Over the years, video standards have been defined by many organizations including: ANSI, ATSC, CEMA, DDGW, EBU, EIA, ETSI, FCC, IBM, IEEE (the former IRE), ITU (the former CCIR), ITV, JEIDA-DISM, NTSC, NATO, SMPTE, and VESA.

THE ORIGINAL ANALOG MONOCHROME SDTV BASEBAND SIGNAL (RS-170)

In 1957, the EIA released the original monochrome TV standard baseband signal known as RS-170.

ANALOG CLOSED-CIRCUIT SIGNALS (RS-330, RS-343, RS-412)

Later, in the 60's, the EIA added several high-resolution monochrome closed-circuit standards RS-330, RS-343, and RS-412. These standards are still being used in military applications today. NATO (and others) have added various tweaks to the original EIA standards to produce special purpose defense system formats such as STANAG (A, B, & C), HOBO, and MAVERIK.

COLOR ANALOG SDTV TERRESTRIAL BROADCAST SIGNALS (NTSC, PAL, SECAM)

The NTSC added a color sub-carrier to EIA RS-170 in order to implement color TV in the United States. For a long time, there wasn't a single standard that defined the amplitude and timing relationships for the NTSC signal. During this time, EIA RS-170-A and FCC 73.699 Diagram #6 were commonly used. More recently, the Society of Motion Picture and Television Engineers (SMPTE) has released an official standard SMPTE 170M-1999.

As color TV spread throughout the world, other (non-compatible) color broadcast TV standards evolved in order to accommodate local AC power and political conditions. In 1974, the CCIR began to document the characteristics of all systems used around the world as CCIR-624-3. This standard identified two distinct types of composite synchronization: American NTSC (type M) and European PAL (all types except M). The standard also documented three-color systems: NTSC, PAL, and SECAM. The CCIR is now known as the ITU, which is responsible for issuing modern European standards. The original CCIR-624-3 standard is now ITU-R 470-6.

Today, studio equipment is generally compatible with either the NTSC or PAL color systems. SECAM is strictly a transmission standard and is obtained by using a signal converter at the output of PAL-compatible studio equipment.

ANALOG CONSUMER SDTV SIGNALS (CVBS, S-VIDEO)

Most consumer equipment has CVBS (composite video baseband signal) inputs and outputs for interconnecting different pieces of equipment in the home. CVBS is a composite signal, meaning that both color and luminance are present on a single wire. One unfortunate side effect of using a single wire for transmitting both color and luminance is that the two components tend to interact. Because consumer equipment is hooked up with wire (not broadcast on a single channel), it is possible to put the luminance and color information components on separate wires in order to improve quality. This is what S-VIDEO is. [S-VIDEO is defined in the ??? standard].

EARLY ANALOG SDTV STUDIO SIGNALS (GBR, YPbPr)

The highest quality color analog signal is obtained by splitting the color video signal into three separate components; either GBR (green, blue, red) or YPbPr (luminance, luminance-blue, luminance-red). This is the type of signal that was used in television studios before the advent of digital signals.

DIGITAL SDTV STUDIO SIGNALS (D1, D2, SDI)

In 1982, the CCIR released CCIR-601-1, a standard for encoding both PAL and NTSC television in an interchangeable digital form for use in television studios. The original CCIR-601-1 standard is now available as ITU-R BT.601-5. This standard is the basis for two legacy digital video systems: a component format known as D1 and a composite format known as D2 [NOTE: "D1" and "D2" are actually the names of SMPTE tape formats supported by the machines whose respective interfaces were component and composite]. Both systems employ a digital 10-bit parallel interface, consisting of DB-25 connectors and a cable with 11 differential-ECL signal pairs (10-signal + 1-clock = 11-pairs) running in-between.

The D1 component standard is documented in SMPTE 125M-1995 (and again in ITU-R BT.656-4). This system delivers video having three components Y, Cb, and Cr. The Y component contains 13.5 mega-samples/second of luminance information, while the Cb and Cr channels work together to communicate color information at half that rate. Data is sent through a single channel in a repeating pattern: Cb0, Y0, Cr0, Y1, Cb1, Y2, Cr1, Y3 … at 27 MHz (13.5 MHz Y + 6.25 MHz Cb + 6.25 MHz Cr = 27.0 MHz data stream). Because there are approximately four Y, two Cb, and two Cr samples for every cycle of the analog NTSC composite system subcarrier (3.58 MHz), the sampling method for this system is referred to as being 4:2:2. This format doesn't incorporate a sub-carrier, so luminance and color do not crosstalk. Therefore, D1 is higher quality than D2 – the format that is discussed next.

The D2 composite standard is documented in SMPTE 244M-1995. In this system, the NTSC (or PAL) analog video signal is regularly sampled (subcarrier and all) at 4x the rate of the color subcarrier (3.58MHz x 4 = 14.3 MHz in the case NTSC or 4.43MHz x 4 = 17.7 MHz in the case of PAL).

A serial version of SMPTE 125M-1995 is described in SMPTE 259M-1997. This modern serial digital interface (SDI) replaces the expensive-bulky ECL interface of SMPTE 125M-1995 with a single 75-ohm coax and 10x higher bit-rate (270 megabit-per-second). In this way, the modern SDI interface feels a lot like the old composite analog interface; that is, one video signal per 75-ohm cable - but it's digital.

EDTV STUDIO SIGNALS (SMPTE 267M, SMPTE 293M, SMPTE 294M)

An anamorphically enhanced version of SMPTE 125M, known as SMPTE 267M-1995, is now available that increases horizontal resolution by a factor of 4/3 in order to maintain detail on the new, wider 16:9 displays (16:9/4:3 * 27MHz = 36 MHz). This enhanced version can also be run through SDI at 360 megabit-per-second – so the bulky/costly parallel ECL interface can again be avoided.

Progressive versions of the legacy interlaced television standards can be found in ITU-R BT.1362 and SMPTE 293M-1996. These formats eliminate the flicker associated with their interlaced counterparts. SMPTE 294M-1997 describes how to put EDTV on the SDI interface.

EARLY HDTV STUDIO SIGNALS (SMPTE 240M, SMPTE 260M, SMPTE 295M)

The Japanese introduced the concept of HDTV in 1960. Today, the original Japanese HDTV analog component standard has been captured as SMPTE 240M-1995. This spec calls for an odd number of active lines (1035). A companion parallel ECL digital interface SMPTE 260M is also documented for interconnecting early high-definition equipment. The digital interface consists of 93-contact connectors and a cable with 31 differential-ECL signal pairs running in-between (10-pair Y + 10-pair Cb + 10-pair Cr + 1-pair clock = 31-pairs). The sampling rate is either 74.25/1.001 or 74.25 MHz.

The Europeans began their own HDTV efforts in 1985. By 1990, the ITV and the Eureka 95 project had produced a collection of standards known as EU95. From these standards came the 1152-line and 1080-line 50 Hz timings documented in ITU-R BT.709-3 and SMPTE 295M-1997, respectively. Sampling rates for these standards are 74.25 MHz or 148.5 MHz.

MODERN HDTV STUDIO SIGNALS (SMPTE 274M, SMPTE 292M)

SMPTE 274M-1998 is a new variant of the original Japanese SMPTE 240M analog component HDTV standard that calls for square pixels and an even number of lines (1080). This standard defines a family of formats and a parallel ECL digital interface identical to the original SMPTE 260M HDTV standard. The timings in this new standard are widely used today. The sampling rates used are 74.25/1.001, 74.25, 148.5/1.001, or 148.5 MHz.

SDI now has a HDTV counterpart known as HD-SDI, which is described in SMPTE 292M-1998. This modern serial digital interface replaces the expensive (bulky) 93-contact ECL interface of SMPTE 260M and 274M standards with a single 75-ohm coax and 20x higher rate bit-stream (1.485 gigabit-per-second). Data is sent over a single channel in a repeating pattern: Cb0, Y0, Cr0, Y1, Cb1, Y2, Cr1, Y3 … (10 X 74.25 MHz Y + 10 X 37.125 MHz Cb + 10 X 37.125 MHz Cr = 1.485 GHz bit stream). The color bandwidth is reduced, from that of the parallel SMPTE 260M and 274M interfaces, in order to keep the bit-rate within the capability of high-quality 75-ohm coax.

DIGITAL HDTV TERRESTRIAL BROADCAST (ATSC, DVB-T, ISDB-T, DMB-T)

The ATSC has been responsible for moving HDTV forward in the US. In 1995, the ATSC introduced a digital HDTV broadcast standard, which transports MPEG-2 compressed picture information (in addition to audio and data) over a single 6 MHz standard television broadcast channel. The scheme replaces the single analog NTSC camera/receiver signal with a vestigial sideband modulated digital data transport mechanism known as VSB (see ATSC A/53 ANNEX D). VSB decouples the source and receiver timings, leaving only picture size, picture aspect, pixel aspect, frame-rate and scanning method to be considered. When these factors are combined, the result is a set of 18 digital picture data compression formats. The formats are listed in Annex A, Section 5.1.2, Table 3 "Compression Format Constraints" of the ATSC Digital Television Standard dated 16 Sept. 95. The 18 include 6 HDTV types and 12 SDTV types. There are 5 picture data formats and 7 (non-documented) signal timings.

The Europeans use a different terrestrial data transport scheme for their HDTV broadcasts. Instead of VSB, a system based on COFDM is used. This system is called DVB-T and is described in ETSI ETS-300-744. [NOTE: Some US broadcast engineers think that COFDM is superior to VSB and want to abandon the current US terrestrial broadcast signal.]

DIGITAL HDTV TRANSPORT SIGNALS (SMPTE 310M, DVB-SPI)

A number of broadcast transport interfaces have been introduced in order to transport MPEG-2 compressed video, AC-3 compressed audio, and ancillary & control data between studio and transmission equipments. In the US, SMPTE 310M is used for this purpose. In Europe, DVB-

ASI, DVB-SSI, or DVB-SPI is used (DVB-SPI being the most popular).

ANALOG SDTV / HDTV CONSUMER COMPONENT VIDEO SIGNALS (YPbPr)

Today, most consumer HDTV gear has YPbPr component analog video inputs and outputs. These signals are almost identical to the analog signals that were once used in television studios, except that analog composite sync is only available on the Y component and use of a GBR color space is not an option. This signal is defined in EIA standards EIA-770-1, EIA-770-2, and EIA-770-3.

DIGITAL CINEMA STUDIO SIGNALS (1080p24)

With the advent of multi-format television, networks and broadcasters worldwide now have to deal with the conversion of original source material to multiple transmission standards. To solve this problem, original material is now shot using 24p film and (in the back-end) converted to 480p23 (i.e. 480p at 24/1.001 Hz), 480p, 720p or 1080i as needed.

In the last couple of years, as new film-like video cameras have become available (e.g. the Sony HDW-F900 24p), both television and movie producers have begun to substitute 1080p24 video for film. A couple of the progressive 24 Hz timings in the SMPTE 274M-1998 standard (#10 and #11) are used here.

Rather than make a special tape machine for the 24 Hz cinema format, some equipment manufacturers have opted to adapt 50 Hz interlaced recorders for use with the new 24 Hz signal. To make the 24 fps progressive video signal more palatable to interlaced 50Hz equipment, a new “48sF” 48s format has emerged. Here, frames are captured at 24 fps progressive (by the camera) and immediately converted to 48 segments-per-second - each segment being a field with half the number of progressively scanned lines. A segmented frame consists of two fields: a first field, containing all the even lines of a progressively scanned 24p frame, followed by a second field, containing all the odd lines of that same progressively scanned 24p frame.

50 Hz displays can be driven with the new 24 Hz signal using a 1080i23 format. In order to view a 1080p23 master recording on a 1080i23 display, one simply uses a progressive-to-interlace converter [and our 1080i23 format, which is based on SMPTE 274M-1998 #11 timing].

COMPUTER VIDEO SIGNALS (VGA, DVI)

IBM set the standards for computer video during the 1980s with the introduction of VGA. Later, the Video Electronics Standards Association (VESA) came along and standardized VGA for use by other manufacturers. VESA then added more formats as computer display resolution increased.

Computer signals are not broadcast, so there is no need to combine sync and video for transmission through a single channel. As a result, computer formats tend to be quite simple. Separate digital horizontal and vertical synchronization signal cables are typically used to avoid the complexities of composite analog or digital synchronization. Bandwidth is not a constraint, so interlace is neither required nor desirable. Progressive scanning is used to avoid flicker as unfiltered computer graphics are displayed.

In an attempt to reduce the number of cables needed to support multimedia displays, VESA developed the P&D interface specification. This spec never caught on, as the connector used was not cost effective and the VGA connector remained entrenched.

With the advent of digital flat panel displays, VESA revisited the P&D standard and developed a new standard connector, retaining some of the better ideas of the P&D. A couple of flat-panel display interface standards were then issued know as FPD and DFP, but again VGA remained entrenched and flat-panel display manufacturers had no recourse but to outfit their displays with expensive analog-to-digital converters.

With the advent of the laptop computer, the FPD-Link LVDS interface was born and remains the interface of choice for this application.

Very recently, the Digital Display Working Group (DDWG) has introduced a non-proprietary analog/digital mixed-signal standard interface for modern computer displays known as DVI. This interface integrates both analog and digital signals into a single connector, like P & D, but seems to be gaining wide acceptance. It looks as if DVI is well on its way to replacing the here-to-fore ubiquitous VGA.

CONSUMER TV / COMPUTER CONVERGENCE (EIA/CEA-861-B)

Several years ago, Microsoft, Intel, Compaq, & Lucent formed the "DTV Team" who's goal was to define an integrated set of formats that might serve both television and computer users. The DTV Team edited and prioritized the original set of 18 ATSC formats into two groups known as HD0 and HD1. The HD0 group of 13 being the bare minimum set to be implemented by all multimedia systems today and the HD1 group of 3 to be implemented in the near future. The remaining 3 were considered to be impractical or bad ideas. Despite this, broadcasters and consumer electronics manufacturers went ahead and implemented one of the forbidden three – that being the ubiquitous 1080i29.

Until recently, digital consumer video sources could only be connected to an HDTV via IEEE-1394 serial buss. Because of the limited bandwidth of the IEEE-1394 interface, only a MPEG-2 compressed HDTV signal could be communicated via this interface. Standards here include AV/C, EIA-775, IEC_61883 protocols, HAVi middleware, and DTCP content protection.

The IEEE-1394 interface requires an HDTV receiver to be more intelligent than a typical high-resolution computer display. To reduce cost and simplify the overall system (especially the software), a simpler higher-bandwidth interface with a new content protection scheme has been proposed.

The consumer electronics industry recently introduced EIA/CEA-861-B, which standardizes the transport of uncompressed digital video from consumer digital video sources to EDTVs and HDTVs over DVI. At the same time, a new content protection scheme, called HDCP, has been developed for this interface.

MEDICAL (RADIOLOGICAL) DISPLAYS

Of course, the desktop and television markets are not the only ones requiring standardization. Other application areas exist, which have not been integrated into the desktop or television standards efforts as yet. One area is radiology. Here, resolutions are extreme (500 to 800 mega pixels-per-second) and formats tend to be established by leading card (e.g. Dome) and monitor (e.g. Siemens, DataRay, Barco, Image Systems, etc.) manufacturers.

WEARABLE AND PROJECTION MICRODISPLAYS (GVID)

Another area, which has yet to be addressed, is microdisplays, where special scanning methods such as field sequential color are required. Sony has developed a new gigabit/second serial interface called "GVID", which may be used here. VESA is currently working on standards in this area.

MORE ABOUT DVI

Now let's begin by taking a look at where DVI fits in relative to other legacy, rival, and complementary video interface.

VIDEO INTERFACES TODAY

As we have seen, there are many different video signal interfaces being used today. These interfaces can be broken down by market, of which there are currently at least six: namely, computer, consumerAV, studio & professionalAV, terrestrial analog & digital broadcast, military, and medical/prepress. Each of these markets uses a different set of interfaces, which shown here.

THE TREND IS ANALOG -> DIGITAL

Today we have a number of analog interfaces. As time goes on, these analog interfaces will give way to digital interfaces, because of the significant advantages they provide. Here, I've listed a few of these advantages.

Many of the analog interfaces that are used today - especially in the consumer market - are very low bandwidth, so quality to suffers. The new digital interfaces will maintain high-quality and high resolution.

Using digital signals will allow us to eliminate the analog-to-digital converters, which add noise to the signal.

With the new digital interfaces, the signal will not degraded when passed from device to device. Instead, the signal will be regenerated periodically to maintain quality - without encountering resampling artifacts. This will make long distance transmission possible.

The digital interfaces will allow audio, video, sync, data, and control information to be integrated and transmitted over a single cable. So, the jumble of cables we currently see at the back of HDTV sets will be eliminated.

Digital signals will provide security, so that valuable content can be protected from unscrupulous copying and unauthorized reception. High-quality content providers will be more willing to provide programming in true high-definition.

Digital signals will allow bandwidth to be conserved via selective refresh. This will allow us to drive very high-resolution displays that would not be practical with analog signaling methods.

Digital signals will simplify testing by allowing us to embed inexpensive and precise test circuits in equipment that can perform very rigorous testing.

VIDEO INTERFACES TOMORROW

As time goes on, only the digital interfaces will survive. The consumer and computer markets will converge and DVI will become the interface of choice. A new version of DVI called HDMI will add audio, data, and control channels to DVI. DVI will be outfitted with a selective refresh feature called digital packet video link (DPVL), which will allow very high-resolution panels to be supported. Other interfaces that complement DVI stay. DTVLink will continue to provide compressed signal transport. Terrestrial digital broadcast standards such as (8VSB, DVB-T, ISDB-T, and DMB-T) will completely replace the current analog broadcast standards. A new wearable market will develop and a new - low power, wearable standard called "MDDI" will emerge for use with cell phones. Less certain is the ultimate fate of VGA and the interfaces that will eventually dominate the highly specialized studio/pro AV and military/medical markets. A modified version of VGA called "NAVI" may surface to provide support for legacy analog displays, with special features to improve quality when driving flat panels.

THE FUTURE OF DVI IS BRIGHT

To summarize, the future of DVI is very Bright. HDMI will push DVI into consumer TV. DPVL will push DVI in niche markets. DVI has momentum - it is a survivor. The proof is that it made it into the test equipment - where other digital interfaces didn't.

Video Interfaces Today

- Computer ➢ VGA, DVI
- ConsumerAV ➢ CVBS, S-VIDEO, YPbPr, DTVLink
- Studio/ProAV ➢ SDI, HD-SDI
- Terrestrial analog ➢ NTSC, PAL, SECAM
- Terrestrial digital ➢ 8VSB, DVT-B, ISBT-T, DMB-T
- Military ➢ Y
- Medical/prepress ➢ Y, RGB

The trend is Analog → Digital

- Low Quality → High Quality
- Noisy Resample → Lossless Regeneration
- Short Haul → Long Distance Transmission
- Separate Cables → One Cable
- Unprotected → Secure
- Wastes Bandwidth → Conserves Bandwidth
- External Test → Embedded Test

Video Interfaces Tomorrow

- Computer ➢ DVI, HDMI, DTVLink, NAVI?
- ConsumerAV ➢ DVI, HDMI, DTVLink
- Studio/ProAV ➢ HDMI?, SDI, HD-SDI
- Terrestrial (analog) ➢ eliminated
- Terrestrial (digital) ➢ 8VSB, DVT-B, ISBT-T, DMB-T
- Military ➢ OpenLDI?
- Medical/Prepress ➢ DVI-DPVL
- Wearable ➢ MDDI

Application		Maturity	Country	Name	Timing	A/D	Connector(s)	Standard(s)	Content Protection	Audio	Bidirectional	Selective Refresh
Studio	Camera Mixer Tape/Disk	Modern	All	HD-SDI	HDTV	D	BNC	SMPTE 292M, SMPTE 296M	NO	NO	NO	NO
				SDI	SDTV, EDTV	D	BNC	SMPTE 259M, SMPTE 294M, SMPTE 305M, ITU-R 601-5	NO	NO	NO	NO
		Legacy		D1	TV	D	DB-25	SMPTE 125M, SMPTE 267M, ITU-R BT.656-4, ITU-R 601-5	NO	NO	NO	NO
				D2	TV	D	DB-25	SMPTE 244M, ITU-R 601-5	NO	NO	NO	NO
				GBR	SDTV, EDTV	A	BNC	SMPTE 253M	NO	NO	NO	NO
	Consumer	Current		HD-YPbPr	HDTV	A	BNC (RCA)	SMPTE 274M, SMPTE296M, EIA-770.3	NO	NO	NO	NO
				SD-YPbPr	SDTV, EDTV	A	BNC (RCA)	SMPTE 293M, ITU-R BT.470-6, EIA-770.1, EIA-770.2	NO	NO	NO	NO
Home				S-VIDEO	TV	A	DIN-4	?	NO	NO	NO	NO
				CVBS	TV	A	BNC (RCA)	SMPTE 170M	NO	NO	NO	NO
Terrestrial				RF	TV	A	F	ITU-R BT.470-6	NO	YES	NO	NO
		Modern	American	ATSC	MPEG-2 Terrestrial	MIXED	F	ATSC A/53 ANNEX D	NO	YES	NO	NO
			European	DVB-T		MIXED	F	ETSI ETS-300-744	NO	YES	NO	NO
			Japanese	ISDB-T		MIXED		?	NO	YES	NO	NO
			Chinese	DMB-T		MIXED		?	NO	YES	NO	NO
			American	310M	MPEG-2 Transport	D	BNC	SMPTE 310M	NO	YES	NO	NO
			European	DVB-ASI		D	BNC	SEK SS-EN 50083-9 ANNEX B	NO	YES	NO	NO
				DVB-SPI		D	DB-25	SEK SS-EN 50083-9, ISO/IEC IS 120402	NO	YES	NO	NO
Computer			All	IEEE1394		D	IEEE-1394	IEC 61883, iLink, HAVi, Lynx, VESA VHN, Apple FireWire	DTCP	YES	NO	NO
		Developing		HDMI	HDTV,SDTV	D	HDMI	HDMI 0.9, EIA/CEA-861-B	HDCP	YES	NO	NO
	Desktop	Modern		DVI-D, HDMI	DMT	D	DVI, HDMI	DDWG DVI 1.0, with DPVL	HDCP	NO	NO	YES
				DVI-A	DMT	A	DVI	DDWG DVI 1.0, VESA VSIS, VESA DDC	NO	NO	NO	NO
		Current		VGA	DMT	A	VGA	VESA VSIS, VESA DDC	NO	NO	NO	NO
	Notebook			FPDLink	DMT	D	LDI	SPWG	NO	NO	NO	NO
	Military & Medical			Y	RS	A	BNC	EIA-343-A, EIA-412-A	NO	NO	NO	NO
		Future?		OpenLDI	DMT	D	LDI	National OpenLDI 0.95, DISM JEIDA-59-1999, Digital PV Link	NO	NO	NO	NO
Telecom	Wearable	Developing		MDDI	?	D	?	VESA workgroup	HDCP?	YES	YES	YES

In 1995, the Advanced Television Standard Committee (ATSC) introduced a digital HDTV broadcast standard that can transport MPEG-2 compressed picture information (in addition to audio and data) over a single 6 MHz standard television broadcast channel. When used, the standard replaces the legacy analog signal with a digital signal known as VSB (see ATSC A/53 ANNEX D). VSB utilizes a data transport stream, which decouples the source and receiver timings, leaving only picture size, picture aspect, pixel aspect, frame rate and scanning method to be matched between source and receiver. When these factors are combined, the result is a set of 18 digital picture data compression formats - not video formats. These compression formats are documented in Annex A, Section 5.1.2, Table 3 "Compression Format Constraints" of the ATSC Digital Television Standard dated 16 Sept. 95. The 18 include 6 HDTV types and 12 SDTV types. There are 5 picture data formats and 7 timing profiles. The left-hand side of Table 1 lists all 18 of the compression formats established by the ATSC. To the right are SMPTE and EIA/CEA format standards, which are compatible with the ATSC timing profiles given. Also listed are Quantum Data formats, which are based on the standard timings. The end result is that not all compression formats have their own unique video format. The slower frame rates (2, 3, 6, 7, 10, 11, 13, & 14) are usually mapped, via interlaced scanning or repeated frames, to video formats having higher field or frame rates. This is done in order to avoid flicker on CRT displays. The technique is similar to that used in motion picture theatres, where each frame of a 24 frame-per-second film is displayed twice in order to increase the flicker rate to a more acceptable 48 hertz. To summarize, there aren't 18 timing formats – there are less.

