



# Viewer License Agreement

## You Must Read This License Agreement Before Proceeding.

This Scroll Wrap License is the Equivalent of a Shrink Wrap ⇒ Click License,  
A Non-Disclosure Agreement that Creates a “Cone of Silence”.

By viewing this Document you **Permanently Release All Rights** that would allow you to restrict the **Royalty Free Use** by anyone implementing in Hardware, Software and/or other Methods in whole or in part what is Defined and Originates here in this Document. This Agreement particularly **Enjoins** the viewer from: Filing any **Patents** (À La Submarine?) on said **Technology & Claims** and/or the use of any **Restrictive Instrument** that prevents anyone from using said **Technology & Claims** Royalty Free and without any Restrictions. This also applies to registering any **Trademarks** including but not limited to those being marked with “™” that Originate within this Document. **Trademarks** and **Intellectual Property** that Originate here belong to the **Author** of this Document unless otherwise noted. Transferring said **Technology** and/or **Claims** defined here without this Agreement to another Entity for the purpose of but not limited to allowing that Entity to circumvent this Agreement is Forbidden and will NOT release the Entity or the Transfer-er from Liability. Failure to Comply with this Agreement is **NOT** an Option if access to this content is desired. This Document contains **Technology & Claims** that are a **Trade Secret: Proprietary & Confidential** and that cannot be transferred to another Entity without that Entity agreeing to this “Non-Disclosure Cone of Silence” **V.L.A.** Wrapper. Combining **Other Technology** with said **Technology** and/or **Claims** by Entity is an acknowledgment that the Entity is automatically placing **Other Technology** under the Licenses listed below making this License Self-Enforcing under an agreement of Confidentiality protected by this Wrapper.

The contents of/and this Document are released under the following licenses so long as this Agreement remains attached to any and all files, papers, etc... that contain any said **Technology** and/or **Claims**. Any Hardware manufactured with said **Technology** and/or **Claims** must contain a brief message, e.g. “**V.L.A.** This Hardware contains Technology and/or Claims that are Licensed for Unrestricted and Royalty Free Use. Any knowledge gained by viewing this hardware design may not be used to file any patents, employ any restrictions, or interfere with the manufacture, sale and use of this hardware”.

Software only: [GNU General Public License 2.0 \(GPL\)](#)

Hardware (w/ || w/o software): Tucson Arizona Packet Radio TAPR [PDF](#) [ODT](#) [TXT](#)

This Document is licensed under [Creative Commons](#) so long as this V.L.A. remains attached to the contents of this document in whole or in part. It may be re-distributed and hosted anywhere.

Open Source ([CC BY 4.0](#)), Proprietary ([CC BY-ND 4.0](#))

Scrolling past this page is **The Point of No Return** and Acknowledges that You have Agreed to the Terms above. If you are Unable or Unwilling to Agree to these Terms then Close this Document.

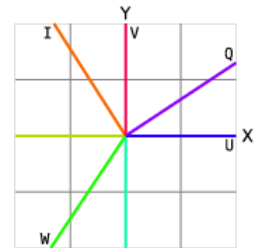
**R, G, B, Range:** 0–1

$$\begin{aligned}
 Y &= 0.299 \times \text{Red} + 0.587 \times \text{Green} + 0.114 \times \text{Blue} \\
 U &= 0.492111 \times (B - Y) \quad (0.4921110411) \\
 V &= 0.877283 \times (R - Y) \quad (0.8772832199) \quad \text{Phase inverted @ } \frac{1}{2}H \\
 W &= -0.509370 \times (R - Y) - 0.194208 \times (B - Y) \leftarrow [G - Y] \\
 &\quad (-0.5093696834) \quad (-0.1942078377) \\
 I &= 0.595901 \times \text{Red} - 0.274557 \times \text{Green} - 0.321344 \times \text{Blue} \\
 &\quad (0.5959007249) \quad (-0.2745567667) \quad (-0.3213439582) \\
 Q &= 0.211537 \times \text{Red} - 0.522736 \times \text{Green} + 0.311200 \times \text{Blue} \\
 &\quad (0.2115366883) \quad (-0.5227362571) \quad (0.3111995688)
 \end{aligned}$$

