H RELATIONSHIP

PAL appears, at first sight, to be a four field system: field 1 being identical to field 5, and field 3 having the opposite pal switch phase. However, if a switch or edit is made between two video sources which are in the same pal sequence only, a small horizontal picture shift will often be noticed, this is due to the relationship between subcarrier and line frequencies. In order to avoid chroma patterning on monochrome receivers the PAL subcarrier frequency was chosen to have a 90 degree offset per television line, with 25Hz added on so that any remaining patterning would run through the picture:

F (pal) = (283.75 x 15.625KHz) + 25Hz = 4.43361875MHz

The drawback of this is that after one PAL frame of four fields the subcarrier will have executed exactly 354689.50 cycles, so it will be 180 degrees shifted from its original phase at the same sync point. Hence the subcarrier to horizontal sync (SC-H) phase will only repeat every EIGHT fields.
A similar problem also exists in NTSC, except that it is a four field system rather than eight field.

F (ntsc) = (227.5 x 15.73426373KHz) = 3.579545MHz

After one NTSC frame of two fields, the subcarrier will have executed exactly 119437.50 cycles, so it will then be exactly 180 degrees shifted from its original phase at the same sync point hence the sc-h phase will only repeat every FOUR fields.

If a video edit or switch is made without regard to the above field sequence, there is a 50/50 chance of picking the wrong eight field match. This will cause an SC-H phase jump producing a picture shift of half a cycle of subcarrier. Whilst this may be acceptable if cutting to a different shot, in animation or tag-editing the shift would be very noticeable. To produce reliable match frame edits it is therefore necessary to identify the correct field sequence. In addition, if due to misalignment, the SC-H phase was displaced from the ideal by 90 degrees, the field relationship would be uncertain.

Both these problems can be addressed by having an instrument which displays the subcarrier phase to horizontal sync phasing. Zero SC-H phase has been defined as a positive zero-crossing of subcarrier at the vertical sync point on field 1.

Systems can now be adjusted in the exactly correct SC-H phase to avoid uncertainty when near to the 90 degree point. A video signal in the exactly wrong eight-field sequence would show up as an 180 degree SC-H phase error.

SERIAL DIGITAL BASICS

625 and 525 digital component video is produced by applying a 4:2:2 sampling structure to the analog signal. This process is defined by a sub-set of international standards ITU-R BT.601 and BT.656. (these were formerly known as CCIR-601 and CCIR-656. The label 'CCIR601' is commonly applied to digital video coded in this manner.)

The luminance (Y) component is sampled at 13.5 MHz, and the colour difference components (U and V) are both sampled at 6.75 MHz. With 10 bit quantisation, this results in a data stream of 10 bit words at a clock frequency of 27 MHz. If the signal source uses 8 bit quantisation, 10 bit data is used with the two least significant bits of each sample code set to binary zero. This is to maintain the same data rate.

The quantizing levels employed in the analog to digital conversion are set to give 66.4mV headroom above peak white and 51.1mV below black. Coded U and V signals have 50mV above and below their normal maximum and minimum excursions.

The synchronisation pulses are discarded in the coding process, and are replaced by Timing Reference Signals (TRS) which are inserted into the data stream to serve the same purpose. Two TRS's are used to synchronise the data stream, EAV (End of Active Video) and SAV (Start of Active Video). These are placed at the beginning and end of the horizontal video blanking period. see fig 5.

Each TRS consists of 4 words:
1) 3ff hex i.e. all '1's
2) 000 hex i.e. all '0's
3) 000 hex i.e. all '0's
4) XYZ, which determines the type of TRS pulse:

XYZ:
Bit 9: always '1'
Bit 8: 0 = frame 1 1 = frame 2
Bit 7: 0 = normal 1 = field blanking
Bit 6: 0 = SAV 1 = EAV
Bit 5: Bits used for Hamming correction.
Bit 4: Bits used for Hamming correction.
Bit 3: Bits used for Hamming correction.
Bit 2: Bits used for Hamming correction.
Bit 1: Always '0'
Bit 0: Always '0'

SERIAL DIGITAL BASICS

The period between EAV and SAV is not used by normal video and is available for other purposes e.g.: error checking, timecodes or embedded audio.

Illegal Values: The values 0 and 3FF hex are used solely by TRS pulses (EAV and SAV) they must not appear anywhere in the active video area.

Out of Gamut: Values apart from the illegal values which should not be used.
Luminance is defined as being between peak white, 700mV, 3AC, hex and black, 0mV, 040 hex.
Chroma is defined as being between max positive, 350mV, 3C0, hex and max negative, -350mV, 040 hex.
The values above and below these are termed "out of gamut".