Table 1. MAPPING BETWEEN THE 18 ATSC COMPRESSION FORMATS AND COMPONENT VIDEO FORMATS

#	Type	Compression Format	Aspect Ratio	Compression Size Values	Square Pixels	Timing Profile	Frame Rate	Production Aperture	Clean Aperture	Line Rate	Studio Standards	Consumer DTV Standards	Quantum Data Formats‡
18	HDTV	5	16:9	1920 X 1080	YES	7	30p	1920 X 1080	1888 X 1062	33.750	SMPTE 274M 7 & 8	EIA/CEA-861-B #34	**1080p29**, 1080p30
17							24p			27.000	SMPTE 274M 10 & 11 (i similar)	EIA/CEA-861-B #32	**1080i23**, 1080p24
16						6	30i			33.750	SMPTE 274M 4 & 5	EIA/CEA-861-B #05	**1080i29**, 1080i30
15		4		1280 X 720		5	60p	1280 X 720	1248 X 702	45.000	SMPTE 296M 1 & 2	EIA/CEA-861-B #04	**720p59**, 720p60
14							30p			-			
13							24p			-			
12	SDTV	3		704 X 480	NO	4	60p	720 X 483	708† X 480	31.468	SMPTE 293M	EIA/CEA-861-B #03	**480pSH**
11							30p			-			
10							24p			-			
9						3	30i	720 X 486	704 X 480	15.734	ITU-R BT.601-5 or SMPTE 267M	EIA/CEA-861-B #07	**480iSH** or **480iWH**
8		2	4:3			4	60p	720 X 483	708† X 480	31.468	Like SMPTE 293M	EIA/CEA-861-B #02	**480p**
7							30p						
6							24p						
5						3	30i	720 X 486	704 X 480	15.734	ITU-R BT.601-5	EIA/CEA-861-B #06	**480i**
4		1		640 X 480	YES	2	60p	640 X 483	640 X 480	31.468	Like SMPTE 293M	EIA/CEA-861-B #01	**480p#**
3							30p			-			
2							24p			-			
1						1	30i	640 X 486		15.734	Like ITU-R BT.601-5		**480i#**

Based on the ATSC Digital Television Standard (Doc. A/53) Annex A section 5.1.2 Table 3 Compression Format Constraints dated September 16, 1995

‡ The frame rates of the formats in bold print have all been adjusted by a factor of 1/1.001 for NTSC compatibility.

† The value listed in the SMPTE 293M-1996 standard must be reduced by an additional 4-pixels so as to conform to the compression size value given in the annex of the ATSC standard.

QD Name	H res	V res	Pixel	Screen	Content	Method	H rate	V rate	F rate	Color Encoding	Studio Std.	CE Digital TV Std.	CE Analog Std.	Computer Std.	Notes
240p2x	720	240	4:9	4:3	4:3	Natural	15.734	59.886	59.886	ITU-R BT.601-5		EIA/CEA-861-B #08			1
240p2xSH	720	240	4:9	4:3	16:9	Scope	15.734	59.886	59.886	ITU-R BT.601-5		EIA/CEA-861-B #09			1
240p4x	360	240	8:9	4:3	4:3	Natural	15.734	59.886	59.886	ITU-R BT.601-5		EIA/CEA-861-B #12			1,2
240p4xSH	360	240	8:9	4:3	16:9	Scope	15.734	59.886	59.886	ITU-R BT.601-5		EIA/CEA-861-B #13			1,2
288p2x	720	288	8:15	4:3	4:3	Natural	15.625	49.920	49.920	ITU-R BT.601-5		EIA/CEA-861-B #23			3
288p2xSH	720	288	8:15	4:3	16:9	Scope	15.625	49.920	49.920	ITU-R BT.601-5		EIA/CEA-861-B #24			3
288p4x	360	288	16:15	4:3	4:3	Natural	15.625	49.920	49.920	ITU-R BT.601-5		EIA/CEA-861-B #27			3,4
288p4xSH	360	288	16:15	4:3	16:9	Scope	15.625	49.920	49.920	ITU-R BT.601-5		EIA/CEA-861-B #28			3,4
480i	720	480	8:9	4:3	4:3	Natural	15.734	59.940	29.970	ITU-R BT.601-5	ITU-R BT.601-5		EIA-770.2 #4		
480i2x	720	480	8:9	4:3	4:3	Natural	15.734	59.940	29.970	ITU-R BT.601-5		EIA/CEA-861-B #06			
480i4x	720	480	8:9	4:3	4:3	Natural	15.734	59.940	29.970	ITU-R BT.601-5		EIA/CEA-861-B #10			
480i#	640	480	1:1	4:3	4:3	Natural	15.734	59.940	29.970	ITU-R BT.601-5	ATSC #1			common practice	
480i#KA	512	384	1:1	4:3	4:3	Safe Title	15.734	59.940	29.970	ITU-R BT.601-5	ATSC #1 w/SMPTE RP 27.3-1989 safe title			common practice	
480iLH	720	360	8:9	4:3	16:9	Letterbox	15.734	59.940	29.970	ITU-R BT.601-5			see naming standard		
480iSH	720	480	8:9	4:3	16:9	Scope	15.734	59.940	29.970	ITU-R BT.601-5			see naming standard		
480iWH	960	480	2:3	4:3	16:9	Widescreen	15.734	59.940	29.970	ITU-R BT.601-5	SMPTE 267M-1995				
480i2xLH	720	360	8:9	4:3	16:9	Letterbox	15.734	59.940	29.970	ITU-R BT.601-5					
480i2xSH	720	480	8:9	4:3	16:9	Scope	15.734	59.940	29.970	ITU-R BT.601-5		EIA/CEA-861-B #07			
480i4xSH	720	480	8:9	4:3	16:9	Scope	15.734	59.940	29.970	ITU-R BT.601-5		EIA/CEA-861-B #11			
480p	720	480	8:9	4:3	4:3	Natural	31.469	59.940	59.940	ITU-R BT.601-5		EIA/CEA-861-B #02	EIA-770.2 #8		
480p2x	720	480	8:9	4:3	4:3	Natural	31.469	59.940	59.940	ITU-R BT.601-5		EIA/CEA-861-B #14			
480p#	640	480	1:1	4:3	4:3	Natural	31.469	59.940	59.940	ITU-R BT.601-5	ATSC #4			common practice	
480p#KA	512	384	1:1	4:3	4:3	Safe Title	31.469	59.940	59.940	ITU-R BT.601-5	ATSC #4 w/SMPTE RP 27.3-1989 safe title			common practice	
CEA0659	640	480	1:1	4:3	4:3	Natural	31.469	59.940	59.940	ITU-R BT.601-5		EIA/CEA-861-B #01		VESA MTS ver 1.0 rev 0.8	
480pLH	720	360	8:9	4:3	16:9	Letterbox	31.469	59.940	59.940	ITU-R BT.601-5					
480pSH	720	480	8:9	4:3	16:9	Scope	31.469	59.940	59.940	ITU-R BT.601-5		EIA/CEA-861-B #03			
480p2xSH	720	480	8:9	4:3	16:9	Scope	31.469	59.940	59.940	ITU-R BT.601-5		EIA/CEA-861-B #15			
480pWH	960	480	2:3	4:3	16:9	Widescreen	31.469	59.940	59.940	ITU-R BT.601-5	see naming standard				
576i	720	576	16:15	4:3	4:3	Natural	15.625	50.000	25.000	ITU-R BT.601-5	ITU-R BT.601-5				
576i2x	720	576	16:15	4:3	4:3	Natural	15.625	50.000	25.000	ITU-R BT.601-5		EIA/CEA-861-B #21			
576i4x	720	576	16:15	4:3	4:3	Natural	15.625	50.000	25.000	ITU-R BT.601-5		EIA/CEA-861-B #25			
576i#	768	576	1:1	4:3	4:3	Natural	15.625	50.000	25.000	ITU-R BT.601-5				common practice	
576i#KA	640	480	1:1	4:3	4:3	Safe Title	15.625	50.000	25.000	ITU-R BT.601-5	w/SMPTE RP 27.3-1989 safe title			common practice	
576iLH	720	432	16:15	4:3	16:9	Letterbox	15.625	50.000	25.000	ITU-R BT.601-5			see naming standard		
576iSH	720	576	16:15	4:3	16:9	Scope	15.625	50.000	25.000	ITU-R BT.601-5			see naming standard		
576iWH	960	576	4:5	4:3	16:9	Widescreen	15.625	50.000	25.000	ITU-R BT.601-5	ITU-R BT.601-5 Part B Annex 1				
576i2xLH	720	432	16:15	4:3	16:9	Letterbox	15.625	50.000	25.000	ITU-R BT.601-5					
576i2xSH	720	576	16:15	4:3	16:9	Scope	15.625	50.000	25.000	ITU-R BT.601-5		EIA/CEA-861-B #22			
576i4xSH	720	576	16:15	4:3	16:9	Scope	15.625	50.000	25.000	ITU-R BT.601-5		EIA/CEA-861-B #26			
576p	720	576	16:15	4:3	4:3	Natural	31.250	50.000	50.000	ITU-R BT.601-5	ITU-R BT.1358	EIA/CEA-861-B #17			
576p2x	720	576	16:15	4:3	4:3	Natural	31.250	50.000	50.000	ITU-R BT.601-5		EIA/CEA-861-B #29			
576p#	768	576	1:1	4:3	4:3	Natural	31.250	50.000	50.000	ITU-R BT.601-5				common practice	
576pLH	720	432	16:15	4:3	16:9	Letterbox	31.250	50.000	50.000	ITU-R BT.601-5					
576pSH	720	576	16:15	4:3	16:9	Scope	31.250	50.000	50.000	ITU-R BT.601-5		EIA/CEA-861-B #18			
576p2xSH	720	576	16:15	4:3	16:9	Scope	31.250	50.000	50.000	ITU-R BT.601-5		EIA/CEA-861-B #30			
576pWH	960	576	4:5	4:3	16:9	Widescreen	31.250	50.000	50.000	ITU-R BT.601-5	see naming standard				
720p50	1280	720	1:1	16:9	16:9	Natural	37.500	50.000	50.000	ITU-R BT.709-3 1125-line		EIA/CEA-861-B #19			
720p59	1280	720	1:1	16:9	16:9	Natural	44.955	59.940	59.940	ITU-R BT.709-3 1125-line	SMPTE 296M-1997 #2	EIA/CEA-861-B #04	EIA-770.3 #2		5
720p60	1280	720	1:1	16:9	16:9	Natural	45.000	60.000	60.000	ITU-R BT.709-3 1125-line	SMPTE 296M-1997 #1		EIA-770.3 #1		5
1035i29	1920	1035	509:531	16:9	16:9	Natural	33.716	59.940	29.970	ITU-R BT.709-3 1125-line	SMPTE 240M-1995 60/1.001 Hz				5
1035i30	1920	1035	509:531	16:9	16:9	Natural	33.750	60.000	30.000	ITU-R BT.709-3 1125-line	SMPTE 240M-1995 60 Hz				5
1080s23	1920	1080	1:1	16:9	16:9	Natural	26.973	47.952	23.976	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #11 segmented frame				5
1080s24	1920	1080	1:1	16:9	16:9	Natural	27.000	48.000	24.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #10 segmented frame				5
1080i25	1920	1080	1:1	16:9	16:9	Natural	28.125	50.000	25.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #6	EIA/CEA-861-B #20			
108Oi25	1920	1080	1:1	16:9	16:9	Natural	31.250	50.000	25.000	ITU-R BT.709-3 1125-line	SMPTE 295M-1997 #2				
1080i29	1920	1080	1:1	16:9	16:9	Natural	33.716	59.940	29.970	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #5	EIA/CEA-861-B #05	EIA-770.3 #4		5
1080i30	1920	1080	1:1	16:9	16:9	Natural	33.750	60.000	30.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #4		EIA-770.3 #3		5
1080p23	1920	1080	1:1	16:9	16:9	Natural	26.973	23.976	23.976	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #11	EIA/CEA-861-B #32			5
1080p24	1920	1080	1:1	16:9	16:9	Natural	27.000	24.000	24.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #10				5
1080p25	1920	1080	1:1	16:9	16:9	Natural	28.125	25.000	25.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #9	EIA/CEA-861-B #33			
1080p29	1920	1080	1:1	16:9	16:9	Natural	33.716	29.970	29.970	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #8	EIA/CEA-861-B #34			5
1080p30	1920	1080	1:1	16:9	16:9	Natural	33.750	30.000	30.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #7				5
108Op50	1920	1080	1:1	16:9	16:9	Natural	62.500	50.000	50.000	ITU-R BT.709-3 1125-line	SMPTE 295M-1997 #1				
1080p50	1920	1080	1:1	16:9	16:9	Natural	56.250	50.000	50.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #3	EIA/CEA-861-B #31			
1080p59	1920	1080	1:1	16:9	16:9	Natural	67.433	59.940	59.940	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #2	EIA/CEA-861-B #16			5
1080p60	1920	1080	1:1	16:9	16:9	Natural	67.500	60.000	60.000	ITU-R BT.709-3 1125-line	SMPTE 274M-1998 #1				5

Notes:

1. The progressive 240p formats can have either 242 or 243 total vertical lines, but only the 243-line format is listed here.
2. The progressive 240p format family can have a variable amount of horizontal resolution, but only the 360-pel case is listed here.
3. The progressive 288p formats can have either 312 or 313 total vertical lines, but only the 313-line format is listed here.
4. The progressive 288p format family can have a variable amount of horizontal resolution, but only the 360-pel case is listed here.
5. This format is detuned (lowered) by a factor of 1/1.001 for NTSC interoperability. This is optional. When not detuned, the frame rate in the format name is incremented by one and an integer frame rate is used instead (e.g. 59.94 is raised to exactly 60 Hz).

Ref#(s)	861B#	Standard Long Name	Old Library 861B Name	New Library 861B Short Name	HRES	VRES	HTOT	VTOT	FRAT	PRAT(nom)	PXAR	FITM	CXAR	NCPP	NPPP	TUNE
1.1	1	DMT0659	DMT0660	DMT0659	640	480	800	525	59.9401	25174825.17	1:1	N	A	1	1	1
1.2	1	DMT0660		DMT0660	640	480	800	525	60	25200000	1:1	N	A	1	1	0
2.1	2	480p59	480p	480p59	720	480	858	525	59.9401	27000000	8:9	N	A	1	1	1
2.2	2	480p60		480p60	720	480	858	525	60	27027000	8:9	N	A	1	1	0
3.1	3	480p59SH	480pSH	480p59SH	720	480	858	525	59.9401	27000000	8:9	S	H	1	1	1
3.2	3	480p60SH		480p60SH	720	480	858	525	60	27027000	8:9	S	H	1	1	0
4.1	4	720p59	720p59	720p59	1280	720	1650	750	59.9401	74175824.18	1:1	N	H	1	1	1
4.2	4	720p60	720p60	720p60	1280	720	1650	750	60	74250000	1:1	N	H	1	1	0
5.1	5	1080i29	1080i29	1080i29	1920	1080	2200	1125	29.97	74175824.18	1:1	N	H	1	1	1
5.2	5	1080i30	1080i30	1080i30	1920	1080	2200	1125	30	74250000	1:1	N	H	1	1	0
6.1	6	480i2x29		480i2x29	720	480	1716	525	29.97	27000000	8:9	N	A	2	1	1
6.2	6	480i2x30		480i2x30	720	480	1716	525	30	27027000	8:9	N	A	2	1	0
7.1	7	480i2x29SH		480i2xS1	720	480	1716	525	29.97	27000000	8:9	S	H	2	1	1
7.2	7	480i2x30SH		480i2xS2	720	480	1716	525	30	27027000	8:9	S	H	2	1	0
8.1	8	240p2x59_1		240p2x_1	720	240	1716	262	59.9401	26948571.43	8:18	N	A	2	1	1
8.2	8	240p2x60_1		240p2x_2	720	240	1716	262	60	26975520	8:18	N	A	2	1	0
8.3	8	240p2x59_2		240p2x_3	720	240	1716	263	59.9401	27051428.57	8:18	N	A	2	1	1
8.4	8	240p2x60_2		240p2x_4	720	240	1716	263	60	27078480	8:18	N	A	2	1	0
9.1	9	240p2x59SH_1		240p2xS1	720	240	1716	262	59.9401	26948571.43	8:18	S	H	2	1	1
9.2	9	240p2x60SH_1		240p2xS2	720	240	1716	262	60	26975520	8:18	S	H	2	1	0
9.3	9	240p2x59SH_2		240p2xS3	720	240	1716	263	59.9401	27051428.57	8:18	S	H	2	1	1
9.4	9	240p2x60SH_2		240p2xS4	720	240	1716	263	60	27078480	8:18	S	H	2	1	0
10.1.01->10.1	10	480i4x29_XX		480i4x29	2880	480	3432	525	29.97	54000000	2:9	L	(2*XX):9	1	XX	1
10.2.01->10.2	10	480i4x30_XX		480i4x30	2880	480	3432	525	30	54054000	2:9	L	(2*XX):9	1	XX	0
11.1.01->11.1	11	480i4x29SH_XX		480i4xS1	2880	480	3432	525	29.97	54000000	2:9	SHL	(2*XX):9	1	XX	1
11.2.01->11.2	11	480i4x30SH_XX		480i4xS2	2880	480	3432	525	30	54054000	2:9	SHL	(2*XX):9	1	XX	0
12.1.01->12.1	12	240p4x59_1XX		240p4x_1	2880	240	3432	262	59.9401	53897142.86	2:18	L	(2*XX):18	1	XX	1
12.2.01->12.2	12	240p4x60_1XX		240p4x_2	2880	240	3432	262	60	53951040	2:18	L	(2*XX):18	1	XX	0
12.3.01->12.3	12	240p4x59_2XX		240p4x_3	2880	240	3432	263	59.9401	54102857.14	2:18	L	(2*XX):18	1	XX	1
12.4.01->12.4	12	240p4x60_2XX		240p4x_4	2880	240	3432	263	60	54156960	2:18	L	(2*XX):18	1	XX	0
13.1.01->13.1	13	240p4x59SH_1XX		240p4xS1	2880	240	3432	262	59.9401	53897142.86	2:18	SHL	(2*XX):18	1	XX	1
13.2.01->13.2	13	240p4x60SH_1XX		240p4xS2	2880	240	3432	262	60	53951040	2:18	SHL	(2*XX):18	1	XX	0
13.3.01->13.3	13	240p4x59SH_2XX		240p4xS3	2880	240	3432	263	59.9401	54102857.14	2:18	SHL	(2*XX):18	1	XX	1
13.4.01->13.4	13	240p4x60SH_2XX		240p4xS4	2880	240	3432	263	60	54156960	2:18	SHL	(2*XX):18	1	XX	0
14.1	14	480p2x59		480p2x59	720	240	1716	525	59.9401	54000000	8:18	N	A	2	1	1
14.2	14	480p2x60		480p2x60	720	240	1716	525	60	54054000	8:18	N	A	2	1	0
15.1	15	480p2x59SH		480p2xS1	720	240	1716	525	59.9401	54000000	8:18	S	H	2	1	1
15.2	15	480p2x60SH		480p2xS2	720	240	1716	525	60	54054000	8:18	S	H	2	1	0
16.1	16	1080p59	1080p59	1080p59	1920	1080	2200	1125	59.9401	148351648.4	1:1	N	H	1	1	1
16.2	16	1080p60	1080p60	1080p60	1920	1080	2200	1125	60	148500000	1:1	N	H	1	1	0
17	17	576p50	576p50	576p50	720	576	864	625	50	27000000	16:15	N	A	1	1	0
18	18	576p50SH	576p50SH	576p50SH	720	576	864	625	50	27000000	16:15	S	H	1	1	0
19	19	720p50	720p50	720p50	1280	720	1980	750	50	74250000	1:1	N	H	1	1	0
20	20	1080i25	1080i25	1080i25	1920	1080	2640	1125	25	74250000	1:1	N	H	1	1	0
21	21	576i2x25		576i2x25	720	576	1728	625	25	27000000	16:15	N	A	2	1	0
22	22	576i2x25SH		576i2xSH	720	576	1728	625	25	27000000	16:15	S	H	2	1	0
23.1	23	288p2x25_1		288p2x_1	720	288	1728	312	50	26956800	16:30	N	A	2	1	0
23.2	23	288p2x25_2		288p2x_2	720	288	1728	313	50	27043200	16:30	N	A	2	1	0
23.3	23	288p2x25_3		288p2x_3	720	288	1728	314	50	27129600	16:30	N	A	2	1	0
24.1	24	288p2x25SH_1		288p2xS1	720	288	1728	312	50	26956800	16:30	S	H	2	1	0
24.2	24	288p2x25SH_2		288p2xS2	720	288	1728	313	50	27043200	16:30	S	H	2	1	0
24.3	24	288p2x25SH_3		288p2xS3	720	288	1728	314	50	27129600	16:30	S	H	2	1	0
25.01->25.10	25	576i4x25_XX		576i4x25	2880	576	3456	625	25	54000000	4:15	L	(4*XX):15	1	XX	0
26.01->26.10	26	576i4x25SH_XX		576i4xSH	2880	576	3456	625	25	54000000	4:15	SHL	(4*XX):15	1	XX	0
27.1.01->27.1	27	288p4x50_1XX		288p4x_1	2880	288	3456	312	50	53913600	4:30	L	(4*XX):30	1	XX	0
27.2.01->27.2	27	288p4x50_2XX		288p4x_2	2880	288	3456	313	50	54086400	4:30	L	(4*XX):30	1	XX	0
27.3.01->27.3	27	288p4x50_3XX		288p4x_3	2880	288	3456	314	50	54259200	4:30	L	(4*XX):30	1	XX	0
28.1.01->28.1	28	288p4x50SH_1XX		288p4xS1	2880	288	3456	312	50	53913600	4:30	SHL	(4*XX):30	1	XX	0
28.2.01->28.2	28	288p4x50SH_2XX		288p4xS2	2880	288	3456	313	50	54086400	4:30	SHL	(4*XX):30	1	XX	0
28.3.01->28.3	28	288p4x50SH_3XX		288p4xS3	2880	288	3456	314	50	54259200	4:30	SHL	(4*XX):30	1	XX	0
29	29	576p2x50		576p2x50	720	576	1728	625	50	54000000	16:15	N	A	2	1	0
30	30	576p2x50SH		576p2xSH	720	576	1728	625	50	54000000	16:15	S	H	2	1	0
31	31	1080p50	1080p50	1080p50	1920	1080	2640	1125	50	148500000	1:1	N	H	1	1	0
32.1	32	1080p23	1080p23	1080p23	1920	1080	2750	1125	23.976	74175824.18	1:1	N	H	1	1	1
32.2	32	1080p24	1080p24	1080p24	1920	1080	2750	1125	24	74250000	1:1	N	H	1	1	0
33	33	1080p25	1080p25	1080p25	1920	1080	2640	1125	25	74250000	1:1	N	H	1	1	0
34.1	34	1080p29	1080p29	1080p29	1920	1080	2200	1125	29.97	74175824.18	1:1	N	H	1	1	0
34.2	34	1080p30	1080p30	1080p30	1920	1080	2200	1125	30	74250000	1:1	N	H	1	1	1