	HSV
	Hue
<b>U</b> #2900FC	249.76°
<b>V</b> #FF0056	339.76°
<b>W</b> #1BFA00	113.52°
<b>I</b> #FC6600	24.29°
<b>Q</b> #8900FE	272.36°

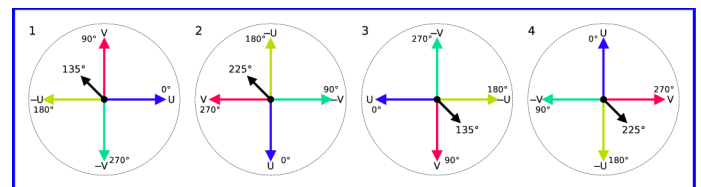
	<b>IRE=1V/140</b>
Luma (Y) Level:	98 700mV
Sync:	-42 300mV
ColorBurst:	±21 ±150mV
Max (Yl & Cy)	130 $\frac{2}{3}$ 1.23V
Min (Rd & Bl)	-32 $\frac{2}{3}$ 66 $\frac{2}{3}$ mV

For more information on signal levels, **Luma/Chroma** matrixing, composite & vector scope images and other info see **NTSC Specifications** .



	<b>1931 CIE</b>
<b>Rec.709 sRGB Gamut</b>	<b>x y nm</b>
<b>Red</b>	0.64 0.33 ~607
<b>Green</b>	0.30 0.60 ~556
<b>Blue</b>	0.15 0.06 ~467
White Point	0.3127 0.329 6504°K
Contrast 2 <sup>12</sup> :1	Gamma 2.4

**PAL On Screen Vector Rotation & V Switch Phases**



## Colorburst & Carrier

The **PAL** line phase alternation signal for **V** uses the standard **135°(+)** / **225°(-)** phase toggling of the colorburst. Synchronous detection on a reduced carrier level will increase signal quality. The option of a 1/3MHz data channel where the composite signal modulates the **I** channel and the data modulates the **Q** channel is possible.

## Claims:

- Using a **3:1** interlace with the **4** phase states of **PAL Chroma** produces a **Luma/Chroma** fine mesh harmonic spacing of 1/2 the frame rate of **12Hz** and a **2** frame repeat rate like **NTSC**.
- A **3:1** interlace also creates Hanover lines instead of bars within a completed frame that are stationary and do not scroll unlike a **2:1** interlace; i.e. the hue palette phase rotation reverses on alternate lines of a field and a full frame whereas with a **2:1** interlace the rotation reversal is with alternate line pairs of a frame that alternate the hue palette phase rotation for every full frame. This makes any hue error effects twice as fine compared to a **2:1** interlace.
- On a per frame basis the diagonal **Chroma** dot pattern for **U & V** is similar to **NTSC** and for axes rotated **45°** away, nearer to **I & Q** the pattern is identical.
- A **3:1** interlace offers **24PsF, 36PsF, & 72fps** motion refresh. For the faster **36 & 72** refresh rate line interpolation for the missing lines can be used for good quality de-interlaced full frame motion.

## 3:1 Interlace

Vertical scan is from top to bottom and the field lines shift down 1/3 horizontal field line per field instead of 1/2 line in a **2:1** interlace. This will produce **2** hammer heads during the vertical blank, offset from the center to each side, or **3** hammer heads separated and centered within the vertical blanking. The vertical sync of the **1<sup>ST</sup>** field is delayed by **1** horizontal line in relation to the other **2** fields. This is necessary to arrange the on screen **Chroma** dots in a uniform diagonal pattern to facilitate the use of a standard **PAL 3** line [diagonal] comb filter for **Luma/Chroma** separation for both field and frame. The **Chroma** dot pattern repeats at a **2** frame interval and complete **Luma/Chroma** separation for static/non-motion areas is realized using an **NTSC** field comb of **1** frame delay.