The data is serialised using an NRZ (None Return to Zero) code to produce a 270 Mb/s signal. This coding method removes any low frequency component and is insensitive to polarity. The data has to be scrambled first to avoid the possible transmission of all '0's. This data is output at 800mV p-p to normal 75 ohm video coaxial cable.

Due to the high frequencies, the cable losses are quite high, typically 10dB per 100 metres at 270 MHz. To allow acceptable cable lengths, automatic cable equalises are used at the receiver which usually allow up to 300 metres of cable to be used. It is important that standard cable is used, otherwise the equaliser will not compensate correctly.

Suitable cable is: PSF 2/3 BELDEN 8281 F&G 1.0/6.6

DIGITAL ERROR DETECTION OVERVIEW

In order to check if the digital video signal has been received correctly a Cyclic Redundancy Check (CRC) can be made on each frame in the generating equipment, this four digit number is then placed in a 'packet' and put in the EAV-SAV space of one line of each field.

At the receiving equipment the incoming video field also has a Cyclic Redundancy Check number calculated, this value is then compared with the 4 digit number sent in the packet. If the two numbers are not identical an error has occurred between transmission and reception of the signal.

This type of error detection is known as Error Detection and Handling or EDH and is defined by SMPTE RP165. In practice two check sums are sent per frame, one for the active video period and one for the full frame. A typical packet consists of:

The Header:	(000, 3FF, 3FF) This always precedes an EDH packet.
Data ID:	(1F4)
Block Number:	(200)
Data Count:	This contains the number of words that follow.
Active picture CRC:	3 words
Full-field CRC:	3 words
Error flags:	3 words
Reserved:	7 words
Check Sum:	This is used to test for transmission errors.

Note, all values in Hex.

EMBEDDED AUDIO OVERVIEW

The period between the EAV and SAV markers can be used to send embedded digital audio signals. This is known as SMPTE 272M. Up to 16 separate audio signals may be sent in a single video channel. These are organised as four GROUPS of four signals, the four signals are often two stereo pairs. Typically only one group will be used, giving two stereo pairs of audio. The audio data is digitised in the sending equipment to 20 bits of resolution, usually at a 48 KHz sample rate. Often only 16 bits are used in practice. The digitised data is arranged in packets which are placed in the EAV-SAV space.
A typical packet consists of:

The Header:	(000, 3FF, 3FF) This always precedes an audio packet.
Data ID:	This contains the Audio Group number.
Block Number:	AES blocks have 192 'frames' of audio data
Data Count:	This contains the number of words that follow.
Audio Sample:	
Audio Sample:	
Audio Sample:	
Audio Sample:	
Check Sum:	This is used to test for transmission errors.

Each audio sample consists of a sample of all four audio signals,
eg: Channel 1 left, Channel 1 right, Channel 2 left, Channel 2 right.
Each signal requires 3 words to hold all 20 bits data, thus each audio sample has 12 words in it. Typically 3 or 4 audio samples are sent in each EAV-SAV period.
As with the video signal, words which consist of all '1's or all '0's are not allowed.