		Where pixel repetition factor varies XX = 01 to 10							248	Total Formats			68	Timings		

#	Name	HRES	VRES	Aperture	PRAT	HRAT	FRAT	HSPP	VSPP	Type	OrgVESAdoc	LateVESAdoc	OrgDate	OldName
1	SMT0660D	640	400	1.6	25.175	31.469	59.940	0	0	VESAstd		SMT640_720x480V1.pdf	23-Jun-00	DDT6460
2	SMT0660	640	480	1.3333333	25.175	31.469	59.940	0	0	VESAstd		SMT640_720x480V1.pdf	23-Jun-00	
3	DMT0685F	640	350	1.8285714	31.500	37.861	85.080	1	0	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT068A
4	DMT0685D	640	400	1.6	31.500	37.861	85.080	0	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT068B
5	DMT0660	640	480	1.3333333	25.175	31.469	59.940	0	0	IBMstd		DMTv1r08.pdf	22-Sep-88	VGA_m3
6	DMT0672	640	480	1.3333333	31.500	37.861	72.809	0	0	VESAstd	VS901101	DMTv1r08.pdf	02-Dec-92	VS901101
7	DMT0675	640	480	1.3333333	31.500	37.500	75.000	0	0	VESAstd	VDMT75HZ	DMTv1r08.pdf	04-Oct-93	DMT6475
8	DMT0685	640	480	1.3333333	36.000	43.269	85.008	0	0	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT6485
9	SMT0760H	720	400	1.8	28.322	31.469	59.941	0	0	VESAstd		SMT640_720x480V1.pdf	23-Jun-00	
10	SMT0760V	720	480	1.5	28.322	31.469	59.941	0	0	VESAstd		SMT640_720x480V1.pdf	23-Jun-00	DDT7260
11	DMT0785H	720	400	1.8	35.500	37.927	85.039	0	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT7285
12	DMT0856	800	600	1.3333333	36.000	35.156	56.250	1	1	VESAprop	VG900601	DMTv1r08.pdf	06-Aug-90	VG900601
13	DMT0860	800	600	1.3333333	40.000	37.879	60.317	1	1	VESAprop	VG900602	DMTv1r08.pdf	06-Aug-90	VG900602
14	DMT0872	800	600	1.3333333	50.000	48.077	72.188	1	1	VESAstd	VS900603A	DMTv1r08.pdf	06-Aug-90	VS900603
15	DMT0875	800	600	1.3333333	49.500	46.875	75.000	1	1	VESAstd	VDMT75HZ	DMTv1r08.pdf	04-Oct-93	DMT8075
16	DMT0885	800	600	1.3333333	56.250	53.674	85.061	1	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT8085
17	DMT1043	1024	768	1.3333333	44.900	35.522	i43.479	1	1	IBMstd		DMTv1r08.pdf	22-Sep-88	VGA_m4
18	DMT1060	1024	768	1.3333333	65.000	48.363	60.004	0	0	VESAprop	VG901101A	DMTv1r08.pdf	10-Sep-91	VG901101
19	DMT1070	1024	768	1.3333333	75.000	56.476	70.069	0	0	VESAstd	VS910801-2	DMTv1r08.pdf	09-Aug-91	VS910801
20	DMT1075	1024	768	1.3333333	78.750	60.023	75.029	1	1	VESAstd	VDMT75HZ	DMTv1r08.pdf	04-Oct-93	
21	DMT1085	1024	768	1.3333333	94.500	68.677	84.997	1	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	
22	DMT1170	1152	864	1.3333333	94.200	63.995	70.016	1	1	VESAprop	VDMTREV	DMTv1r06.pdf	01-Oct-95	
23	DMT1175	1152	864	1.3333333	108.000	67.500	75.000	1	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	
24	DMT1185	1152	864	1.3333333	121.500	77.487	85.057	1	1	VESAprop	VDMT85HZ	DMTv1r06.pdf	01-Oct-95	
25	DMT1260A	1280	960	1.3333333	108.000	60.000	60.000	1	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT126A
26	DMT1275A	1280	960	1.3333333	129.600	75.000	75.000	1	1	VESAprop	VDMTREV	DMTv1r06.pdf	01-Oct-95	DMT127A
27	DMT1285A	1280	960	1.3333333	148.500	85.938	85.002	1	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT128A
28	DMT1243G	1280	1024	1.25	78.750	43.633	i43.436	1	1					DMT1243
29	DMT1260G	1280	1024	1.25	108.000	63.981	60.020	1	1	VESAstd	VDMTREV	DMTv1r08.pdf	18-Dec-96	DMT1260
30	DMT1275G	1280	1024	1.25	135.000	79.976	75.025	1	1	VESAstd	VDMT75HZ	DMTv1r08.pdf	04-Oct-93	DMT1275
31	DMT1285G	1280	1024	1.25	157.500	91.146	85.024	1	1	VESAstd	VDMTPROP	DMTv1r08.pdf	01-Mar-96	DMT1285
32	DMT1648	1600	1200	1.3333333	135.000	62.500	i48.040	1	1					
33	DMT1660	1600	1200	1.3333333	162.000	75.000	60.000	1	1	VESAstd	VDMTREV	DMTv1r08.pdf	18-Dec-96	
34	DMT1665	1600	1200	1.3333333	175.500	81.250	65.000	1	1	VESAstd	VDMTREV	DMTv1r08.pdf	18-Dec-96	
35	DMT1670	1600	1200	1.3333333	189.000	87.500	70.000	1	1	VESAstd	VDMTREV	DMTv1r08.pdf	18-Dec-96	
36	DMT1675	1600	1200	1.3333333	202.500	93.750	75.000	1	1	VESAstd	VDMTREV	DMTv1r08.pdf	18-Dec-96	
37	DMT1680	1600	1200	1.3333333	216.000	100.000	80.000	1	1					
38	DMT1685	1600	1200	1.3333333	229.500	106.250	85.000	1	1	VESAstd	VDMTREV	DMTv1r08.pdf	18-Dec-96	
39	DMT1760	1792	1344	1.3333333	204.750	83.640	60.000	0	1	VESAstd	VDMTREV	DMTv1r08.pdf	17-Sep-98	
40	DMT1775	1792	1344	1.3333333	261.000	106.270	74.997	0	1	VESAstd	VDMTREV	DMTv1r08.pdf	17-Sep-98	
41	DMT1860	1856	1392	1.3333333	218.250	86.333	59.995	0	1	VESAstd	VDMTREV	DMTv1r08.pdf	17-Sep-98	
42	DMT1875	1856	1392	1.3333333	288.000	112.500	75.000	0	1	VESAstd	VDMTREV	DMTv1r08.pdf	17-Sep-98	
43	DMT1960	1920	1440	1.3333333	234.000	90.000	60.000	0	1	VESAstd	VDMTREV	DMTv1r08.pdf	17-Sep-98	
44	DMT1975	1920	1440	1.3333333	297.000	112.500	75.000	0	1	VESAstd	VDMTREV	DMTv1r08.pdf	17-Sep-98	
45	DMT2060	2048	1536	1.3333333	239.933	95.820	60.000	**0**	**1**	VESAprop			21-Aug-98	GTF2060
46	DMT2075	2048	1536	1.3333333	319.915	120.450	75.000	**0**	**1**	VESAprop			21-Aug-98	GTF2075

The new 802B TV output circuit improves composite video performance significantly. The new revision has significantly better multiburst flatness and pulse response. The chroma/luminance linearity is also greatly improved. We adjusted the square-pixel formats, in the format library of the new units, so that the DSS output timing stays relatively constant as one switches between square to non-square pixel formats (i.e. DSS output pulse timing, as measured in microseconds, remains close to ITU-R BT.601 as one switches between square and non-square pixels).

That new version of the 802B provides support for the following composite video formats:

NTSC#KA	Square pixel NTSC with SMPTE RP 27.3-1989 80% safe title area shrink
NTSC#	Square pixel NTSC
NTSC	NTSC (ITU-R BT.601 525-line, 0.714V video, 0.286V sync, 7.5 IRE setup)
NTSC-LH	NTSC with 16x9 Letterbox (same as NTSC except Letterbox)
NTSC-SH	NTSC with 16x9 Anamorphic (same as NTSC except Anamorphic)
NTSC-J	Japanese NTSC (same as NTSC except without 7.5 IRE setup)
NTSC-JLH	Japanese NTSC with 16x9 Letterbox (same as NTSC-J except Letterbox)
NTSC-JSH	Japanese NTSC with 16x9 Anamorphic (same as NTSC-J except Anamorphic)
NTSC44	NTSC with PAL subcarrier (0.714V video, 0.286V sync, 7.5 IRE setup)
PAL-60	NTSC with PAL subcarrier & levels (0.700V video, 0.300V sync, no setup)
PAL#KA	Square pixel PAL with 83% safe title area shrink
PAL#	Square pixel PAL
PAL	PAL (ITU-R BT.601 625-line, 0.700V video, 0.300V sync, no setup)
PAL-N	PAL with modified subcarrier used in Argentina, Paraguay and Uruguay

The new 802B videoboard does not support PAL-M, which is only used in Brazil. PAL-M is unlike other PAL modulation standards in that it uses a 3.57561100MHz subcarrier and has characteristics that are approximately the same as NTSC (525-line timing, 0.714V video, 0.286V sync, 7.5 IRE setup).

You can tell if an 802B has this new capability using one of three methods:

1. Render the "GenStats" image and, under the "Options" heading, look for the postscript "(AD)" after the letters "TV". The postscript "(AD)" indicates that the unit has the new and improved composite video capabilities.

2. Power-on the unit and view the messages that appear on the LCD as the unit powers-up. You can hold down and release keys, after the power is turned on, in order to slow down the rapid succession of displays - so that you can read them. One of these displays shows the letters "Main:" and "Video:". The number after the letters "Video:"

indicate the revision-level of video board that is in the unit. The videoboard revisions greater (or equal to) 71 have the improvements discussed in this note.

3. All 802Bs manufactured after serial number 02090001 have the improved videoboard in them. Some early beta units may exist with serial numbers below this value.

The following table lists the composite digital and analog sync types currently available on modern and upgraded Quantum Data products.

Table 1 Available Composite Sync Types

TYPE CODE	Description	TYPE STATUS	ASCT	DSCT	SSST=5
0	Composite sync not allowed	implemented	OK	OK	ERROR
1	SMPTE 274M(p)/296M - VESA	future	ERROR	ERROR	ERROR
2	Type M - minus serration & eq	implemented	OK	OK	OK
3	Type M - minus eq	implemented	OK	OK	OK
4	Type M (North American)	implemented	OK	OK	OK
5	Australian AS 4933.1-200X draft	implemented	OK	OK	ERROR
6	Type N - minus serration & eq	implemented	OK	OK	OK
7	Type N - minus eq	future	ERROR	ERROR	ERROR
8	Type N (European)	implemented	OK	OK	OK
9	SMPTE 274M(p)/296M - EIA/CEA	implemented	OK	ERROR	ERROR
10	SMPTE 274M(p)/296M - QDI	implemented	OK	ERROR	OK
11	SMPTE 295M - EIA/CEA	implemented	OK	ERROR	ERROR
12	SMPTE 295M - QDI	implemented	OK	ERROR	OK
13	SMPTE 274M(i) - VESA	future	ERROR	ERROR	ERROR
14	SMPTE 274M(i) - EIA/CEA	implemented	OK	ERROR	ERROR
15	SMPTE 274M(i) - QDI	implemented	OK	ERROR	OK

Unfortunately, when the EIA/CEA recently defined the relationship between digital horizontal sync and analog composite sync (in EIA/CEA-861-B), they did so using a mapping that is incompatible with the way we defined it back in 1992 (before there were any HDTV standards with digital TTL sync). Our digital horizontal sync pulse began with the leading edge of the negative alternation of the tri-level analog sync pulse and ended with the trailing edge of the positive alternation of the tri-level pulse. The new EIA/CEA standard, on the other hand, maps the leading and trailing edges of digital horizontal sync to the leading and trailing edges of the positive alternation of the analog tri-level sync pulse. Because of this, our standard sync pulse delay was too short by one horizontal sync pulse width and our horizontal sync pulse width twice as wide as it should be, relative to EIA/CEA-861-B.

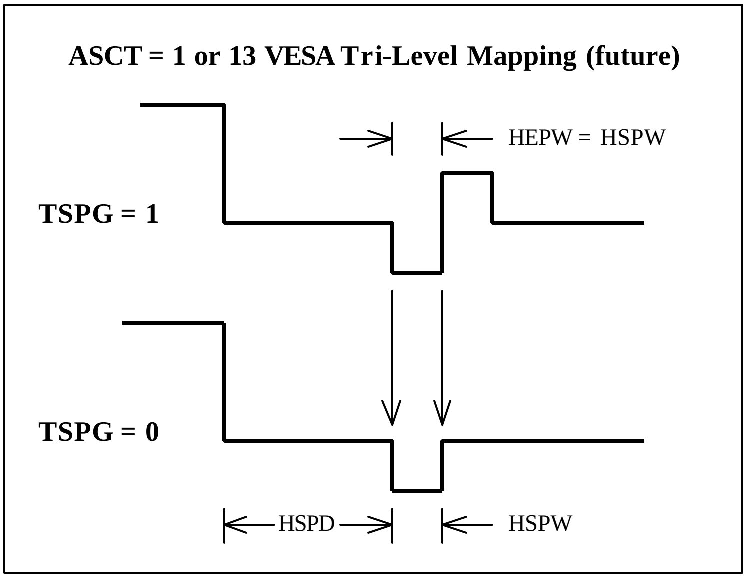
The solution to this problem was to revise the CS type list as shown above - adding new HDTV tri-level sync types (9, 11 and 14) so as to allow one to specify any one of the three possible mappings. The existing QDI types continue to be supported without change. New EIA/CEA types align the leading and trailing edges of the positive alternation of the tri-level pulse with those of horizontal sync. Future VESA types may align the leading and trailing edges of the negative alternation of the tri-level pulse with those of horizontal sync.

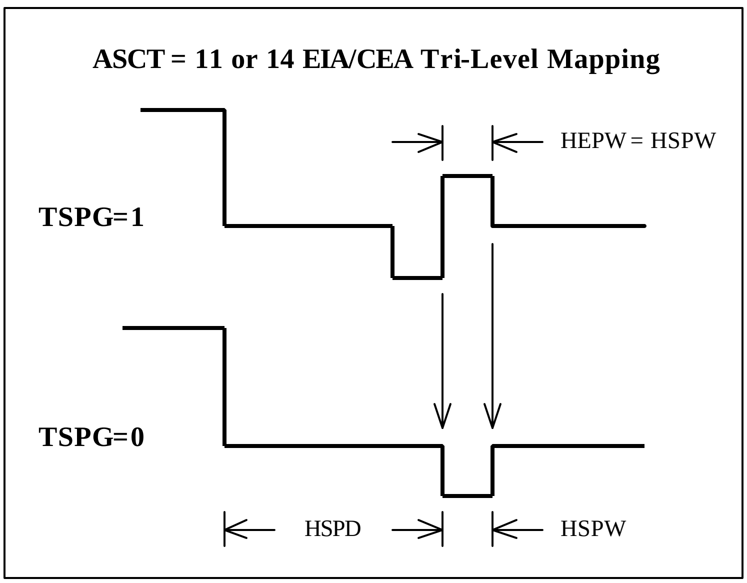
All the HDTV formats were updated in terms of their HSPD and HSPW, accordingly. All HDTV formats in our library now follow EIA/CEA-861-B guidelines.

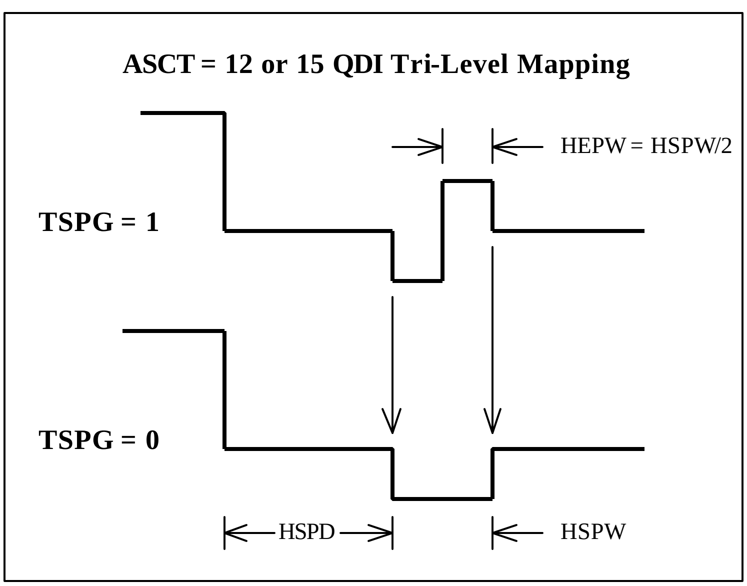
Recently, a new type of composite sync (type 5) has been introduced by Standards Australia. The sync is described in draft document AS 4933.1-200X and is very similar to SMPTE 295M sync (types 11 and 12).

How TSPG works...

The parameter only affects tri-level analog composite sync types (ASCT = 1, 11, 12, 13, 14, & 15).
FMTN initializes TSPG = 1.
The exact function of TSPG depends on the analog sync composite type (ASCT) that is selected (see Figure 1).







M. Stockfisch
Version 1.0
06/26/2003

Introducing the "Australian" Timings

The timings, currently being used to drive high-definition televisions, are largely based on industry standard professional broadcast studio formats (such as ITU-R BT.601-5, ITU-R BT.709-5, ITU-R BT.1358-98, SMPTE 274M-1998, SMPTE 295M-1997, and SMPTE 296M-2001). When used to drive 50Hz consumer CRT-based displays, these timings require four different line rates and three different blanking ratios to be accepted (as summarized in Table 1).

Table 1 Modern "Professional" Display Timings

Format Name(s)	Active Pixels	Active Lines	Total Pixels	Total Lines	Line Blank (%)	Fields	Frame Rate (Hz)	Line Rate (KHz)	Pixel Rate (MHz)
576i	720	576	864	625	20	2	25	15.625	13.500
576p50	720	576	864	625	20	1	50	31.250	27.000
720p50	1280	720	1650	750	28.91	1	50	37.500	74.250
1080i25, 1080s25	1920	1080	2640	1125	37.50	2	25	28.125	74.250

CRT-based displays typically have difficulty making glitchless transitions and maintaining centering when presented with varying line rates and blanking ratios.

Recently, Standards Australia has floated a draft revision (AS 4933.1—200X version 5-A dated November 2002) of a standard (first published as AS 4933.1—2000), which includes a new set of formats that reduce the number of line rate & blanking ratio combinations to one. In this new scheme, a set-top-box (STB) receives and decompresses incoming "professionally" timed content and scan converts it to one of two alternate frame timings; namely, 625-lines @ 50 frames/sec or 1250-lines @ 25 frames/sec. Both of these output frame timings share a common line rate and blanking ratio. With line rate and blanking ratio now fixed, glitches and centering problems are completely eliminated. Figures 1 & 2 illustrate the various scan conversions that are involved.

Library Formats

Our new format library now includes all of the timings that you will need to test your displays for compatibility with the proposed timings, which are listed in Table 2.

Table 2 Original "Legacy" Australian Timings

Format Name(s)	Content Pixels	Content Lines	Active Pixels	Active Lines	Total Pixels	Total Lines	Line Blank (%)	Fields	Frame Rate (Hz)	Line Rate (KHz)	Pixel Rate (MHz)
576i50WL	720	576	720	576	1152	625	20	2	50	31.250	36.000
576i50WH	960	576	960	576	1152	625	20	2	50	31.250	36.000
576pWL	720	576	720	576	1152	625	20	1	50	31.250	36.000
576pWH	960	576	960	576	1152	625	20	1	50	31.250	36.000
1152iLA	720	576	720	1152	1152	1250	20	2	25	31.250	36.000
1152iSH	1280	720	1280	1152	1536	1250	20	2	25	31.250	48.000
1152iLH	1920	1080	1920	1080	2304	1250	20	2	25	31.250	72.000

Our new library also includes an alternate set of non-proprietary Australian-compatible timings (see Table 3), whose line parameters have been "SMPTE-tuned". The formats in this set have been adjusted slightly, from the original draft timings of AS 4933.1-200X, so as to follow the latest ITU_R BT.709-5 recommendations regarding pixel rate.

Table 3 Modern "SMPTE-tuned" Australian Timings

Format Name(s)	Content Pixels	Content Lines	Active Pixels	Active Lines	Total Pixels	Total Lines	Line Blank (%)	Fields	Frame Rate (Hz)	Line Rate (KHz)	Pixel Rate (MHz)
576i50_L	720	576	720	576	1188	625	23.75	2	50	31.250	37.125
576i50_H	960	576	960	576	1188	625	23.75	2	50	31.250	37.125
576pWL_	720	576	720	576	1188	625	23.75	1	50	31.250	37.125
576pWH_	960	576	960	576	1188	625	23.75	1	50	31.250	37.125
1152iLA_	720	576	720	1152	1188	1250	23.75	2	25	31.250	37.125
1152iSH_	1280	720	1280	1152	1584	1250	23.75	2	25	31.250	49.500
1152iLH_	1920	1080	1920	1080	2376	1250	23.75	2	25	31.250	74.250

Modern television signals (i.e. those described in Part 2 of ITU-RBT.709-5) are harmonically related to 148.5MHz, whereas legacy signals (i.e. those described in Part 1 of ITU-R BT.709-5) are not - they are instead tuned to 144MHz. 148.5MHz and 144MHz are harmonics of 4.752GHz, which is out of the range of ordinary digital logic. Therefore, both sets of pixel frequencies cannot be easily derived from a common fixed clock source, without resorting to PLL technology. ITU-R BT.709-5 recommends, "…for new HDTV programme production and international exchange, systems described in Part 2 are preferred". In other words, formats based on 148.5MHz are now preferred. The timings in the alternate Australian set, provided in our new library, are all harmonically tuned to 148.5MHz in keeping with Part 2 of ITU_R BT.709-5. In order to allow formats from the modern and legacy sets to be distinguished, the names of the modern "SMPTE-tuned" timings have underlines in them. Figures 3 & 4 show the equivalent "SMPTE-tuned" mappings that might be provided by a STB.

STB Received Format Versus CRT Display Interconnect Format

To summarize, formats received (over the air) by a STB can be mapped to alternate CRT interconnect formats in order to keep horizontal timing glitch-free and centered. Table 4 lists some important cases. This table assumes that the physical screen of the display has a 16:9 aspect ratio.

Table 4 STB Received Formats Versus CRT Interconnect Formats

STB Received Format Name(s)	STB Scan Conversion	CRT Interconnect Legacy Signal Format		CRT Interconnect Modern "SMPTE-tuned" Signal Format	
		Long Name	Short Name	Long Name	Short Name
576i	Double Field Rate & Letterbox	576i50WHLA	576i50WL	576i50WHLA_	576i50_L
	2/1 Vertical Scope & Letterbox	1152iLSA	1152iLA	1152iLSA_	1152iLA_
576p	Letterbox	576pWHLA	576pWL	576pWHLA_	576pWL_
720p50	4/5 Vertical Scope 720 to 576-lines	576pWH	576pWH	576pWH_	576pWH_
	8/5 Vertical Scope 720 to 1152-lines	1152iSH	1152iSH	1152iSH_	1152iSH_
1080i25, 1080s25	Pixel /Line Halved & Letterbox	576i50WH	576i50WH	576i50WH_	576i50_H
	Letterbox	1152iLH	1152iLH	1152iLH_	1152iLH_

New Sync Types

The new Australian timings utilize two new sync types: composite type 5 and separate type 6. Composite type 5 can be used to specify Australian analog composite sync (ACS) and digital composite sync (DCS) via ASCT and DSCT parameters, respectively. In addition, separate sync type 6 can be used to specify Australian digital separate sync (DSS) via the DSST parameter.