Full Wide Definition

FWVGA

**PAL-Film**

**24PsF**

**480i72**

**16:9**

+46<sup>2</sup>/<sub>3</sub>% better than NTSC-M/PAL-M within a 6MHz Channel Space  
 64×36cm ⇒ 73<sup>1</sup>/<sub>2</sub>cm/29" Diag, 750µm Line Pitch, 3.172MHz Chroma

General:

Aspect Ratio	16:9	1/2 Contrast	357:240 ≈ 1.4874
Total Picture Pixels (Digital)	854×480 ; 409920 Pixels		714×480 ; 342720
Kell Factor (Analog Resolution)	604×340 ; 204960 Pixels		505×340 ; 171360
Maximum Digital Equiv. @-9dB	856×480 ; 410880 Pixels		606×340 ; 205440

Vertical:

Frames Per Second	24Hz	Pixel Aspect 1.196:1
Total Lines Per Frame	526	33 <sup>1</sup> / <sub>3</sub> / 15 ScanLines/Inch
Fields Per Second	72Hz	
Total Lines Per Field	175 <sup>1</sup> / <sub>3</sub>	
Picture Lines	160	
Lines Per Blank	15 <sup>2</sup> / <sub>3</sub>	
Blank	1.215ms	
Sync	185µs ; 2 <sup>1</sup> / <sub>3</sub> Lines	

Horizontal:

Resolution Fair:	504 <sup>5</sup> / <sub>6</sub>	Max@-9dB:606
Lines Per Second	12.624kHz	
Period (HP)	79.214µs (502 <sup>1</sup> / <sub>2</sub> )	
Picture	69.913µs (443 <sup>1</sup> / <sub>2</sub> )	OverScan
Total Picture Pixels	524 <sup>2</sup> / <sub>3</sub> ≈ 1 <sup>2</sup> / <sub>3</sub> × YBW × (HP-HB) ; (504 <sup>5</sup> / <sub>6</sub> + 19 <sup>5</sup> / <sub>6</sub> ) ≈ 3 <sup>3</sup> / <sub>4</sub> %, 2 <sup>3</sup> / <sub>5</sub> µs	
Viewable Picture Pixels/Line	504 <sup>5</sup> / <sub>6</sub> ; 67.312µs (427×2 Dot Clock)	
Blank (HB)	9.301µs (59 )	
Front Porch	1.025µs ( 6 <sup>1</sup> / <sub>2</sub> )	Horiz = 23.999Hz × 526
Sync	3.547µs (22 <sup>1</sup> / <sub>2</sub> )	↳ 12623.518Hz × 283 <sup>1</sup> / <sub>4</sub>
Back Porch	4.729µs (30 )	= 3.575611494MHz
		LSB:1 <sup>1</sup> / <sub>2</sub> USB:1 <sup>1</sup> / <sub>8</sub> MHz
		PAL-M Chroma

Luma & Chroma:

Luma (Y) Bandwidth @-3dB	4 <sup>1</sup> / <sub>2</sub> MHz, Full Cut @ 4 <sup>3</sup> / <sub>4</sub> MHz
Vestigial Sideband	7 <sup>5</sup> / <sub>8</sub> MHz, Corner 5 <sup>5</sup> / <sub>8</sub> MHz, Carrier @ +889.76kHz
Chroma:	Sub-Sampling 2 <sup>2</sup> / <sub>5</sub> :1:1
Sub-Carrier	3.17178MHz ; 8× ⇒ 25.37424MHz
1/2H Odd Harmonic	502 <sup>1</sup> / <sub>2</sub> :251 <sup>1</sup> / <sub>4</sub> :167 <sup>1</sup> / <sub>2</sub>
U Bandwidth	1 <sup>7</sup> / <sub>8</sub> MHz (USB +1 <sup>1</sup> / <sub>3</sub> MHz & LSB -1 <sup>7</sup> / <sub>8</sub> MHz)
V Bandwidth	1 <sup>7</sup> / <sub>8</sub> MHz (USB +1 <sup>1</sup> / <sub>3</sub> MHz & LSB -1 <sup>7</sup> / <sub>8</sub> MHz)
Color Burst Duration	2.522µs ; 8 cycles 2×(1 <sup>1</sup> / <sub>2</sub> +8+5 <sup>1</sup> / <sub>2</sub> )=30
Baseband Guard	1 <sup>4</sup> / <sub>5</sub> 1MHz

