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Everything You Need For Your HD Modular Infrastructure

IS IN REACH

HD System

Common Name	Pixel/Rate/Scan Nomenclature	SMPTE Standard Reference	SMPTE 292 Levels	Scan Type	Frame Rate	Total Lines	Active Lines	Total Horiz. Pixels	Active Horiz. Pixels	Data Rate	Major Use	Major Tape Recording Formats	Connection Type
1080p60	1920x1080/60/1:1	274M - 1		P	60	1125	1080	2200	1920	2.970Gb/s	HD Production		Dual Link / Fibre
1080p59	1920x1080/59.94/1:1	274M - 2		P	59.94	1125	1080	2200	1920	2.970/1.001Gb/s	for Film		
1080p50	1920x1080/50/1:1	274M - 3		P	50	1125	1080	2640	1920	2.970Gb/s			
1080i60	1920x1080/60/2:1	274M - 4	D	I	30	1125	1080	2200	1920	1.485Gb/s		DVCPro-HD, HDCam, HDV	Single Link / Fibre
1080i59	1920x1080/59.94/2:1	274M - 5	E	I	29.97	1125	1080	2200	1920	1.485/1.001Gb/s	US TV Networks	DVCPro-HD, HDCAM, HD-D5, HDCam SR	
1080i50	1920x1080/50/2:1	274M - 6	F	I	25	1125	1080	2640	1920	1.485Gb/s	Euro1080/HD1	HD-D5, HDV, HDCam SR	
1080p30	1920x1080/30/1:1	274M - 7	G	P	30	1125	1080	2200	1920	1.485Gb/s		HDCAM	
1080p29	1920x1080/29.97/1:1	274M - 8	H	P	29.97	1125	1080	2200	1920	1.485/1.001Gb/s		HDCAM	
1080p25	1920x1080/25/1:1	274 M - 9	I	P	25	1125	1080	2640	1920	1.485Gb/s		HDCAM, HD-D5	
1080p24	1920x1080/24/1:1	274M - 10	J	P	24	1125	1080	2750	1920	1.485Gb/s		HDCAM, HD-D5	
1080p23	1920x1080/23.98/1:1	274M - 11	K	P	23.98	1125	1080	2750	1920	1.485/1.001Gb/s		HDCAM, HD-D5	
1080sf30	1920x1080/30/1:1SF	RP211 - 12		SF	30	1125	1080	2200	1920	1.485Gb/s			
1080sf29	1920x1080/29.97/1:1SF	RP211 - 13		SF	29.97	1125	1080	2200	1920	1.485/1.001Gb/s		HDCamSR	
1080sf25	1920x1080/25/1:1SF	RP211 - 14		SF	25	1125	1080	2640	1920	1.485Gb/s		HD-D5, HDCam SR	
1080sf24	1920x1080/24/1:1SF	RP211 - 15		SF	24	1125	1080	2750	1920	1.485Gb/s		HD-D5, HDCam SR	
1080sf23	1920x1080/23.98/1:1SF	RP211 - 16		SF	23.98	1125	1080	2750	1920	1.485/1.001Gb/s	HD Production	HD-D5, HDCam SR	
720p60	1280x720/60/1:1	296M	L	P	60	750	720	1650	1280	1.485Gb/s		DVCPro-HD, HDV	Single Link / Fibre
720p59	1280x720/59.94/1:1	296M	M	P	59.94	750	720	1650	1280	1.485Gb/s	US TV Networks	DVCPro-HD, HD-D5, HDCam SR	
720p50	1280x720/50/1:1			P	50	750	720	1980	1280	1.485Gb/s		HDV	
720p30	1280x720/30/1:1			P	30	750	720	3300	1280	1.485Gb/s		HDV	
720p29	1280x720/29.97/1:1			P	29.97	750	720	3300	1280	1.485Gb/s			
720p25	1280x720/25/1:1			P	25	750	720	3960	1280	1.485Gb/s		HDV	
720p24	1280x720/24/1:1			P	24	750	720	4125	1280	1.485Gb/s			
720p23	1280x720/23.98/1:1			P	23.98	750	720	4125	1280	1.485Gb/s			
1035i60	1920x1035/60/2:1	260M	A	I	30	1125	1035	2200	1920	1.485Gb/s			
1035i59	1920x1035/59.94/2:1	260M	B	I	26.97	1125	1035	2200	1920	1.485/1.001Gb/s	Japanese TV		
1080p50a	1920x1080/50/1:1	295M		P	50	1250	1080	2376	1920	2.970Gb/s	Graphics (includes		
1080i25a	1920x1080/25/2:1	295M	C	I	25	1250	1080	2376	1920	1.485Gb/s	"Alpha Channel")		
625i50	625/50/2:1	125/259M		I	25	625	576	864	720	270Mb/s	Current SD standard		
525i59	525/59.94/2:1	125/259M		I	29.97	525	486	858	720	270Mb/s	(PAL/NTSC)		

HDV. There are currently 2 forms of HDV - HDV1 (720p) and HDV2 (1080i)

Format vs Standards Conversion:

Format Conversion

This is the process of converting picture information between Formats but at the Same Frame Rate. Examples are:

- 1080i59 to 525p59 (down conversion)
- 625i50 to 720p50 (up conversion)
- 720p59 to 1080i59 (cross conversion or HD aspect ratio conversion).