Special Even-Total Interlace

The high-definition (HD) timings, of the AS 4933.1—200X draft standard, are loosely based on selected timings from the SMPTE 295M-1997, ITU-R BT.1358-98, and ITU-R BT.709-5 (Section 5 1250/50/2:1 system) standards. In the case of the 1152-line timings, a system almost identical to the 1250/50/2:1 system - described in the SMPTE 295M-1997 & ITU-R BT.709-5 standards - is used. This system utilizes a special interlacing technique that requires the display to have special vertical deflection circuitry. All of the 1152i formats have an even number of total lines per frame (625 x 2 = 1250), which does not provide for a naturally interlaced scanning raster. The frame must be electronically split in two unequal fields (624.5 and 625.5 lines) and a special DC-coupled vertical raster deflection circuit used. If not present, the two interlaced fields will be perfectly paired and will lay directly on top of each other – resulting in a distorted and under sampled 625-line picture.

Zoom Logic

Australian-compatible displays are required to apply a 6.7% vertical zoom, in order to fill the screen and square the pixels, whenever the (1080-letterboxed-in-1152) formats 1152iLH & 1152iLH_ are present. The presence of these formats can be detected as follows:

1. In the case of digital or analog composite sync (ACS or DCS), 1152iLH & 1152iLH_ can be detected by the presence of a very short ½-line vertical sync pulse width. In all of the other cases (i.e. 576i50WL, 576i50WL_, 576pWL, 576pWL_, 576pWH, 576pWH_, 1152iLA, 1152iLA_, 1152iSH, 1152iSH_, and 576i50), the vertical sync pulse width is 5-lines, so that the two modes can be easily distinguished via suitable low-pass filter and pulse dropout detector.

2. In the case of digital separate sync (DSS), the presence 1152iLH & 1152iLH_ can be detected by comparing horizontal and vertical sync polarity. The horizontal and vertical sync polarities will be opposite whenever either of these formats (1152iLH & 1152iLH_) is present, while the polarities will be the same in the other cases (i.e. 576i50WL, 576i50_L, 576i50WH, 576i50_H, 576pWL, 576pWL_, 576pWH, 576pWH_, 1152iLA, 1152iLA_, 1152iSH, and 1152iSH_). In both cases, the vertical sync width remains at 5-lines.

Vertical Sync Pulse Width Special Case

Whenever the 1152iLH & 1152iLH_ formats are present, you will note that the width of the vertical sync pulse is automatically switched from ½-line to 5-lines in response to a change from either composite sync type (ACS or DCS) to separate (DSS) sync, respectively. Normally, this sort of change would require two separate formats – one for composite sync and one for digital sync – and would force you to switch formats instead of just sync types via the usual ACS, DCS, or DSS keys or SSST parameter sync selection controls. In order to avoid this complication, we have added special logic, in the case of composite sync type number 5, that causes the composite vertical sync pulse width to be automatically shortened to ½-line, whenever a composite sync type is selected and the horizontal (HSPP) and vertical (VSPP) sync pulse polarities of the format are opposite.

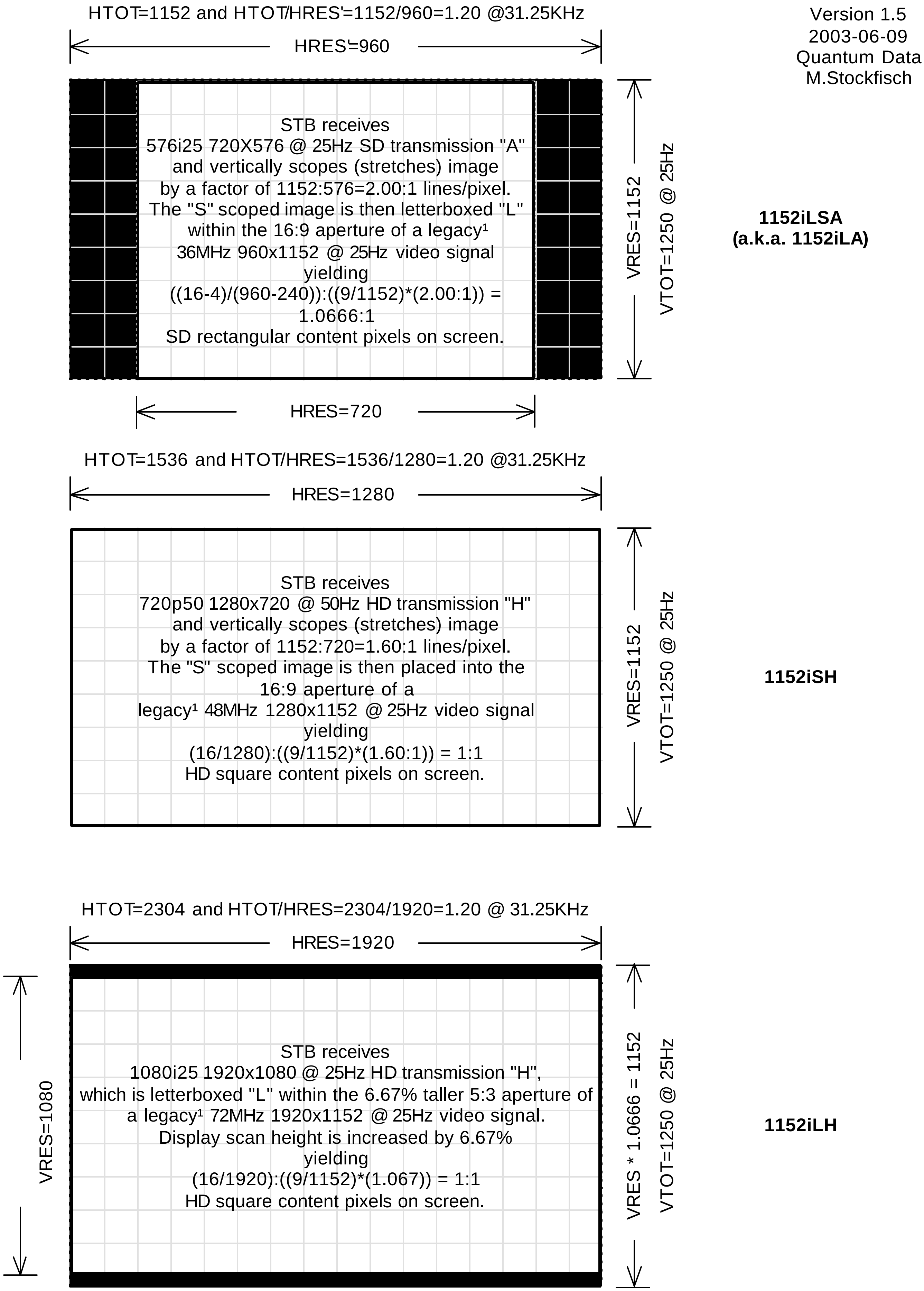
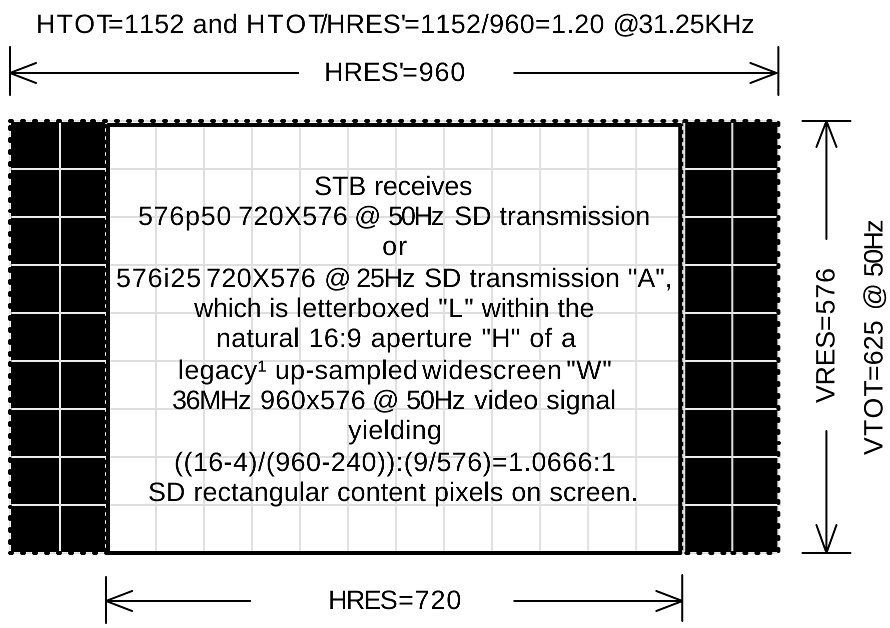
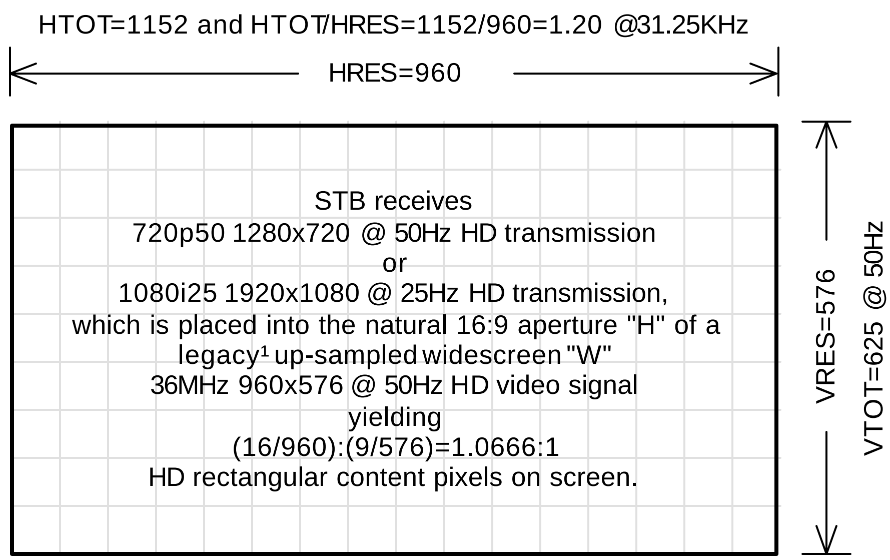


Figure 1 Australian Interlaced 25 Frames/second 16:9 Rasters



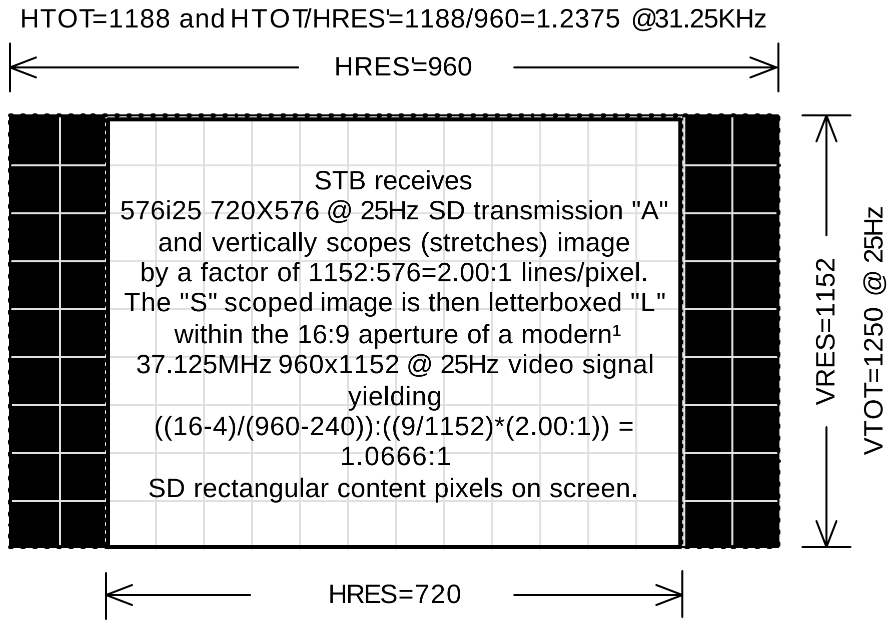
576i50WHLA
(a.k.a. 576i50WL)
or
576pWHLA
(a.k.a. 576pWL)



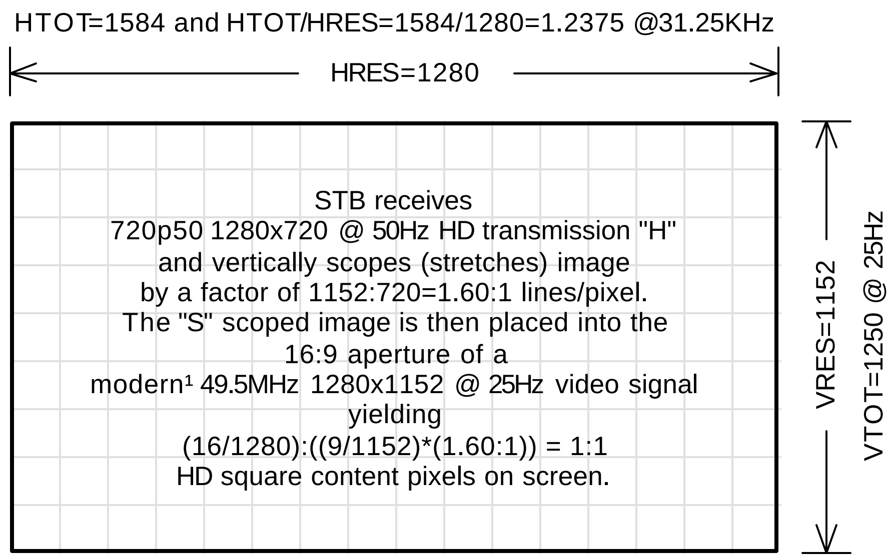
576i50WH
or
576pWH

Figure 2 Australian Progressive 50 Frames/second 16:9 Rasters

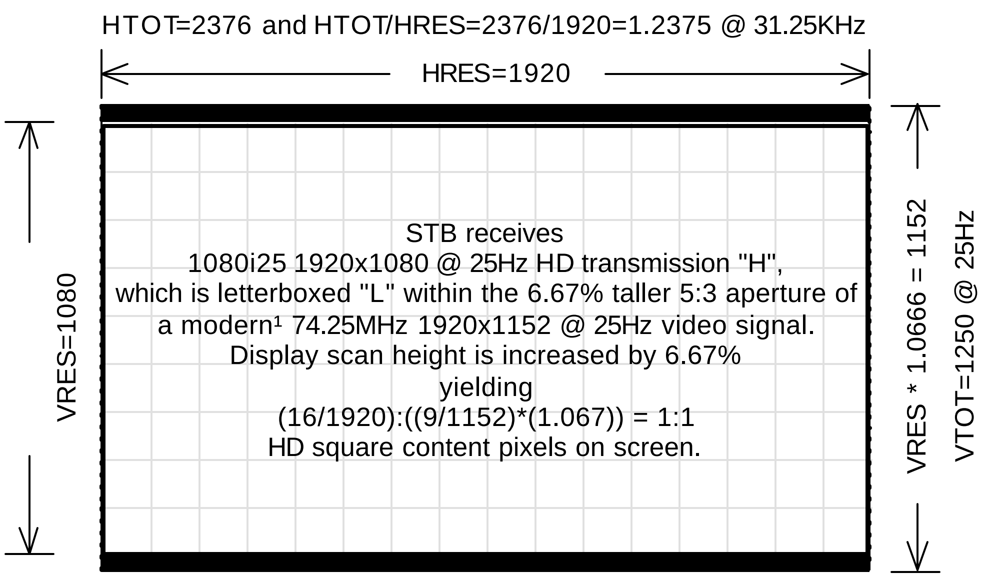
Version 1.5
2003-06-09
Quantum Data
M.Stockfisch



1152iLSA_
(a.k.a. 1152iLA_)



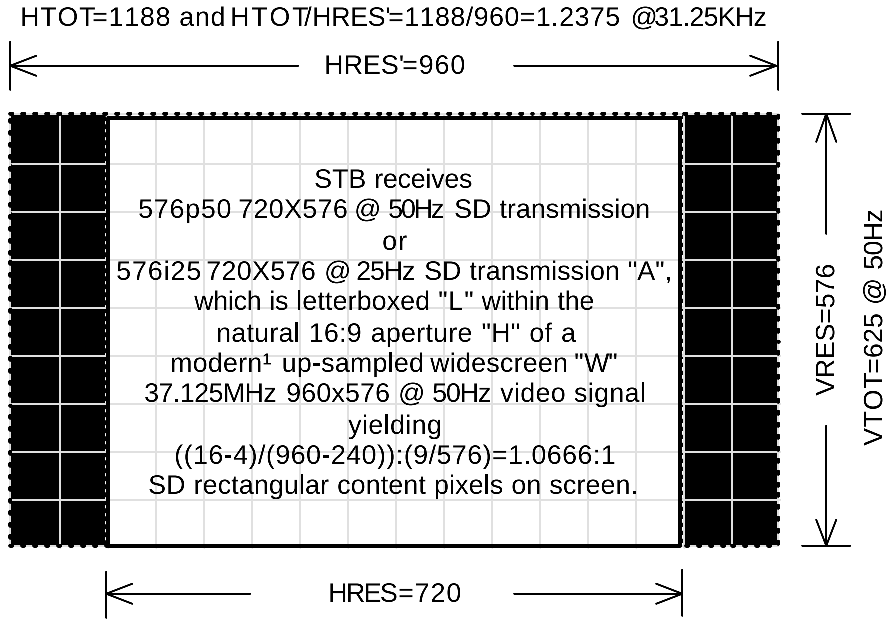
1152iSH_



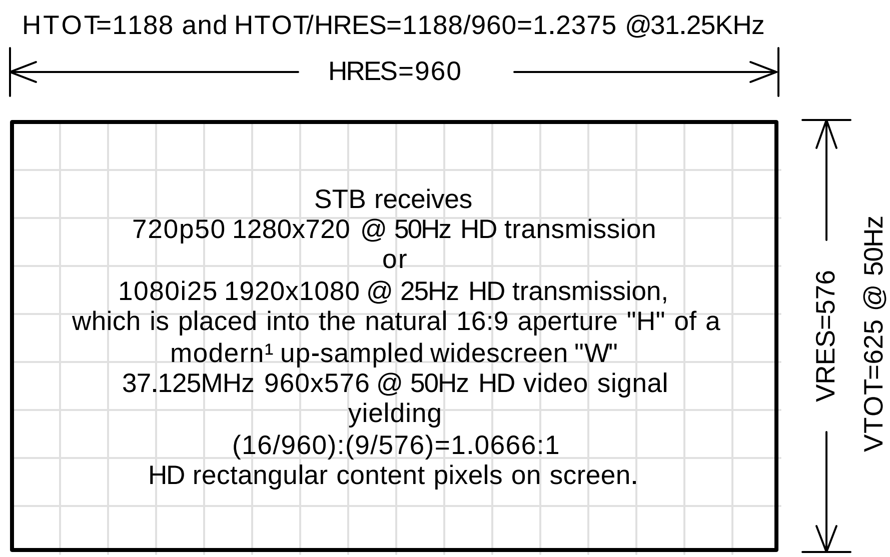
1152iLH_

Figure 3 SMPTE-tuned Australian Interlaced 25 Frames/second 16:9 Rasters

Version 1.5
2003-06-09
Quantum Data
M.Stockfisch



576i50WHLA_
(a.k.a. 576i50_L)
or
576pWHLA_
(a.k.a. 576pWL_)



576i50WH_
(a.k.a. 576i50_H)
or
576pWH_

Figure 4 SMPTE-tuned Australian Progressive 50 Frames/second 16:9 Rasters

Version 1.5
2003-06-09
Quantum Data
M.Stockfisch

NOTES

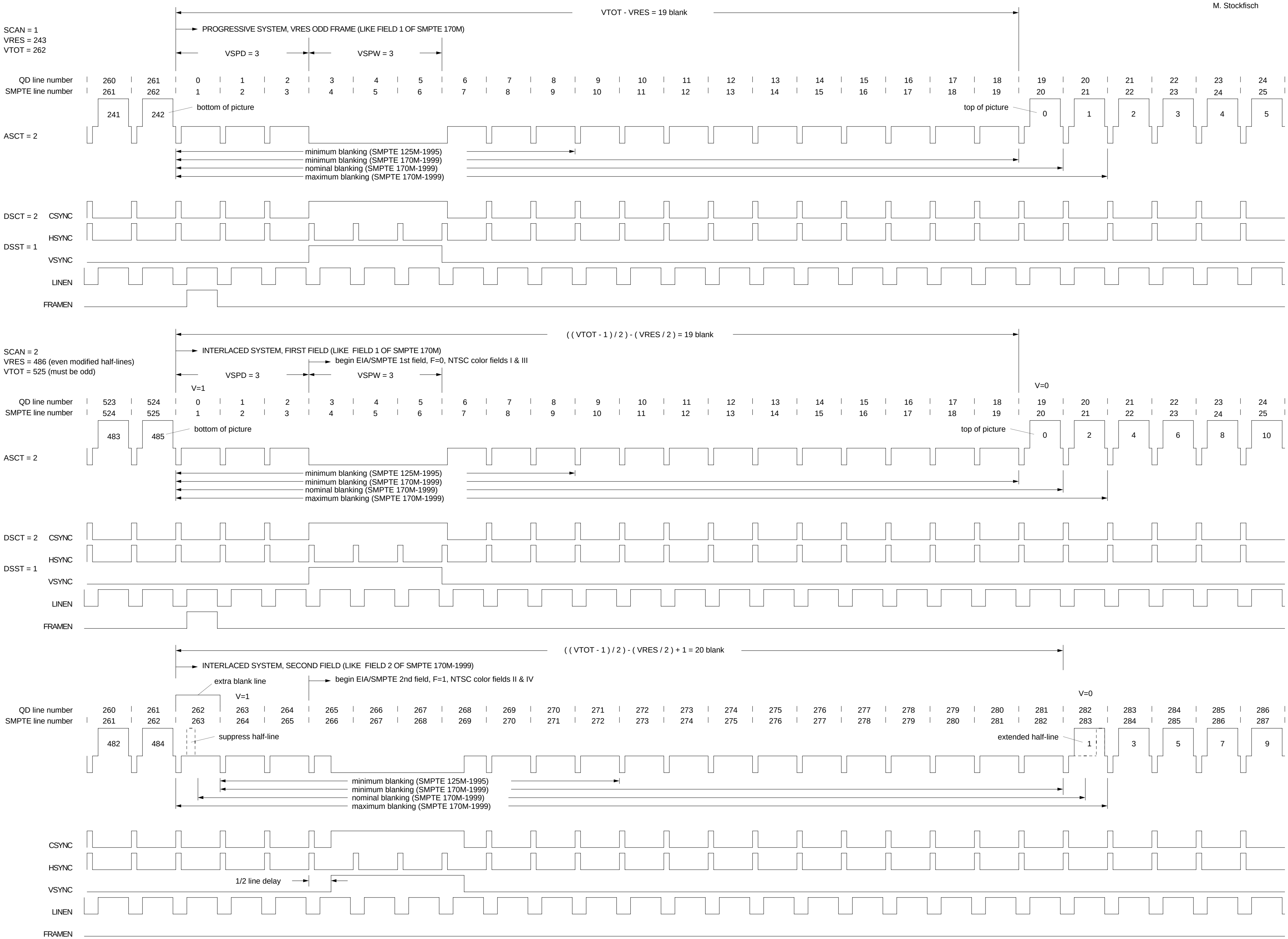
[1] Modern television signals (i.e. those described in Part 2 of ITU-R BT.709-5) are harmonically related to 148.5MHz, whereas legacy signals (i.e. those described in Part 1 of ITU-R BT.709-5) are not - they are instead tuned to harmonics of 144MHz. 148.5MHz and 144MHz are harmonics of 4.752GHz, which is out of the range of ordinary digital logic. Therefore, both sets of pixel frequencies cannot be easily derived from a common fixed clock source, without resorting to PLL technology. ITU-R BT.709-5 recommends that "for new HDTV programme production and international exchange, systems described in Part 2 [i.e. those based on 148.5MHz] are preferred". Quantum Data has created an alternate set of non-proprietary compatible Australian timings, whose line timings are slightly changed from the original 144MHz-based draft timings of AS 4933.1-200X. This alternate set is harmonically tuned to148.5MHz in keeping with Part 2 of ITU_R BT.709-5. In order to allow formats from the two sets to be distinguished, the names of the modern "SMPTE-tuned" timings contain underline characters.