MTS Sound:

	(L+R)	(L-R)	(SAP)
Sub-Carrier Frequency	4.86024MHz	FM ±25kHz, ±25kHz, ±15kHz	
H Harmonic	385	±73kHz Total peak modulation.	
L+R Equalization	75 µs	Pre-Emphasis	
L-R Sub-Carrier	37.872 kHz	AM DSB-SC	3×H
Pilot	18.936 kHz		1 <sup>1</sup> / <sub>2</sub> ×H
Encoding/Compression	Zenith-dbx (THAT Corp.) See NTSC Specifications		

Rec.709 sRGB Gamut

x	y	Temp
0.3127	0.329	6504°K
Contrast 2 <sup>12</sup> :1	Gamma ~2.4	

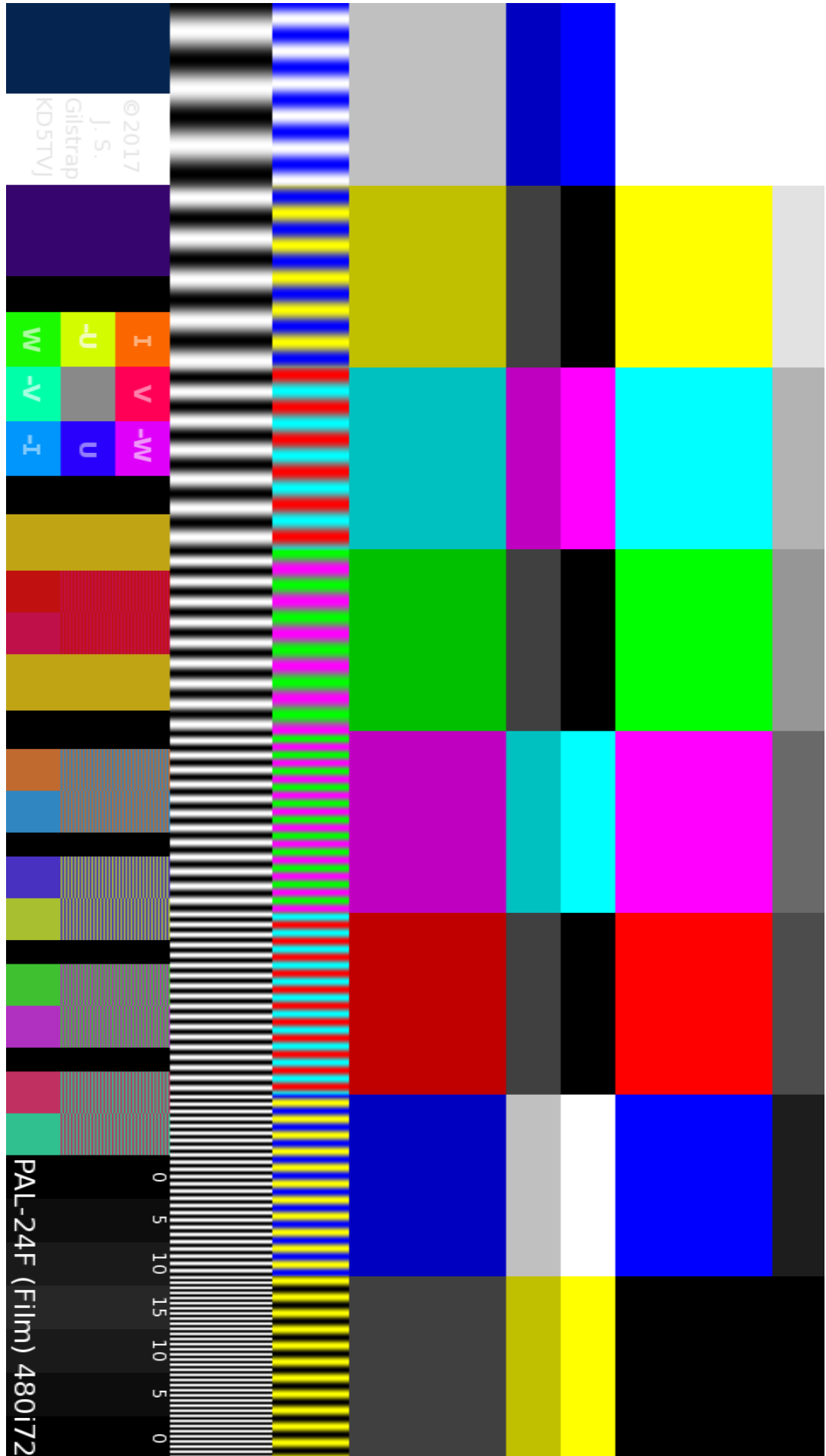
↕ Chroma LoR/Freq: 90<sup>2</sup>/<sub>3</sub>kHz, 180/1<sup>1</sup>/<sub>3</sub>MHz