EAV and SAV

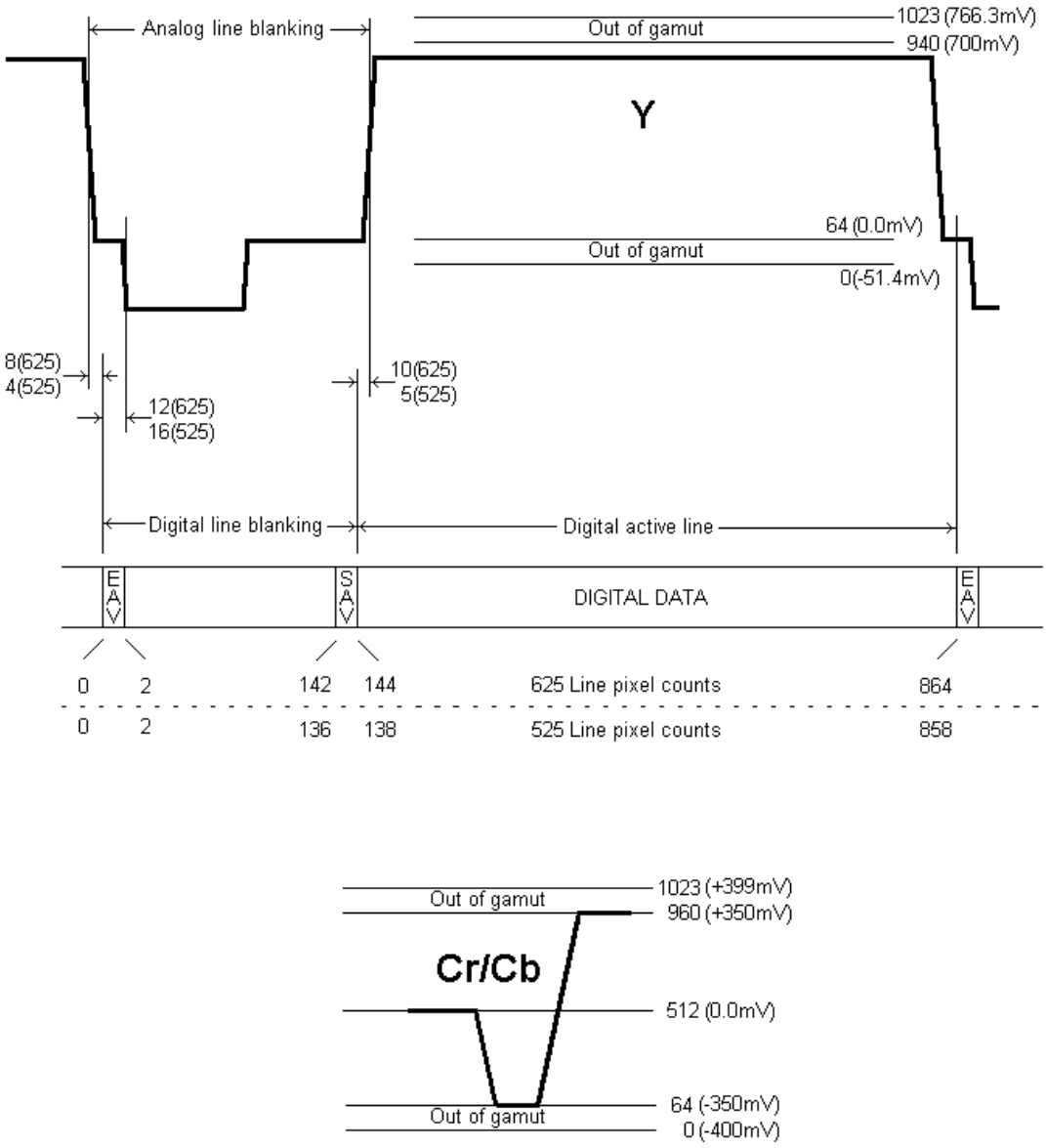


Fig 6.

SD SDI Field Blanking – 625

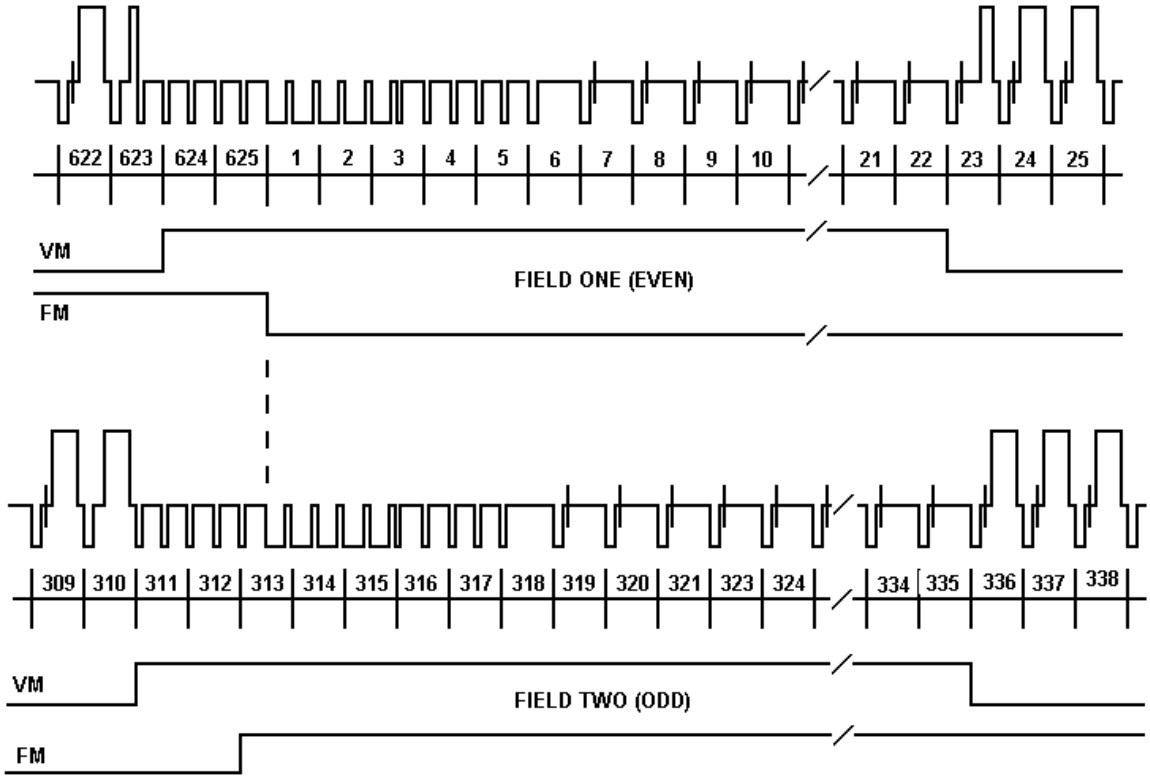


Fig 7.