Set-Top-Box (STB)
Standard Definition (SD)
High Definition (HD)
4:3 Aspect Ratio (A)
16:9 Aspect Ratio (H)
Widescreen Sampling Rate (W)
Scope (S)

All vertical rates given are frame rates. The 576i50 formats listed have a field rate of 100Hz.

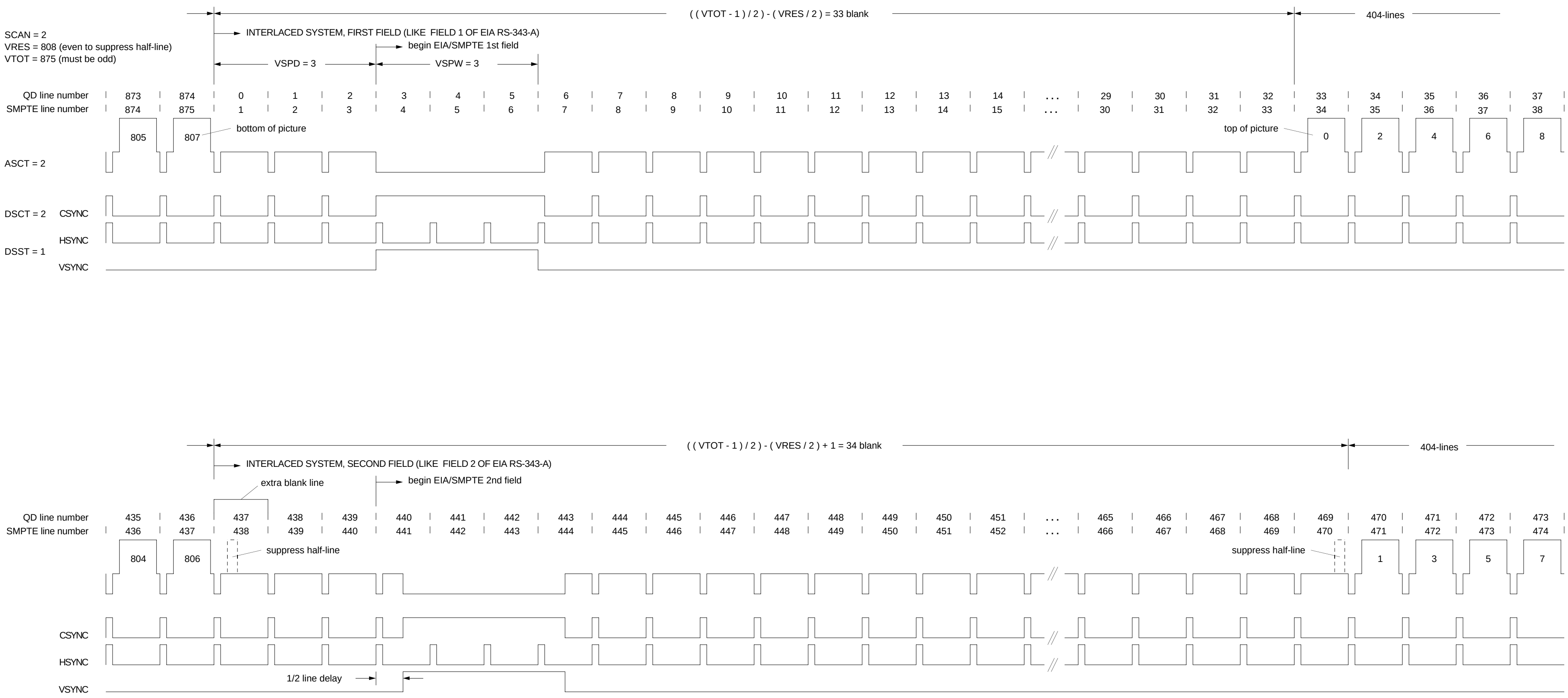
Legacy television content contains pixels having a nominal (4/720):(3/576)=1.0666:1 rectangular shape, which require similarly shaped on-screen pixels in order to avoid distortion.

Version 2.3
02-21-2003
M. Stockfisch



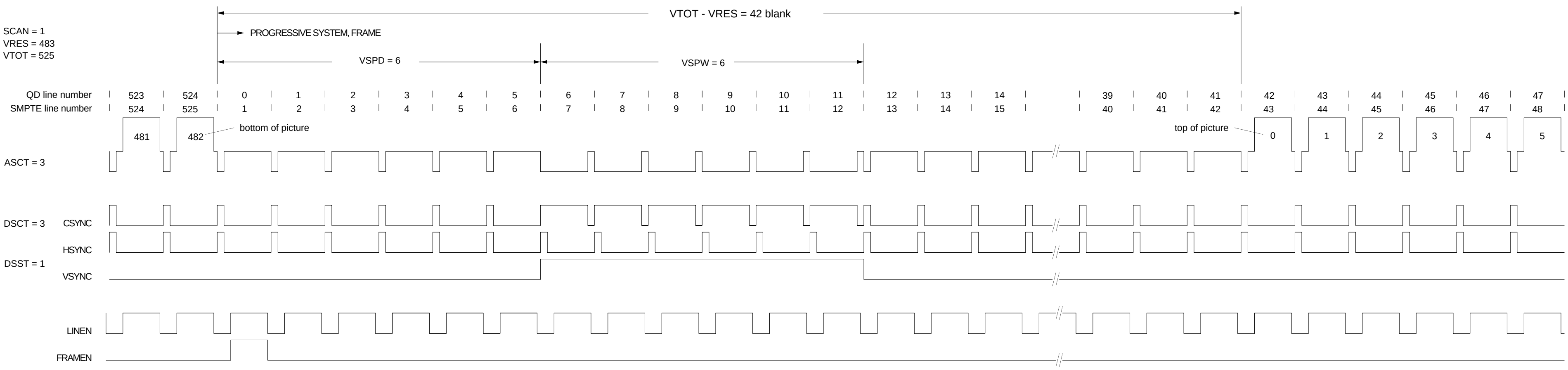
Composite Sync Type 2 (Type M -minus serrations & equalizers)

Version 1.2
03-14-2003
by M. Stockfisch

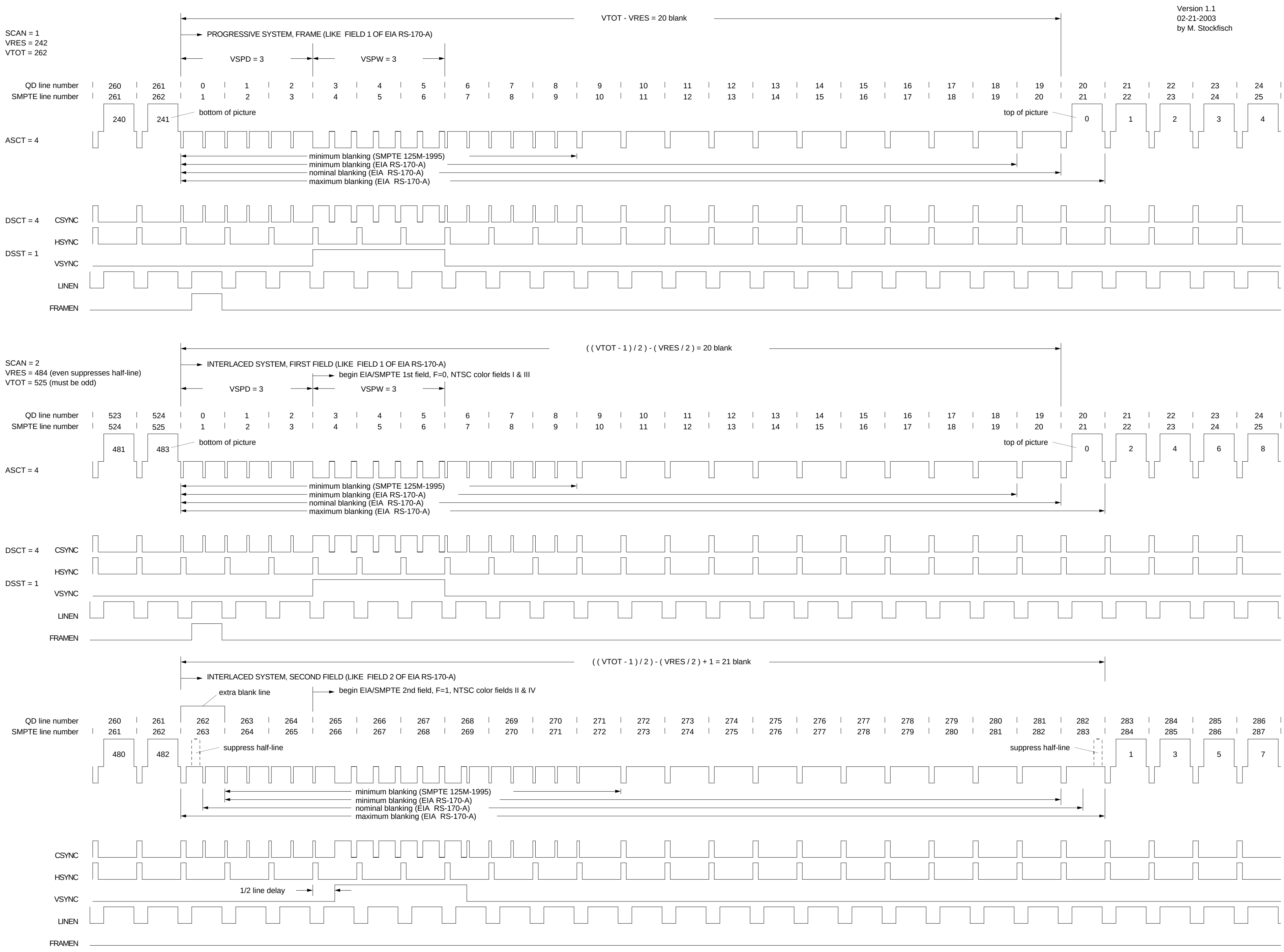


Composite Sync Type 2 (Type M minus serrations & equalizers)

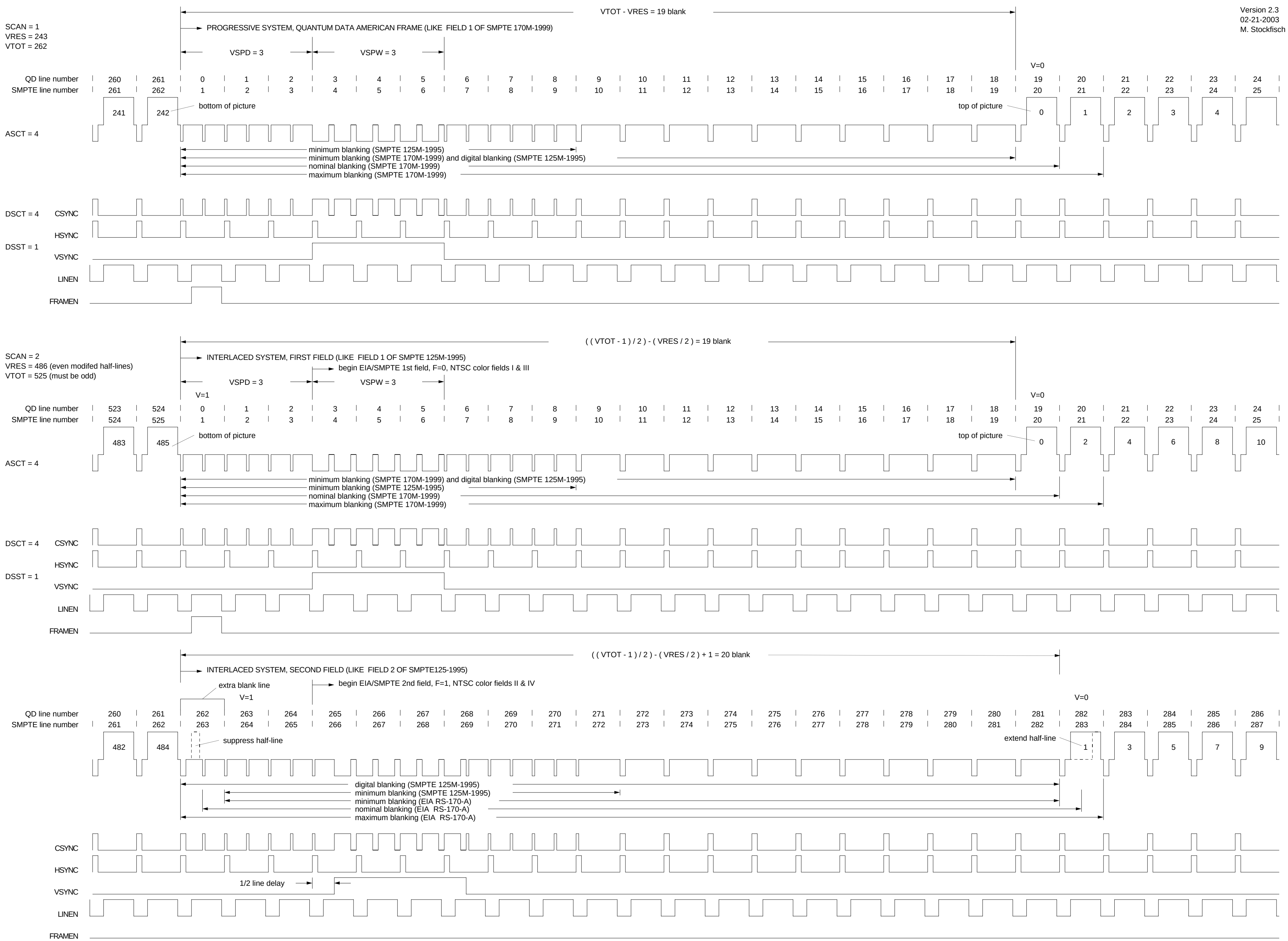
Version 2.3
02-21-2003
M. Stockfisch



Composte Sync Type 3 (Type M minus equalizers)

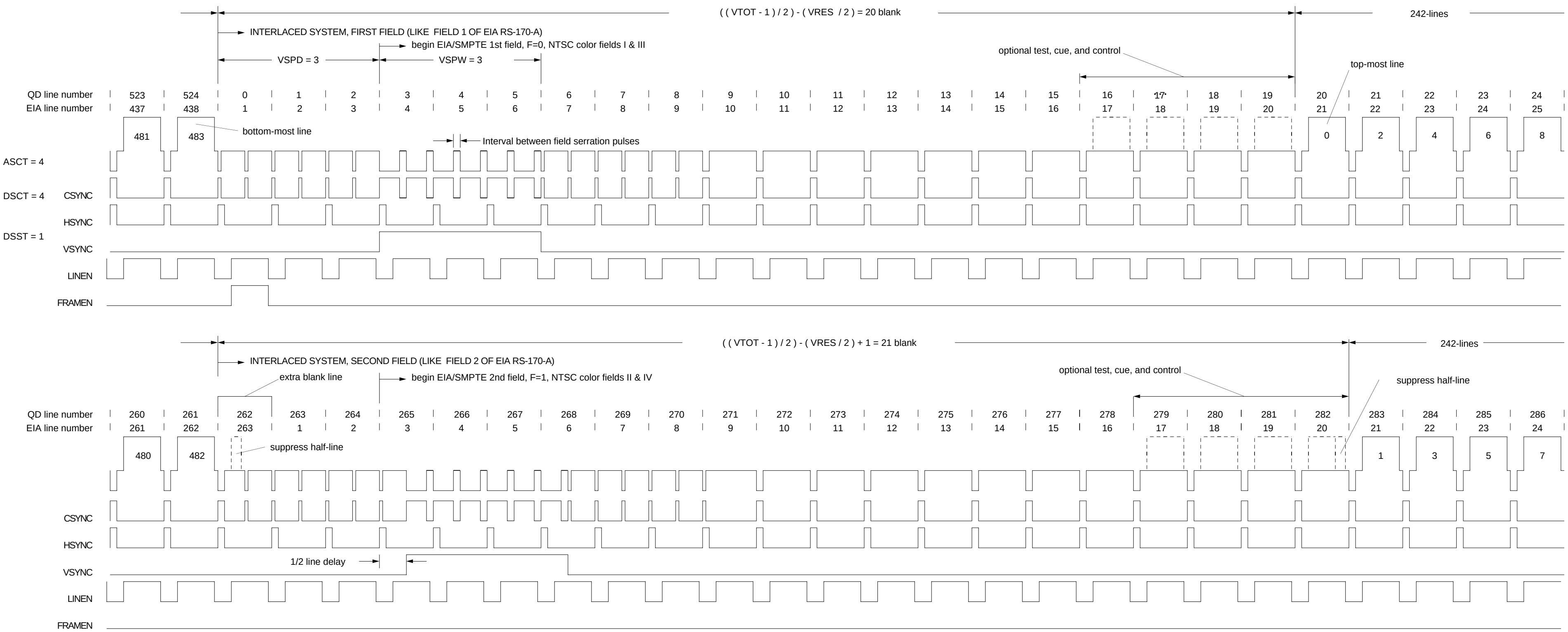


Composite Sync Type 4 (Type M with suppressed half-lines)



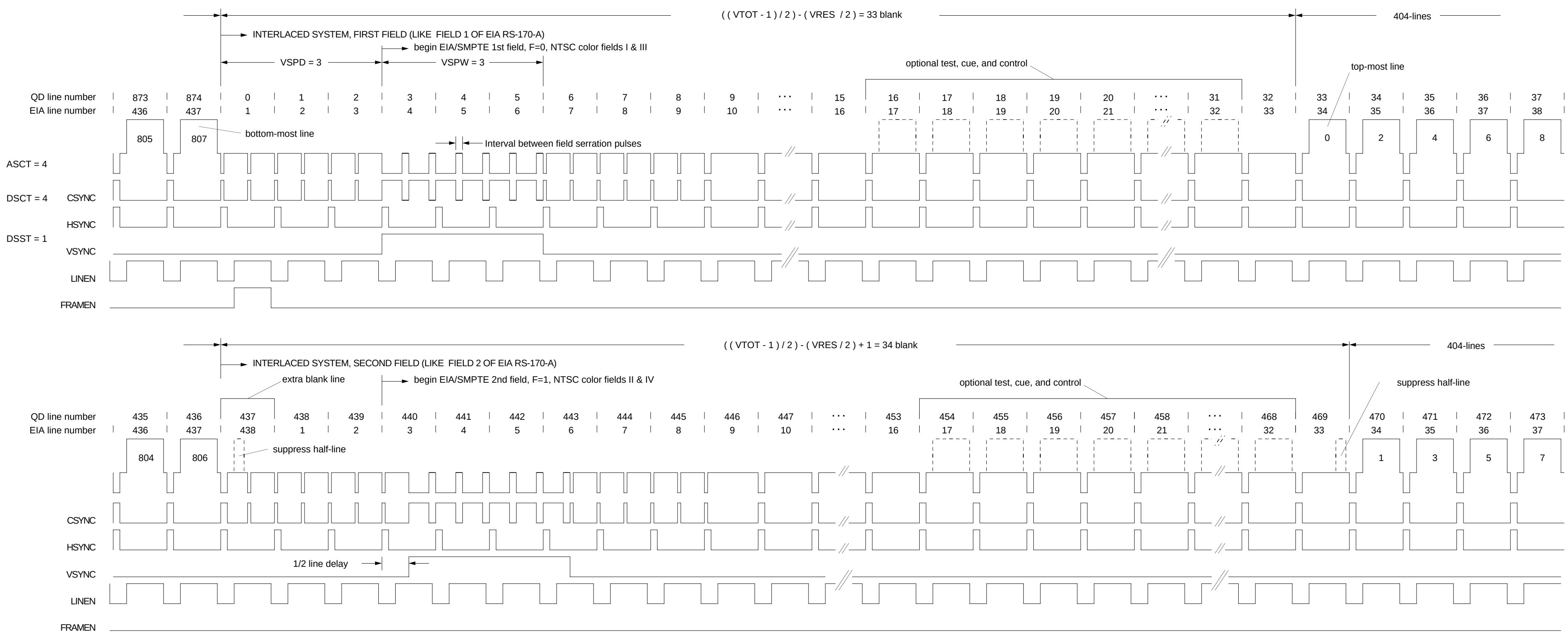
Composite Sync Type 4 (Type M with modified half-lines so as to follow digital blanking and yield 486-lines)

```
Version 1.0
02-27-03
M. Stockfisch

PRAT = 27.000E6     [ PixelRate = 1.485GHz / 55 = 27.000MHz ≈ (12MHz minimum BW * 2.2 Nyquist samples) ]
HRAT = (15750/1.001) = 15.734265734 [ horizontal rate offset for NTSC interoperability )
HTOT = 1716         [ PixelRate / HRAT ]
HRES = 1422
HBNK = 294          [ PixelRate * 10.9uS ]
HSPD = 40           [ PixelRate * 1.5uS ]
HSPW = 126          [ PixelRate * 4.7uS ]
HEPW = 63           [ PixelRate * 2.35uS ]
HVSA = 6            [ HorizontalVerticalSerrationAdjustment = ( HSPW - (PixelRate * 4.44uS interval between field serration pulses ) ) ]
HBPD = 0
HBPW = 738          [ PixelRate * 27.3uS ]
AVSS = 0.714
ASSS = 0.286
AVPS = 7.5          [ 5.4% = 0.714 * 7.5IRE ]
AVPG = 1
GAMC = 0
GAMA = 1.0
SSST = 4
ASSG = 0, 1, 0
SCAN = 2
VRES = 485 - 1 = 484 (minus one, as legacy half-lines are suppressed for compatibility with modern computer graphics)
VTOT = 525 (must be odd)
```