# 854x480

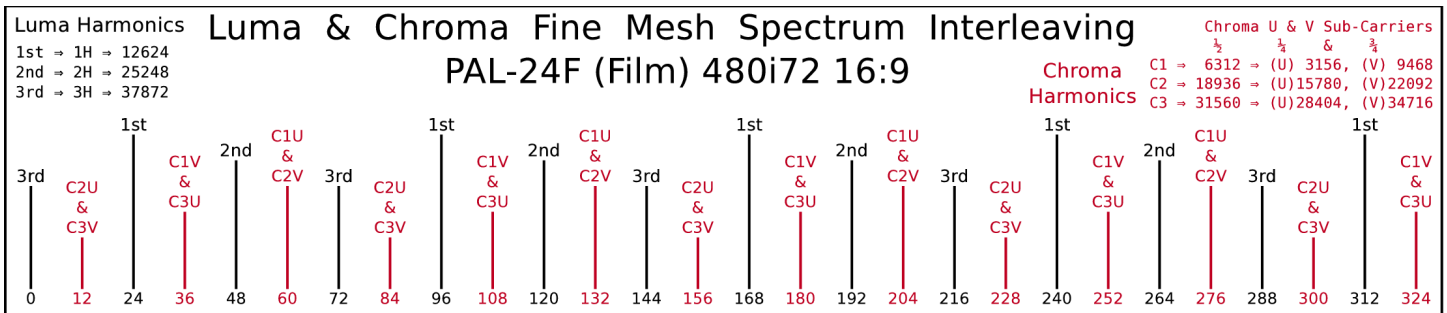
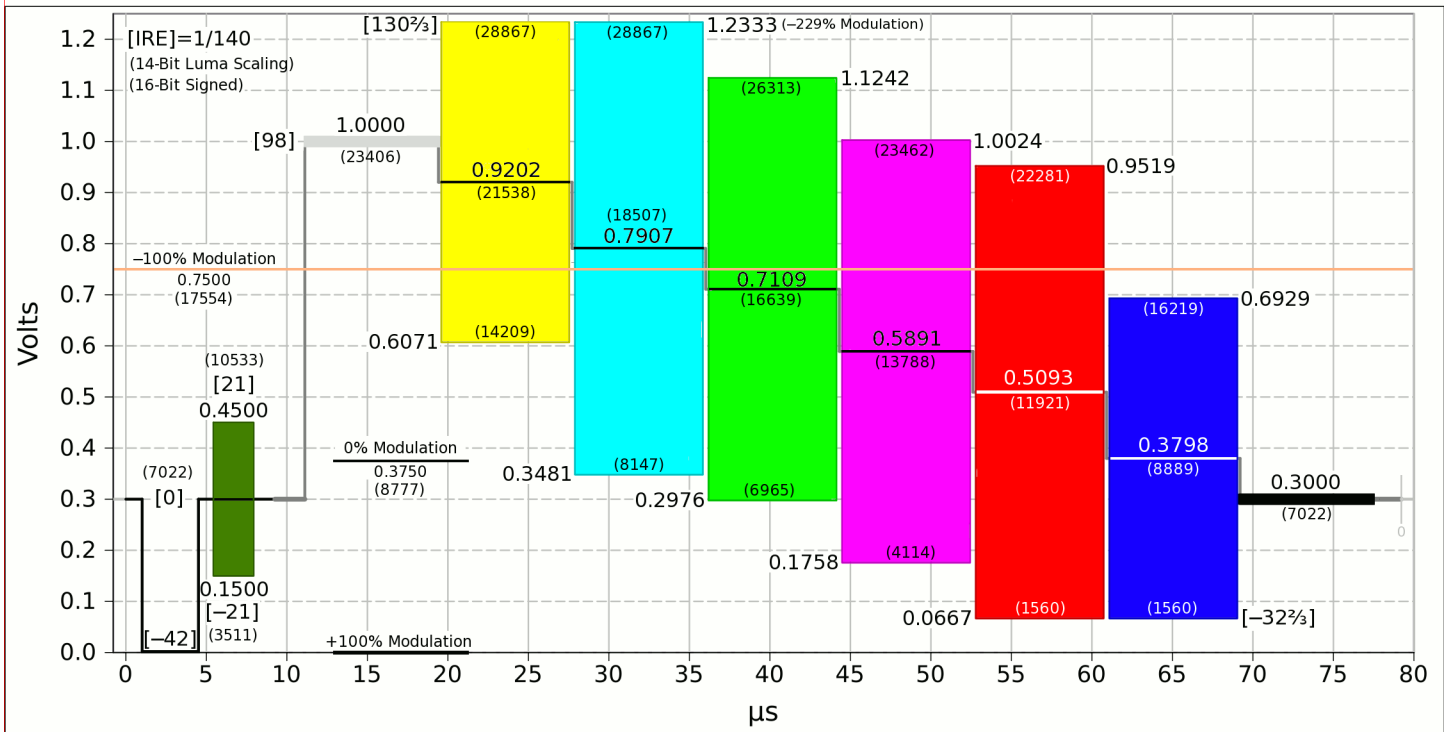
Expanded to  
1708