Standards Conversion:

A Standards Converter is needed if input and output Frame Rates are different. Examples are:

- 1080i59 to 1080i50
- 1080i50 to 1080i59
- 720p59 to 1080i50

HD Embedded Audio

Embedded audio was significantly more complex in Standard Definition than it is in High Definition. Several different versions (or levels in SMPTE-speak) exist for SD, whereas there is a single standard for HD – see table

	SD							HD	
	SMPTE 272M							SMPTE 299M	
LEVEL	A	B*	C**	D	E	F	G	PREFERRED	OPTIONALLY
Max No. of Embedded Groups	4	1	4	4	4	4	4	4	4
Max No. of AES Channels	8	2	8	8	8	8	8	8	8
Audio Sample Frequency	48kHz	48kHz	48kHz	48kHz	44.1kHz	32kHz	34-48kHz	48kHz	32-48kHz
Audio Word Bit Count	20	20	24	20 or 24	20 or 24	20 or 24	20 or 24	24	24
Asynchronous Audio	N	N	N	Y	Y	Y	Y	N	Y
Audio Chs can be switched off	Y	Y	Y	Y	Y	Y	Y	N	N
Asynchronous Groups	N	N	N	Y	Y	Y	Y	N	N

The single standard encompasses an option – and as a result all sampling frequencies between 32kHz and 48kHz are included as well as synchronous or asynchronous operation. However, it is worth noting that there are restrictions in the handling of individual channels inside groups within the standard – for example all channels must be synchronous to one another, even if the group embedding is being done asynchronously to the video.

Dolby E

Dolby E is a compressed form of the original PCM audio and is more accurately described as a data stream. One of its features is that it is synchronous to the video and frame timed, so synchronous embedded can be implemented. It is essential that the Dolby E data is not processed in Sample Rate Converters, which are often used to synchronise PCM audio signals.

* Intended for composite video applications ** Full capacity not available for 525/60 systems.

60 vs. 59.94?

The original US television standard (monochrome) was established with a 60Hz field frequency because that was the frequency of A.C. line power, which was a practical reference for television receivers to use and avoided problems with hum bars. However, with the advent of colour transmissions, a more accurate and stable reference was required. In addition, at a 60Hz field rate, there was an added problem that the audio signal (modulated at 4.5MHz) would cause interference with the 3.58MHz (exactly 315/88) of the colour subcarrier.

Early analogue receivers needed fairly simple multiplier circuitry to generate the correct signal frequencies, and the adoption of a **5MHz** master oscillator allowed relatively easy generation of the

3.58MHz colour subcarrier **= 5MHz x 63 ÷ 88.**
(3x3x7) (2x2x2x11)

This in turn allowed a line frequency of

15.734kHz = 5MHz x 63 ÷ 88 x 2 ÷ 455,
(5x7x13)

which results in a field frequency of

59.94Hz = 5MHz x 63 ÷ 88 x 2 ÷ 455 x 2 ÷ 525.
(fields) (lines)

It also happens to be the case that **59.94** is equal to

60 x 1000 ÷ 1001

1001 has prime factors of **7**, **11**, & **13**, so it is possible to use a **60kHz** reference and divide it by **1001** to arrive at the field frequency. This ratio has significance throughout the HD signal world.

The 59.94 field rate had become the established standard for 525 line systems – even if consumer specifications tended to refer to it as 60Hz. However, motion picture film had standardised on 24 frames per second as an origination format (when projected in movie theatres each frame is normally displayed 3 times to minimise flicker effects), and conversion of film to television presented significant problems. A conversion at a 60Hz field rate is simpler than at 59.94Hz, so when movies started to appear on digital media (DVDs), they were produced at 60Hz. By this stage receiver technology had moved on so that the different field rate did not matter.

As a result, when the HD standards were agreed, in each case a 59.94 version and a 60 version were included. In practice, HD services that originate in organisations that also produce standard definition 525 line services (i.e. at 59.94Hz) tend to always use the 59.94 version, whereas those that do not may use either – with film-based operations tending to favour 60Hz.

The "down-the-wire" transmission rate of each is normally 1.485Gb/s (although the 59.94 version is strictly 1.485 x 1000 ÷ 1.001) and in practice most well designed HD equipment will accept either rate. However, it is worth noting that absolute signal conversion between 59.94 and 60 requires true temporal conversion (which is complex) so most equipment will only deliver the same rate at the output as is delivered at the input.

SF - Not Science Fiction?

Progressive Segmented Frame - often reduced to PsF or SF – is a method of mixing the technologies of interlace and progressive scanning, to allow a progressively scanned image to occupy less bandwidth. In normal interlace scanning, each field scans alternate lines, with field 1 scanning odd lines (1, 3, 5, etc) and field 2 scanning even lines (2, 4, 6, etc) - and with field 2 being scanned later than field 1. With SF, both field 1 and field 2 are scanned at the same time, but are transmitted in sequence - thus at 1/2 the vertical resolution of the original frame in each field. At the display these 2 fields are again matched in time, to allow a "progressive" single frame to be shown.

SF has a further advantage when related to film applications. The normal film speed of 24 frames per second requires "translation" to match 25, 29.97 or 30 fps rates used in HD television. Film is essentially a "progressive" format - each frame is a complete picture and no interlace between frames is required. SF allows this progressive format to be maintained - because there is no temporal change between the 2 fields in a SF signal, while minimising bandwidth requirements using "interlacing". When translated to TV rates (either at 3:2 or 2:2 pulldown), the progressive image has a closer temporal match to the original film than is possible with a true interlace system, particularly now that modern displays (LCD & plasma) are natively progressive scan devices.

HD Aspect Ratio Conversion

The process of up and down conversion between the High Definition formats and Standard Definition formats will often involve changes to the picture aspect ratio. It is critical that the geometry of the original picture is not altered - so that circles in the original do not become ovals in the conversion - but this necessitates either some loss of the original, or areas of screen without picture in the converted version. Some commonly used conversions and their impact on the original picture are shown below. If the original SD material is already 16:9, then no aspect ratio conversion will be required when up converting.