SD SDI Field Blanking – 525

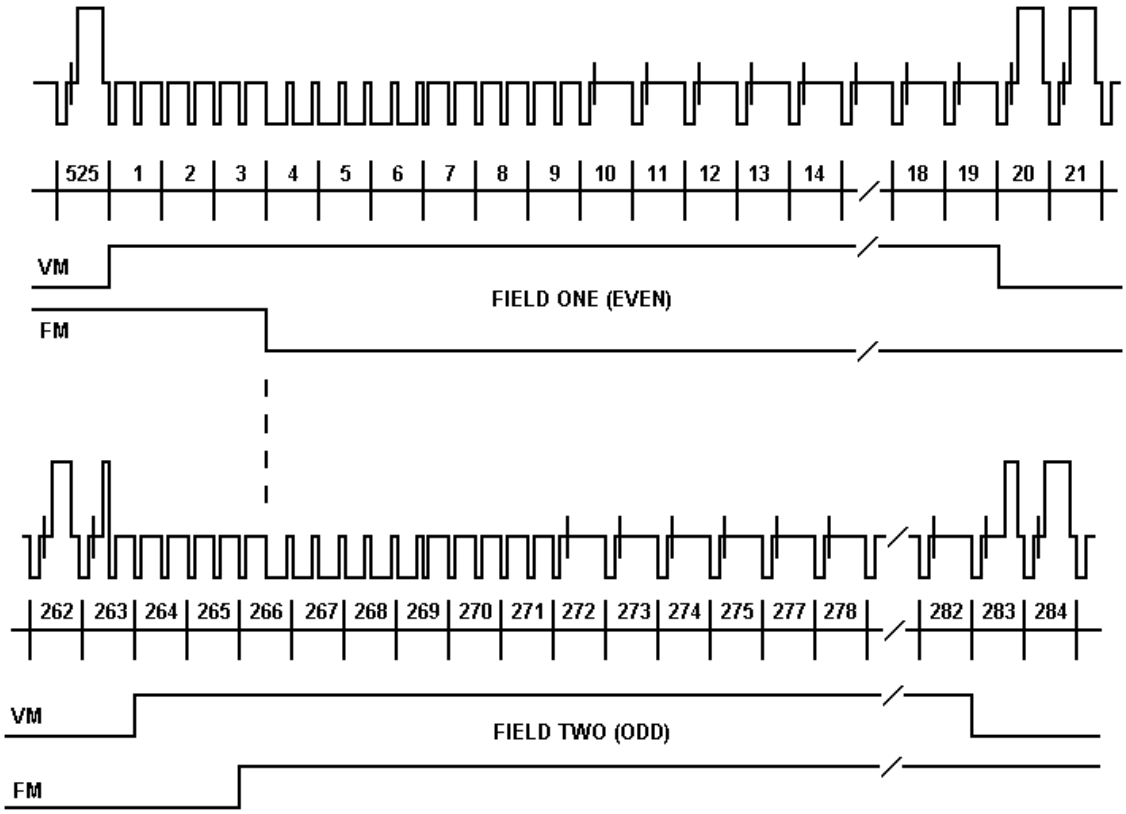


Fig 8.

USEFUL WEBSITES

HAMLET	www.hamlet.co.uk	
HAMLET (USA)	www.hamlet.us.com	
SMPTE	www.smpte.org	Society of Motion Picture Television Engineers
DIN	www.din.de	German Standards Institute
EBU	www.ebu.ch	European Broadcasting Union
AES	www.aes.org	Audio Engineering Society
ITU	www.itu.int	International Telecommunication Union

CONTACT DETAILS AND CUSTOMER SUPPORT

For any form of assistance in maintaining your Digi Gen, please contact:

Hamlet Video International Limited
Maple House 11 Corinium Business Centre Raans Road Amersham Bucks HP6 6FB England
Main Line: +44 (0)1494 729 728
Fax Line: +44 (0)1494 723 237
Free phone (UK) 0500 625 525
E-mail: sales@hamlet.co.uk Web site: www.hamlet.co.uk

Hamlet Video International USA service center , Tecads Inc, 23 Del Padre St, Foothill Ranch, CA 92610, U.S.A.
Tel: +1 (949) 597 1053,
Fax: +1 (949) 597 1094.
Toll Free Tel number: (866) 4 HAMLET
E-mail: service@hamlet.us.com Web site: www.hamlet.us.com

In correspondence concerning this instrument, please quote the serial number, which you will find printed on the label at the back of the unit.