2x HorizSample

378.720kHz  
30x12624Hz  
( 51 Lines)



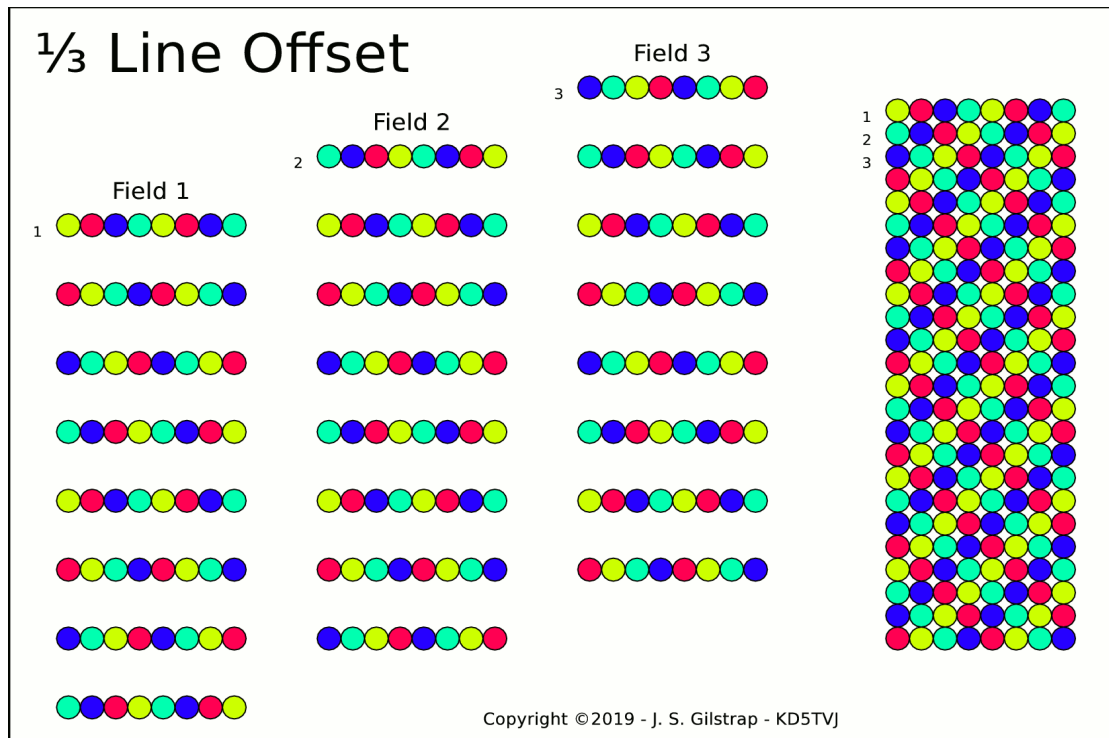
# PAL-24F (Film) 480i72 16:9 Composite Luma/Chroma