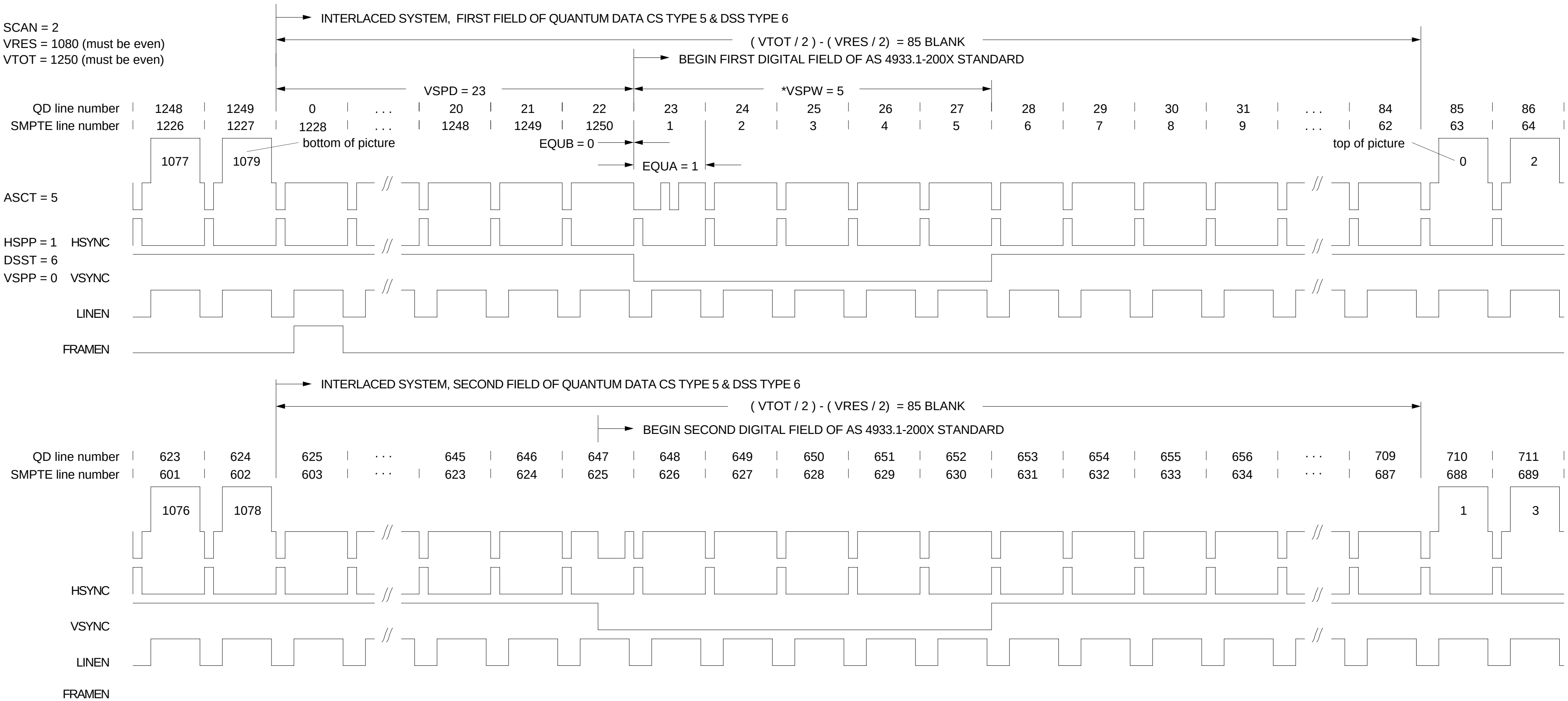
Composite Sync Type 4 (NATO Defense Standard STANAG Class C 525-line timing minus legacy half-lines)

```
Version 2.0
03-14-03
M. Stockfisch

PRAT = 45.000E6      [ PixelRate = 1.485GHz / 33 = 45.000MHz ≈ (20MHz minimum BW * 2.2 Nyquist samples) ]
HRAT = 26250/1.001 = 26223.776224 [note: horizontal rate is offset for NTSC compatibility ]
HTOT = 1716          [ PixelRate / HRAT ]
HRES = 1401
HBNK = 315           [ PixelRate * 7.0uS ]
HSPD = 40            [ PixelRate * 0.9uS ]
HSPW = 124           [ PixelRate * 2.75uS ]
HVSA = 34            [ HorizontalVerticalSerrationAdjustment = ( HSPW - (PixelRate * 2.0uS interval between field serration pulses) ) ]
HEPW = 62
HBPD = 0
HBPW = 768           [ PixelRate * 17.05uS ]
AVSS = 0.714
ASSS = 0.286
AVPS = 7.5           [ 5.4% = 0.714 * 7.5IRE ]
AVPG = 1
GAMC = 0
GAMA = 1.0
SSST = 4
ASSG = 0, 1, 0
SCAN = 2
VRES = 809 - 1 = 808 (minus one, as legacy half-lines are suppressed for compatibility with modern computer graphics)
VTOT = 875 (must be odd)
```



Composite Sync Type 4 (NATO Defense Standard STANAG Class A 875-line timing minus legacy half-lines)

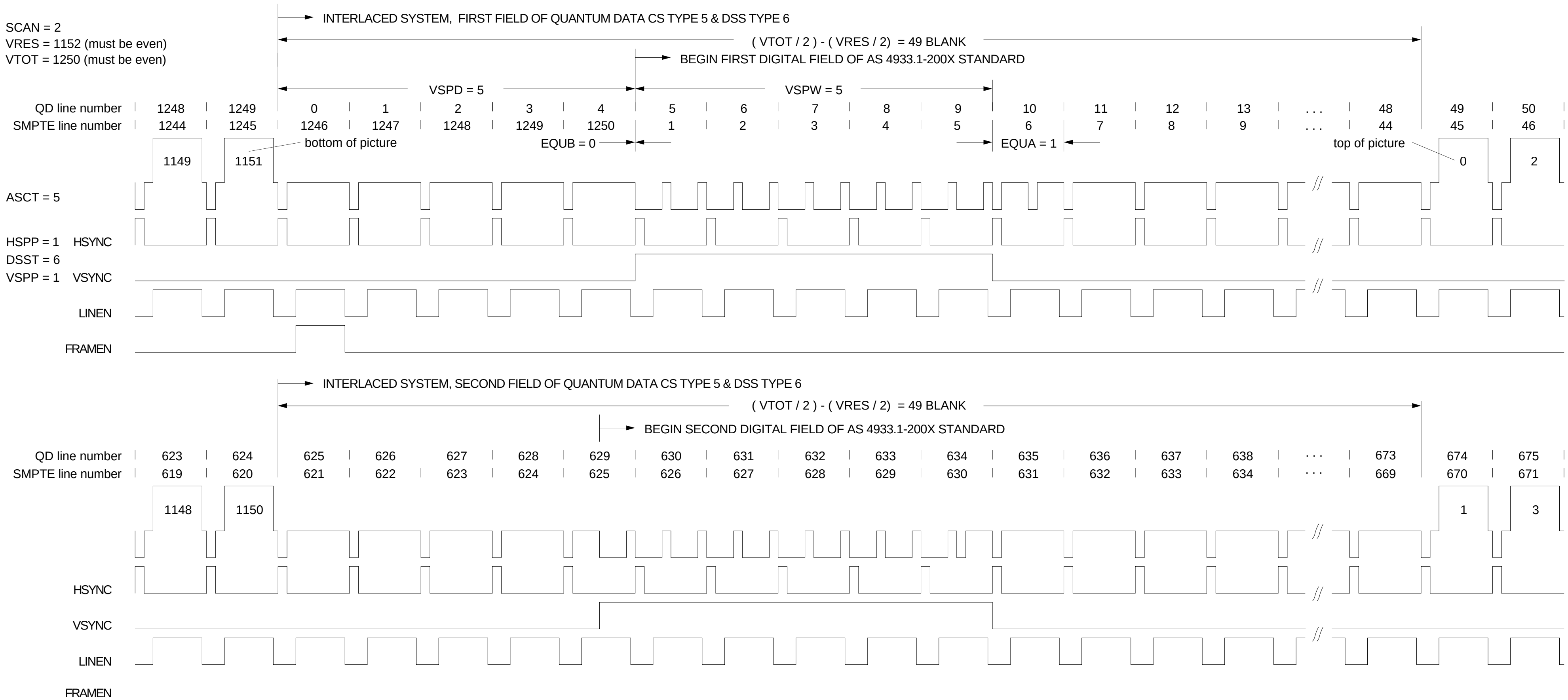
Version 1.0
06/20/2003
by M. Stockfisch
Quantum Data



* Special case: VSPW is reduced to 0.5-line, whenever analog sync is selected and the digital separate sync types have been programmed for opposite polarity (i.e. HSPP not equal to VSPP).

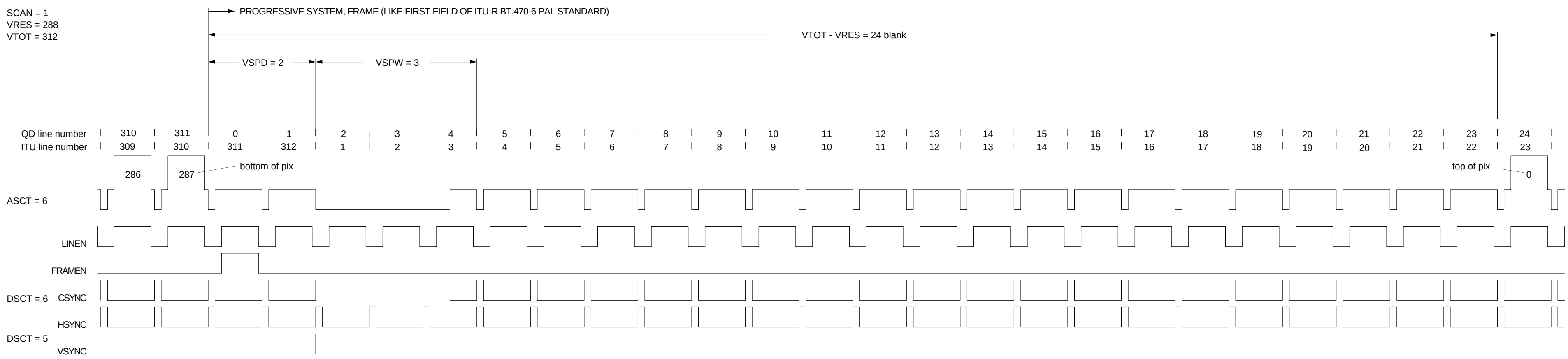
"Australian" Composite Sync Type 5 1152iLH (per AS4933.1-200X)

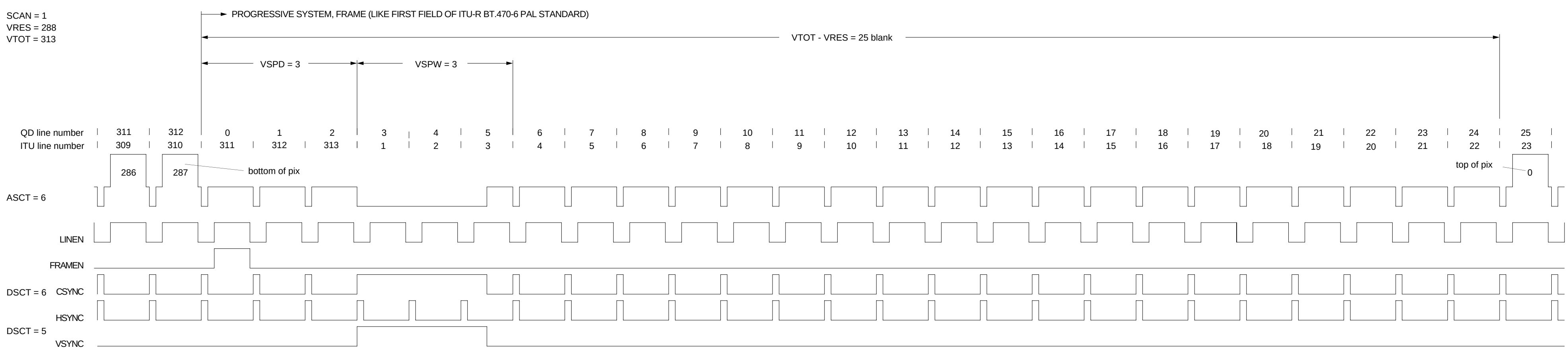
Version 1.0
06/20/2003
by M. Stockfisch
Quantum Data



"Australian" Composite Sync Type 5 1152iSH (per AS4933.1-200X)

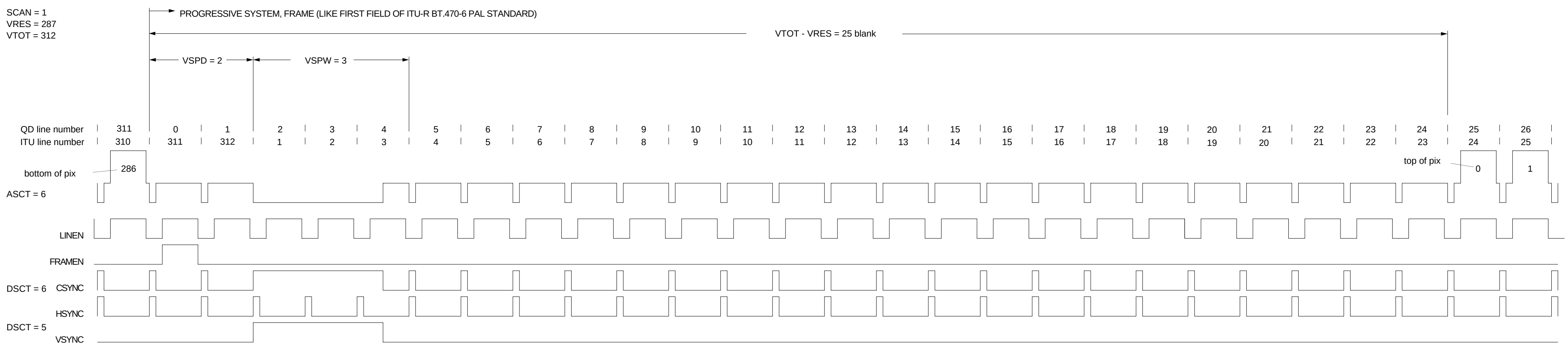
Version 1.1
02-24-2003
by M. Stockfisch

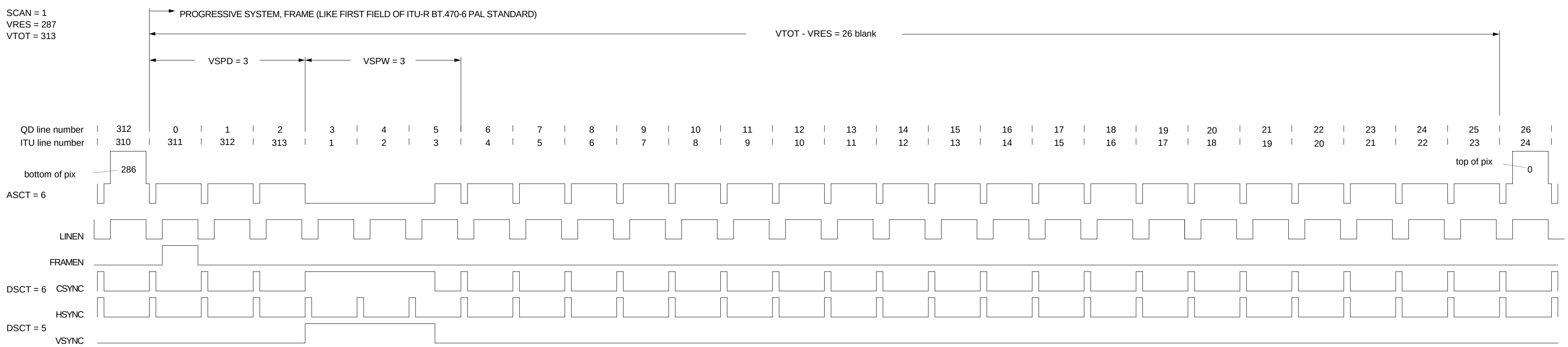




Composite Sync Type 6 Progressive (Type N minus serrations & equalizers with maximum centered even VRES and odd & even VTOT)

Version 1.1
02-21-2003
by M. Stockfisch

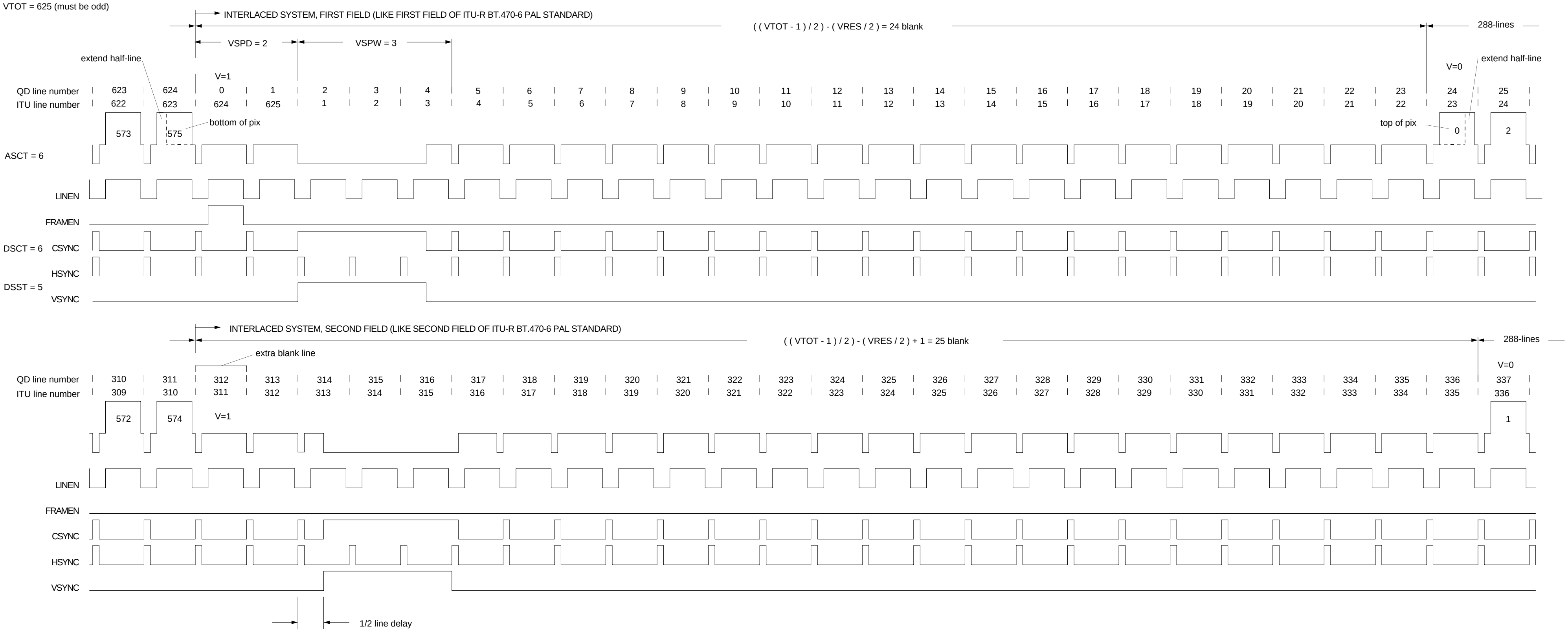




Composite Sync Type 6 Progressive (Type N minus serrations & equalizers with maximum centered odd VRES and odd & even VTOT)

Version 1.2
02-24-2003
by M. Stockfisch

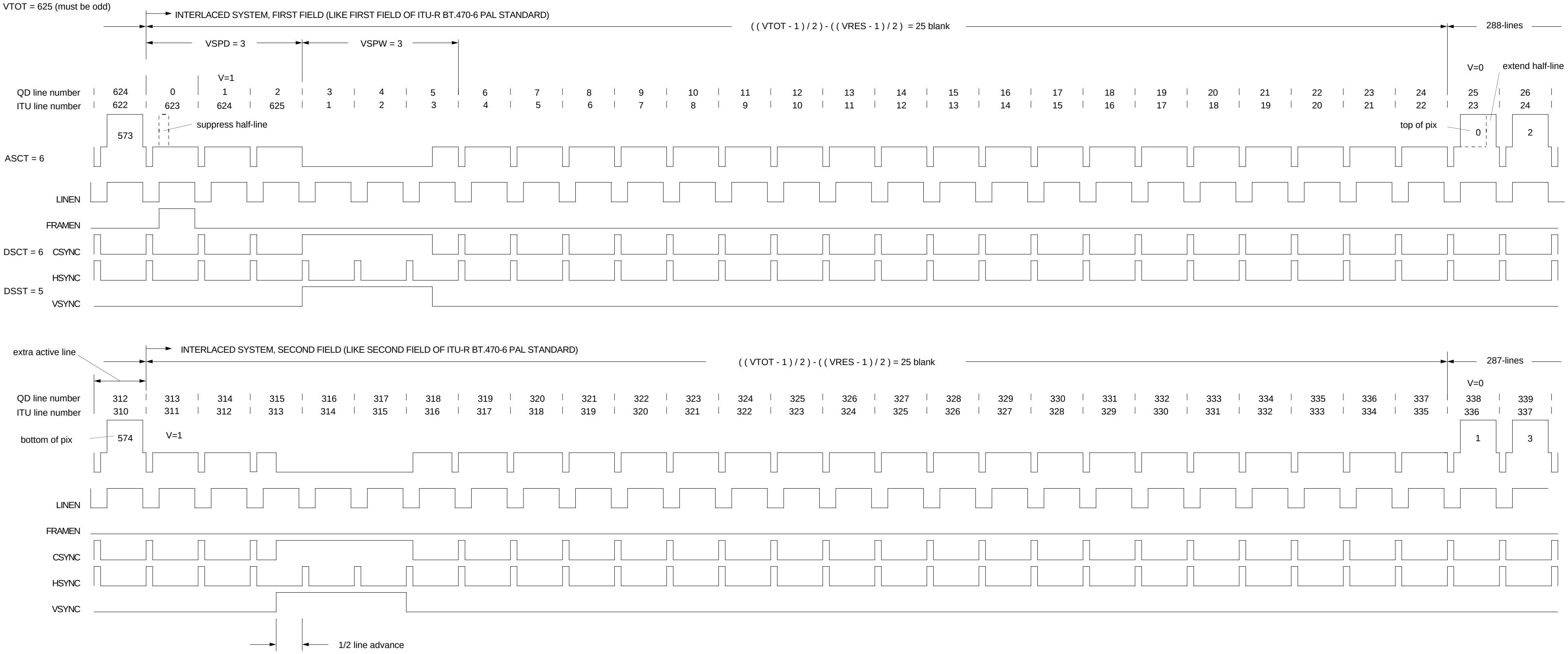
SCAN = 2
VRES = 576 (even modified half-lines)
VTOT = 625 (must be odd)



Composite Sync Type 6 Interlaced (Type N minus serrations & equalizers with maximum centered even VRES)

Version 1.2
02-21-2003
by M. Stockfisch

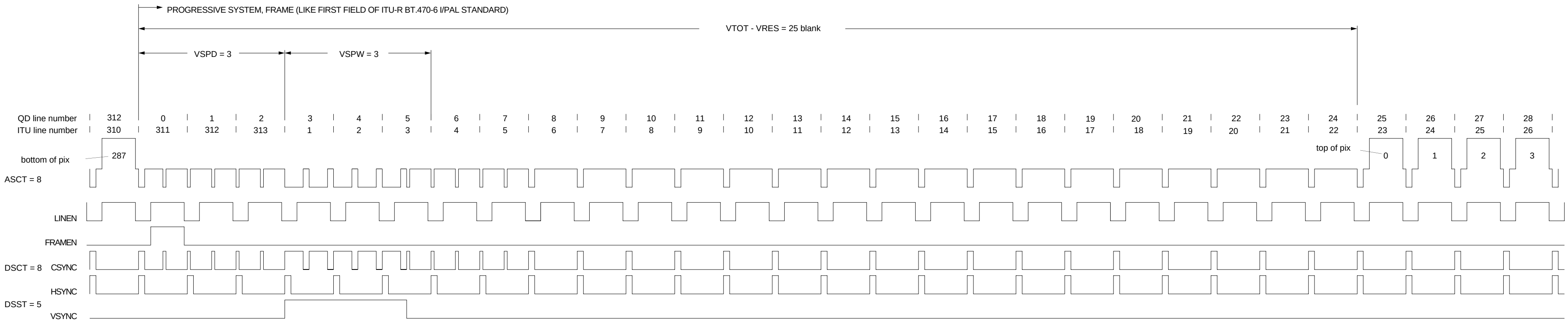
SCAN = 2
VRES = 575 (odd modified half-lines)
VTOT = 625 (must be odd)



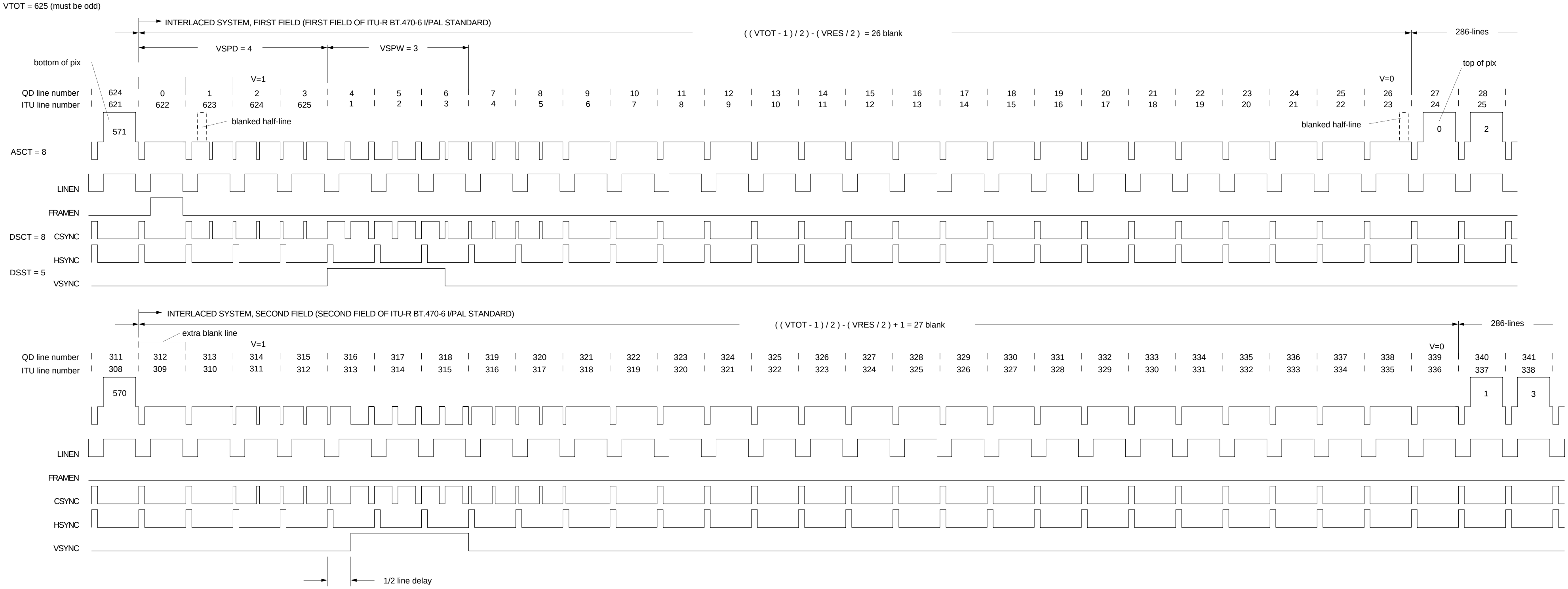
Composite Sync Type 6 Interlaced (Type N minus serrations & equalizers with maximum centered odd VRES)

Version 1.2
02-21-2003
by M. Stockfisch

SCAN = 1
VRES = 288 (max even - while maintaining equilization pulses)
VTOT = 313



SCAN = 2
VRES = 572 (max even - while maintaining centering and equilization pulses)
VTOT = 625 (must be odd)

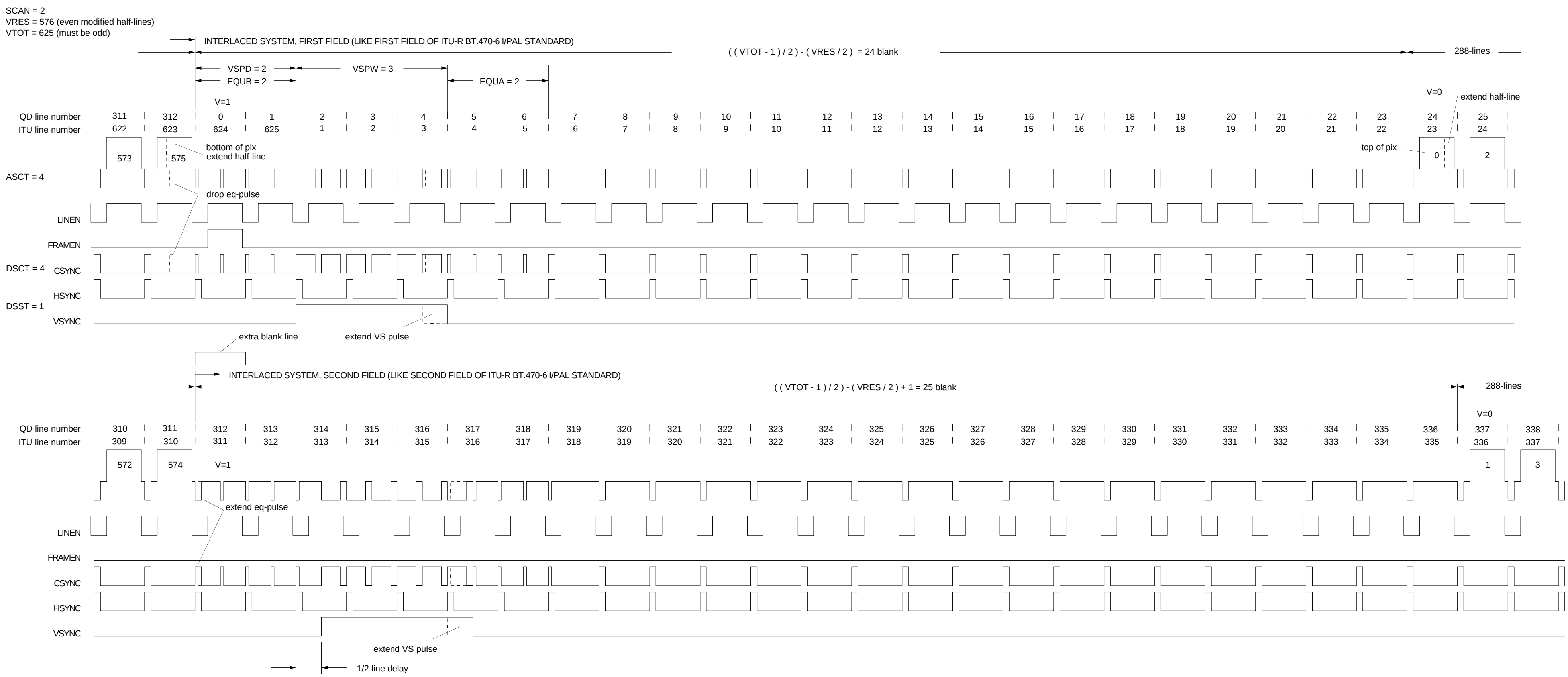


Composite Sync Type 8 (Type N with maximum centered even VRES)

Version 1.2
02-21-2003
by M. Stockfisch

Composite Sync Type 8 (Type N with odd VRES)

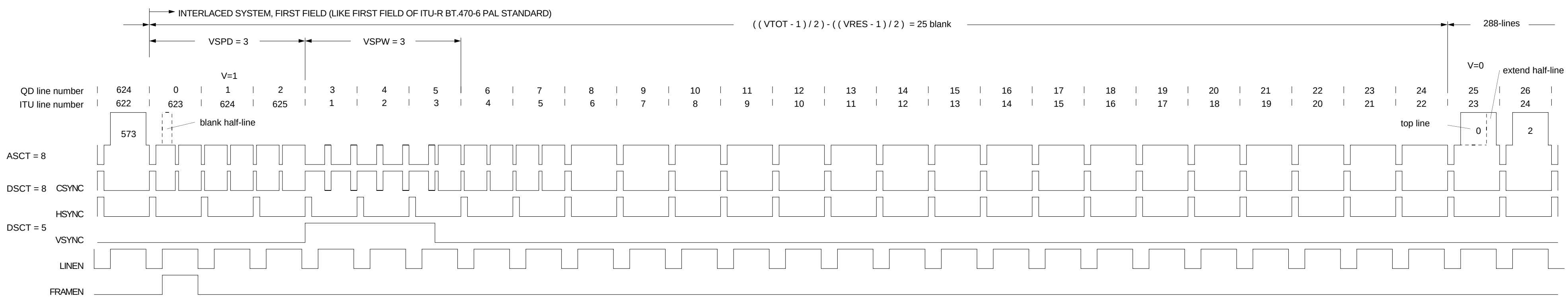
Version 1.3
02-27-2003
by M. Stockfisch

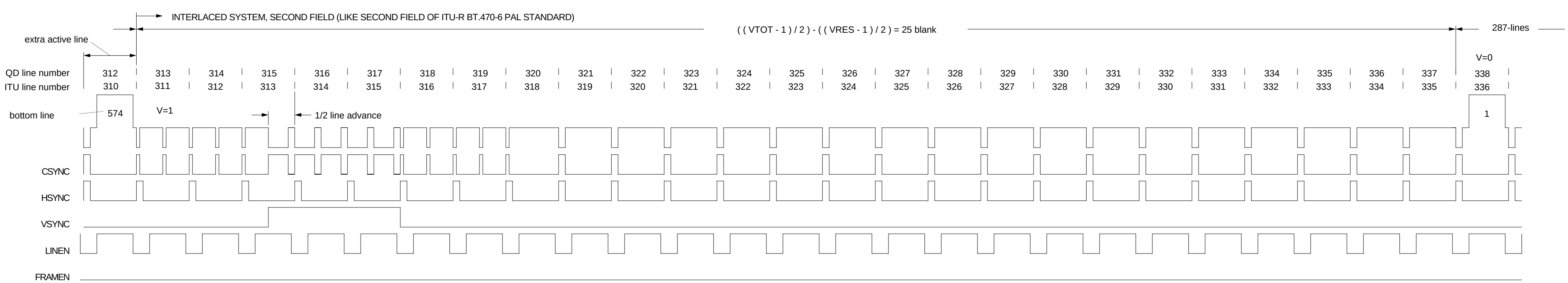


Full 576i Frame Implemented Using Composite Sync Type 4
(switch to Type M with modified half-lines so as to follow digital blanking and yield 576-lines)

Version 1.0
02-28-2003
by M. Stockfisch

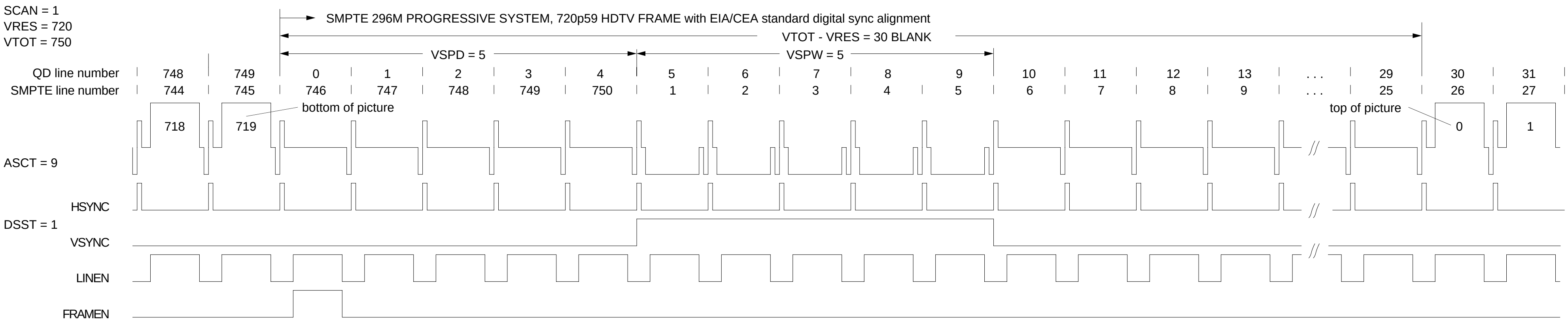
```
PRAT = 33.000E6     [ PixelRate = 1.485GHz / 45 = 33.000MHz = (15MHz minimum BW * 2.2 Nyquist samples) ]
HRAT = 15625
HTOT = 2112         [ PixelRate / HRAT ]
HRES = 1716
HBNK = 396          [ PixelRate * 12uS ]
HSPD = 50           [ PixelRate * 1.5uS ]
HSPW = 156          [ PixelRate * 4.7uS ]
HEPW = 78           [ PixelRate * 2.35uS ]
HVSA = 0            [ HorizontalVerticalSerrationAdjustment = ( HSPW - (PixelRate * 4.44uS interval between field serration pulses ) ) ]
HBPD = 0
HBPW = 900          [ PixelRate * 27.3uS ]
AVSS = 0.700
ASSS = 0.300
AVPS = 0.0          [ 0.0% = 0.700 * 0IRE ]
AVPG = 0
GAMC = 0
GAMA = 1.0
SSST = 4
ASSG = 0, 1, 0
SCAN = 2
VRES = 575 (legacy half-lines are merged in top line for compatibility with modern computer graphics)
VTOT = 625 (must be odd)
```





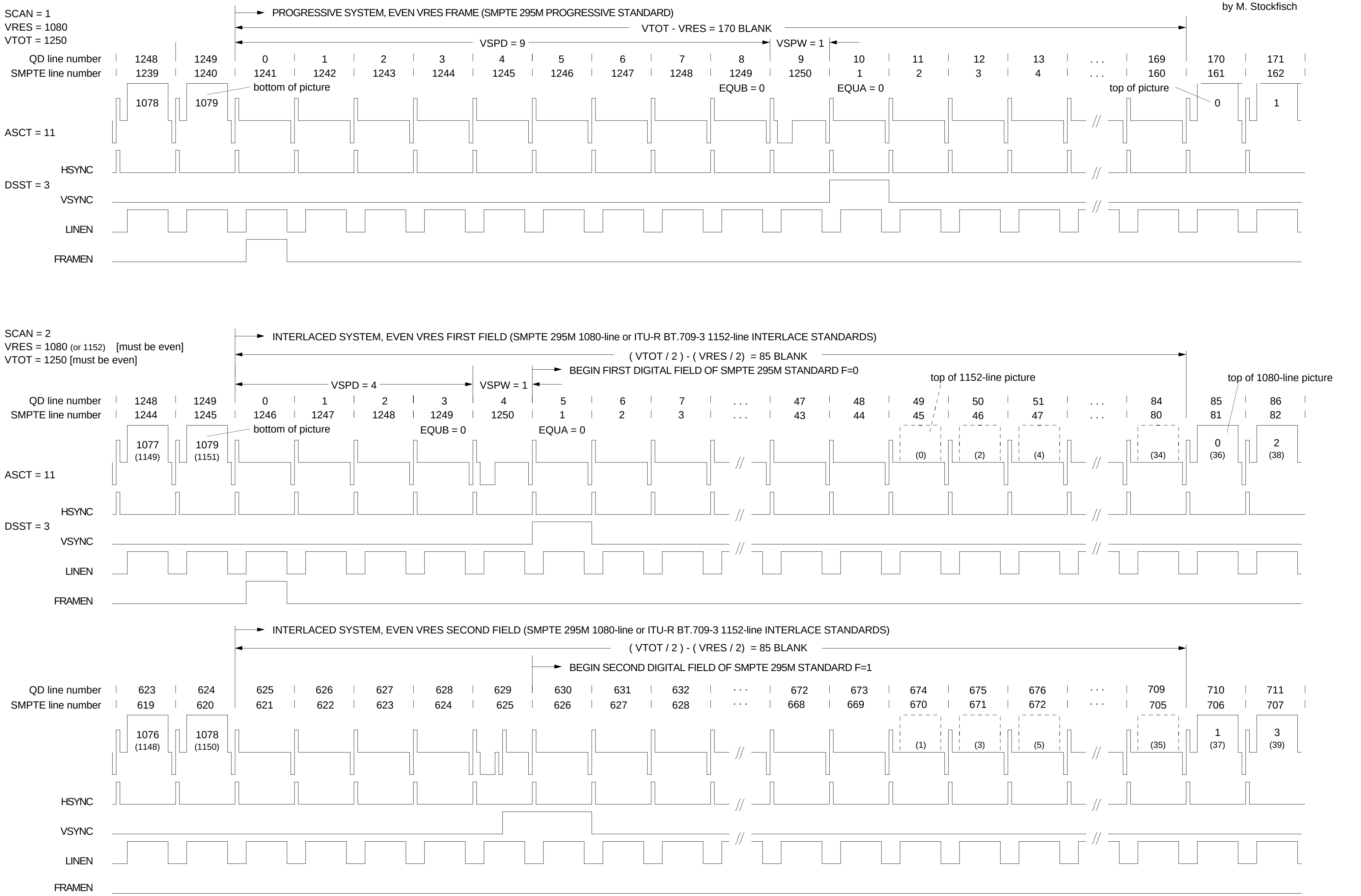
Composite Sync Type 8 (NATO Defense Standard STANAG Class B 625-line timing with legacy half-lines merged into one full-line at top)

Version 1.0
02-19-2003
by M. Stockfisch



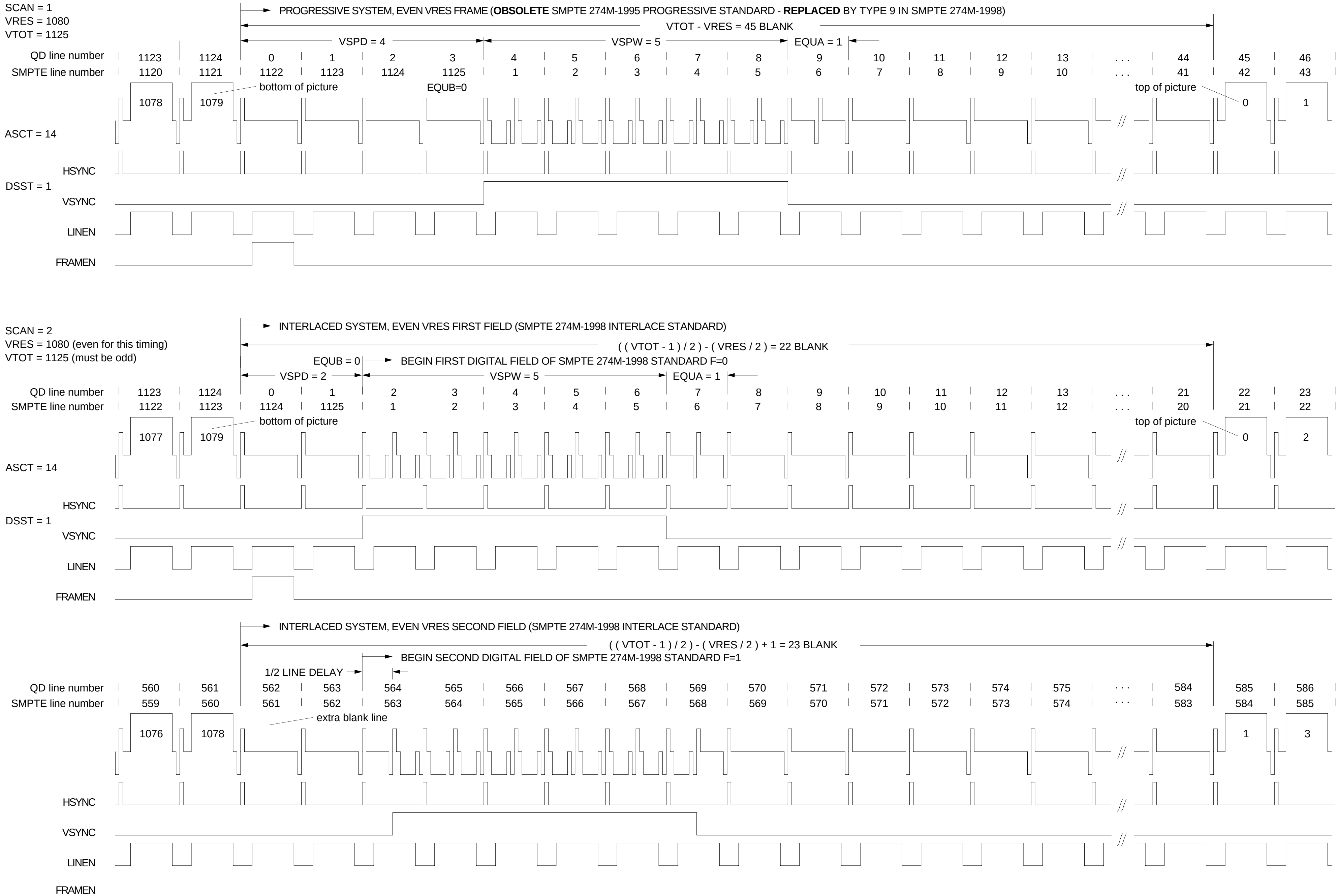
Composite Tri-Level Sync Type 9 (SMPTE 296M) with EIA/CEA Digital Sync Alignment

Version 1.1
02-26-2003
by M. Stockfisch



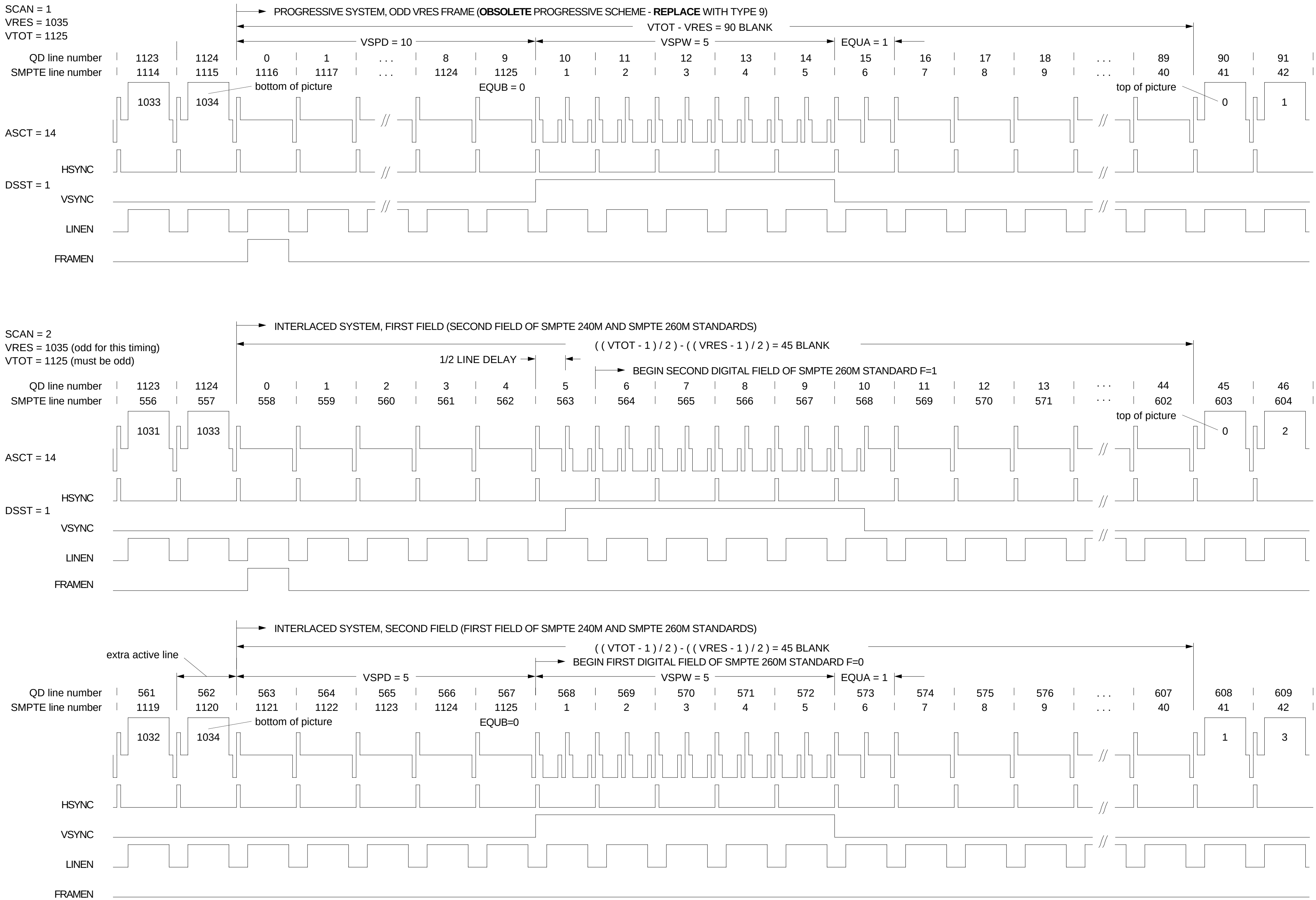
Composite Tri-Level Sync Type 11 (even VRES per SMPTE 295M or ITU-R BT.709-3) with EIA/CEA Digital Sync Alignment

Version 1.0
02-21-2003
by M. Stockfisch



Composite Tri-Level Sync Type 14 (even VRES per SMPTE 274M) with EIA/CEA Digital Sync Alignment

Version 1.0
02-21-2003
by M. Stockfisch



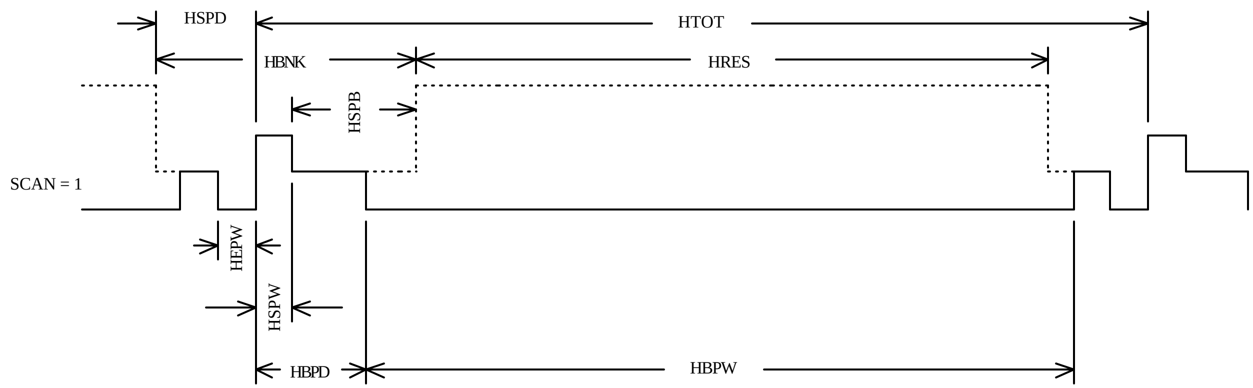
Composite Tri-Level Sync Type 14 (odd VRES per SMPTE 240M and SMPTE 260M) with EIA/CEA Digital Sync Alignment

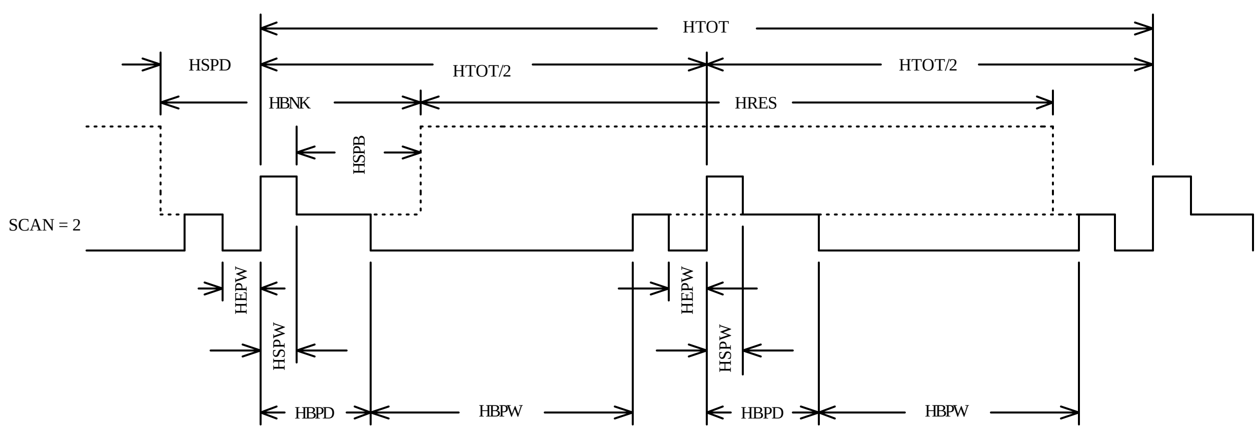
Modern EIA/CEA Tri-level Sync Modes & Timing

Version 1.2

M. Stockfisch

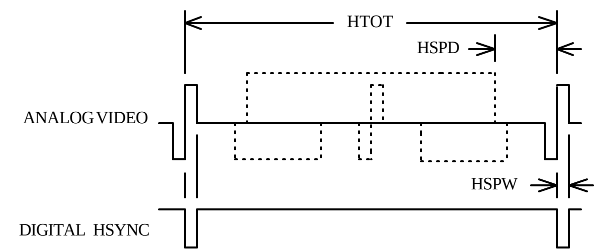
ASCT	SCAN	HTOT	HRES	HBNK	HSPD	HSPW	HSPB	HEPW	HBPD	HBPW	HEPW =	HBPD =	HBPW =	FORMATS	STANDARDS
9	1	1980	1280	700	440	40	220	40	260	1280	HSPW	6.5*HSPW	HTOT-HSPD-(2*HSPW)	720p50	SMPTE 296M #3
9	1	1650	1280	370	110	40	220	40	260	1280	HSPW	6.5*HSPW	HTOT-HSPD-(2*HSPW)	720p59, 720p60	SMPTE 296M #1, #2
9	1	2200	1920	280	88	44	148	44	132	1980	HSPW	3*HSPW	HTOT-HSPD-(2*HSPW)	1080p29, 1080p30, 1080p59, 1080p60	SMPTE 274M #1, #2, #7, #8
9	1	2640	1920	720	528	44	148	44	132	1980	HSPW	3*HSPW	HTOT-HSPD-(2*HSPW)	1080p25, 1080p50	SMPTE 274M #3, #9
9	1	2750	1920	830	638	44	148	44	132	1980	HSPW	3*HSPW	HTOT-HSPD-(2*HSPW)	1080p23, 1080p24	SMPTE 274M #10, #11
11	1	2376	1920	456	147	66	243	66	309	594	HSPW	(3*HSPD)-(2*HSPW)	HTOT/4	108Op50	SMPTE 295M #1
11	2	2376	1920	456	147	66	243	66	309	594	HSPW	(3*HSPD)-(2*HSPW)	HTOT/4	108Oi25	SMPTE 295M #2
14	2	2200	1920	280	88	44	148	44	132	880	HSPW	3*HSPW	((HTOT-HSPD-HEPW)/2)-(4*HEPW)	1080i29, 1080i30	SMPTE 274M #4, #5
14	2	2640	1920	720	528	44	148	44	132	880	HSPW	3*HSPW	((HTOT-HSPD-HEPW)/2)-(4*HEPW)	1080i25	SMPTE 274M #6
14	2	2750	1920	830	638	44	148	44	132	880	HSPW	3*HSPW	((HTOT-HSPD-HEPW)/2)-(4*HEPW)	1080i23, 1080i24	based on SMPTE 274M #6 and #11





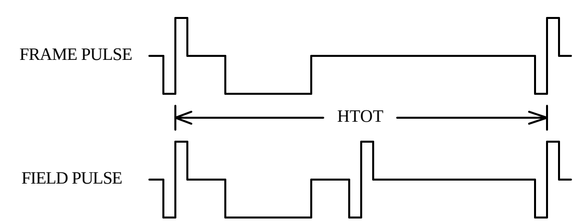
EIA/CEA-861-B DIGITAL SYNC ALIGNMENT DETAIL

EIA/CEA tri-level sync types 9, 11, & 14 define the relationship between digital horizontal sync and analog composite syncsuch that the leading edge of the digital horizontal sync pulse is aligned with the leading and trailing edges of the positive alternation of thetri-level analog sync pulse.



SMPTE 295M 108Op50 & 108Oi25 (ten-eight-oh) DETAIL

In SMPTE 295M, each vertical sync pulse consists of a single broad pulse. Progressive systems (SCAN=1) supply a single FRAME PULSE before each frame. Interlaced systems (SCAN=2), on the other hand, supply a FRAME PULSE before the first field (which contains the top time) and a FIELD PULSE before the second field.

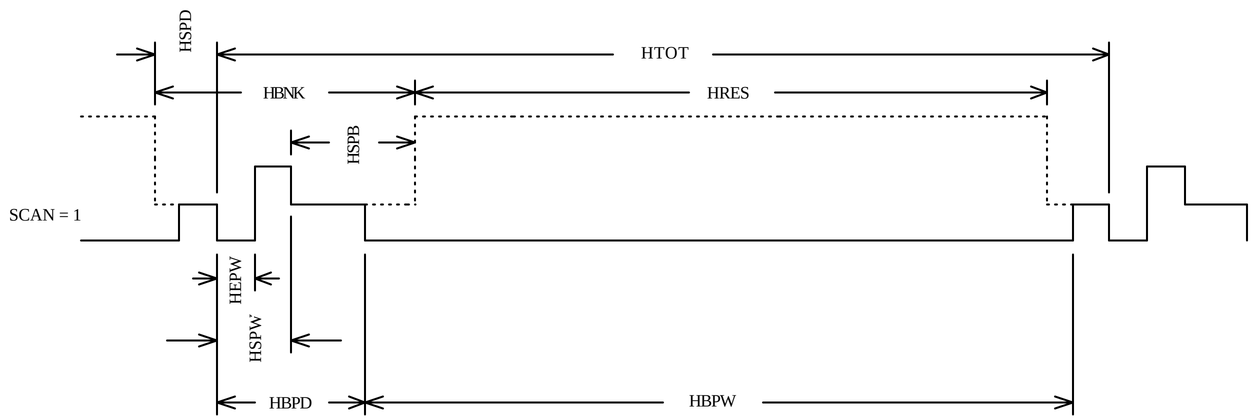


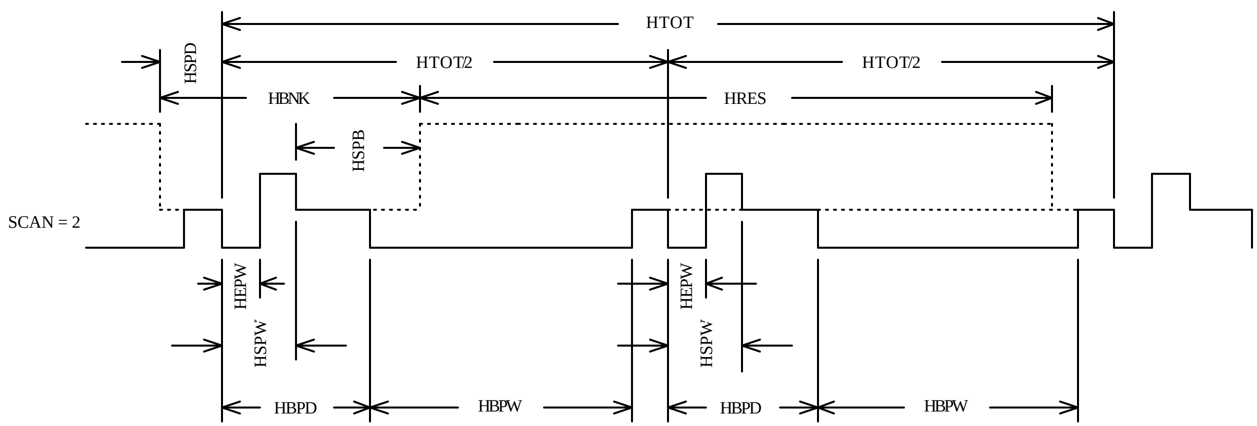
Legacy Quantum Data Tri-level Sync Modes & Timing

Version 1.2

M. Stockfisch

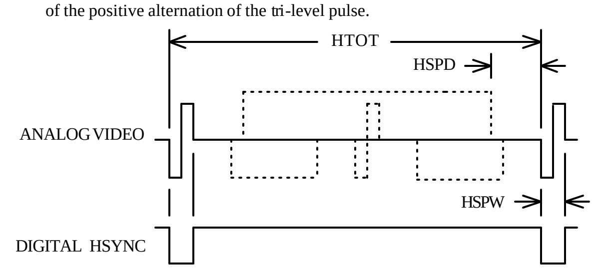
ASCT	SCAN	HTOT	HRES	HBNK	HSPD	HSPW	HSPB	HEPW	HBPD	HBPW	HEPW =	HBPD =	HBPW =	FORMATS	STANDARDS
10	1	1980	1280	700	400	80	220	40	300	1280	HSPW/2	3.75*HSPW	HTOT-HSPD-(2*HSPW)	720p50	SMPTE 296M #3
10	1	1650	1280	370	70	80	220	40	300	1280	HSPW/2	3.75*HSPW	HTOT-HSPD-(2*HSPW)	720p59, 720p60	SMPTE 296M #1, #2
10	1	2200	1920	280	44	88	148	44	176	1980	HSPW/2	2*HSPW	HTOT-HSPD-(2*HSPW)	1080p29, 1080p30, 1080p59, 1080p60	SMPTE 274M #1, #2, #7, #8
10	1	2640	1920	720	484	88	148	44	176	1980	HSPW/2	2*HSPW	HTOT-HSPD-(2*HSPW)	1080p25, 1080p50	SMPTE 274M #3, #9
10	1	2750	1920	830	594	88	148	44	176	1980	HSPW/2	2*HSPW	HTOT-HSPD-(2*HSPW)	1080p23, 1080p24	SMPTE 274M #10, #11
12	1	2376	1920	456	81	132	243	66	375	594	HSPW/2	HSPW+(3*HSPD)	HTOT/4	108Op50	SMPTE 295M #1
12	2	2376	1920	456	81	132	243	66	375	594	HSPW/2	HSPW+(3*HSPD)	HTOT/4	108Oi25	SMPTE 295M #2
15	2	2200	1920	280	44	88	148	44	176	880	HSPW/2	2*HSPW	((HTOT-HSPD-HEPW)/2)-(4*HEPW)	1080i29, 1080i30	SMPTE 274M #4, #5
15	2	2640	1920	720	484	88	148	44	176	880	HSPW/2	2*HSPW	((HTOT-HSPD-HEPW)/2)-(4*HEPW)	1080i25	SMPTE 274M #6
15	2	2750	1920	830	594	88	148	44	176	880	HSPW/2	2*HSPW	((HTOT-HSPD-HEPW)/2)-(4*HEPW)	1080i23, 1080i24	based on SMPTE 274M #6 and #11





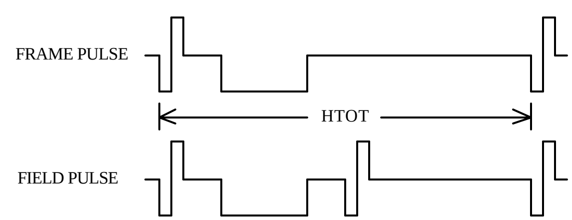
QDI DIGITAL SYNC ALIGNMENT DETAIL

Quantum Data tri-level sync types 10, 12, & 15 define the relationship between digital horizontal sync and analog composite syncsuch that the leading edge of the digital horizontal sync pulse is aligned with the leading edge of the negative alternation of thetri-level analog sync pulse. Also, the trailing edge of the digital horizontal sync pulse ends with the trailing edge of the positive alternation of the tri-level pulse.

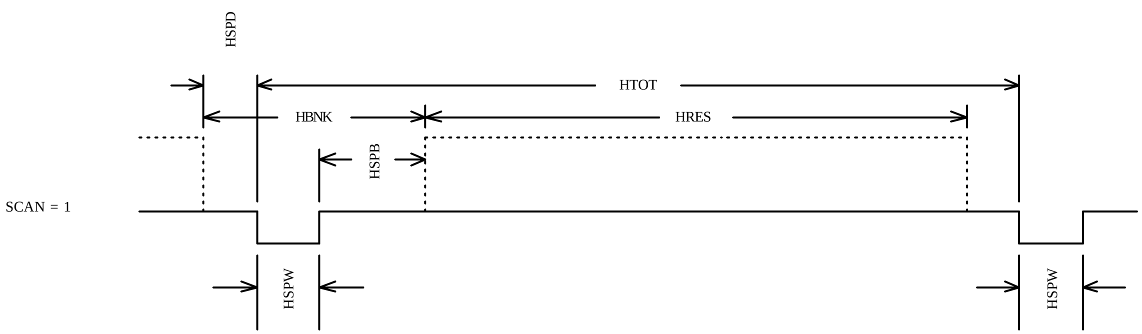


SMPTE 295M 108Op50 & 108Oi25 (ten-eight-oh) DETAIL

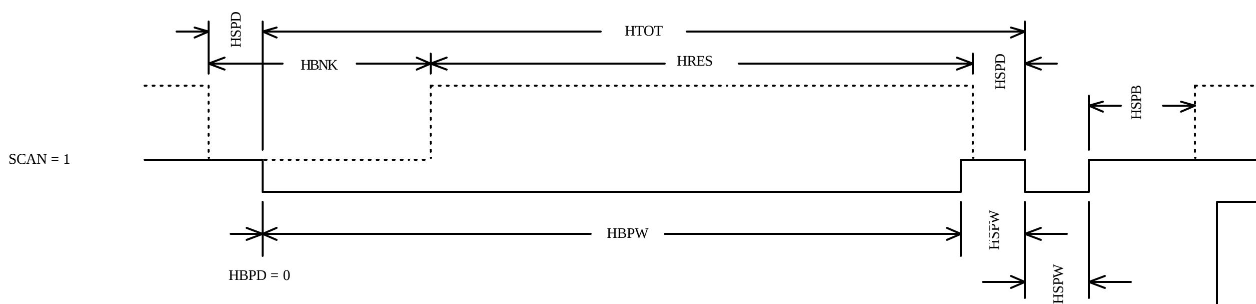
In SMPTE 295M, each vertical sync pulse consists of a single broad pulse. Progressive systems (SCAN=1) supply a single FRAME PULSE before each frame. Interlaced systems (SCAN=2), on the other hand, supply a FRAME PULSE before the first field (which contains the top time) and a FIELD PULSE before the second field.



ASCT	SCAN	HTOT	HRES	HBNK	HSPD	HSPW	HSPB	HEPW	HBPD	HBPW	HEPW =	HBPW =	FORMATS	STANDARDS
2	1	858	720	138	16	62	60	NA	NA	NA	NA	NA	DMT1043, IBM0675	EIA RS-343-A
3	1	858	720	138	16	62	60	NA	0	842	NA	HTOT - HSPW + HVSA	480p	SMPTE 293M
3	1	1144	960	184	21	83	80	NA	0	1061	NA	HTOT - HSPW + HVSA	480pWH	SMPTE 267M
3	1	1152	960	192	16	84	92	NA	0	1068	NA	HTOT - HSPW + HVSA	576pWH	ITU-R BT.601-5 Part B
3	1	1188	960	228	19	100	109	NA	0	1088	NA	HTOT - HSPW + HVSA	576pWH_	576pWH at harmonic of SMPTE 274M 148.5 MHz
4	1 or 2	858	720	138	16	62	60	31	0	413	HSPW/2	(HTOT / 2) -HSPW + HVSA	480i	ITU-R BT.470-6 TYPE M
4	2	1152	720	432	136	84	92	42	0	492	HSPW/2	(HTOT / 2) -HSPW + HVSA	576i50WL	AS 4933.1-200X (letterboxed SD @ 100 fields/sec)
4	2	1188	720	468	139	100	109	50	0	494	HSPW/2	(HTOT / 2) -HSPW + HVSA	576i50_L	576i50WL at harmonic of SMPTE 274M 148.5 MHz
4	2	1152	960	192	16	84	92	42	0	492	HSPW/2	(HTOT / 2) -HSPW + HVSA	576i50WH	AS 4933.1-200X (widescreen HD @ 100 fields/sec)
4	2	1188	960	228	19	100	109	50	0	494	HSPW/2	(HTOT / 2) -HSPW + HVSA	576i50_H	576i50WH at harmonic of SMPTE 274M 148.5 MHz
5	2	1152	720	432	136	84	92	84	0	492	HSPW	(HTOT / 2) -HSPW + HVSA	1152iLA	AS 4933.1-200X (2/1 vertical scope 576 in 1152)
5	2	1188	720	468	139	100	109	100	0	494	HSPW	(HTOT / 2) -HSPW + HVSA	1152iLA_	1152iLA at harmonic of SMPTE 274M 148.5 MHz
5	2	1536	1280	256	21	112	123	112	0	656	HSPW	(HTOT / 2) -HSPW + HVSA	1152iSH	AS 4933.1-200X (8/5 vertical scope 720 in 1152)
5	2	1584	1280	304	25	133	146	133	0	659	HSPW	(HTOT / 2) -HSPW + HVSA	1152iSH_	1152iSH at harmonic of SMPTE 274M 148.5 MHz
5	2	2304	1920	384	32	168	184	168	0	984	HSPW	(HTOT / 2) -HSPW + HVSA	1152iLH	AS 4933.1-200X (6.7% letterbox 1080 in 1152)
5	2	2376	1920	456	38	200	218	200	0	988	HSPW	(HTOT / 2) -HSPW + HVSA	1152iLH_	1152iLH at harmonic of SMPTE 274M 148.5 MHz
6	1	864	720	144	12	64	68	NA	NA	NA	NA	NA	NONE	NONE
7	1	864	720	144	12	64	68	NA	0	800	NA	HTOT - HSPW + HVSA	576p	ITU-R BT.1358
8	1 or 2	864	720	144	12	64	68	32	0	368	HSPW/2	(HTOT / 2) -HSPW + HVSA	ITU0925X	ITU-R BT.470-6 TYPE I

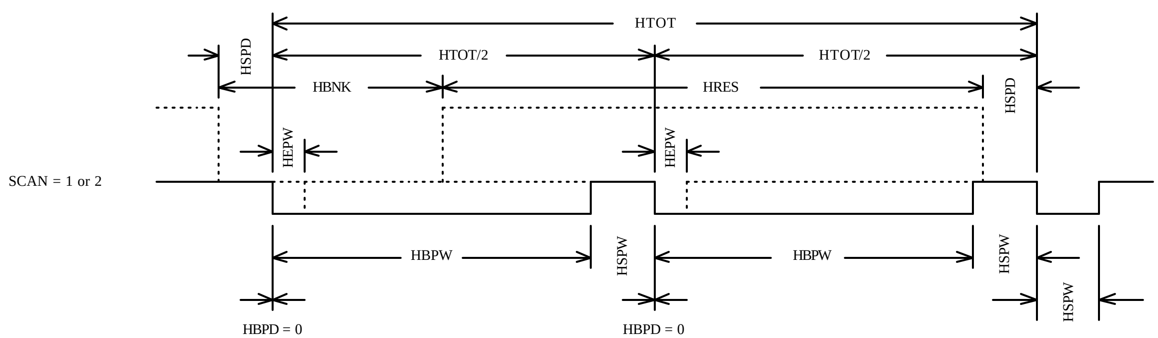


NOTES
1. NA = not applicable
2. SCAN = number of fields scanned per frame
3. ASCT = analog sync composite type
4. HVSA = 0 (horizontal vertical serration adjustment)
5. Australian types 1152iLH_ & 1152iLH are flagged by DSS HSPP ≠ VSPP (or ACS VSPW =0.5) to signal the need for a 6.7% vertical size increase, while all other Australian types have DSS HSPP = VSPP (or ACS VSPW=5).
6. Legacy Australian types are harmonically related to 144MHz, while modern equivalents are harmonics of 148.5MHz.



Bi-level Sync Modes & Timing

Version 1.3
06-19-2003
M. Stockfisch



DIGITAL SYNC ALIGNMENT DETAIL

Bi-level sync types 2, 3, 4, 6 & 8 define the relationship between digital horizontal sync and analog composite sync such that the leading and trailing edges of the digital horizontal sync are aligned with the leading and trailing edges of the bi-level analog syn. The leading and trailing edges of vertical sync are aligned with the leading edge of horizontal sync.