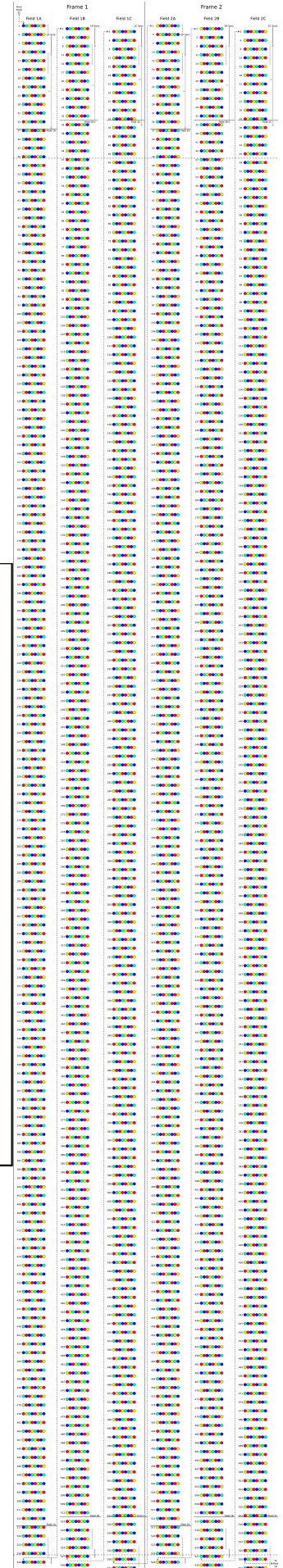
In the image above using a 3:1 interlace the normalized spectrum distribution of Luma with PAL Chroma is shown at the fine mesh level. The 3:1 interlace with a 72Hz field rate ending with  $\frac{1}{3}$  line causes the Luma and Chroma harmonics to be placed at 24Hz intervals which is also the frame rate. When a 3:1 interlace is used with PAL Chroma the sub-carrier is placed at  $3 \times H \times [\text{Integer} + \frac{1}{2}] \div 2$  (H = Horizontal Sync) so at the coarse mesh level the U & V Chroma clusters will lie on the  $\frac{1}{4}$  &  $\frac{3}{4}$  offsets respectively, in between the Luma Clusters. Having both the Luma and Chroma fine mesh harmonics spaced at 24Hz intervals for cluster triads, the Chroma SC being placed on the  $\frac{1}{4}$  mark, and that H/2 is evenly divisible by 24 means that all Chroma harmonics are shifted by  $\pm 12\text{Hz}$  off center thus moving them away from interference with the Luma and placing them exactly centered in between them. The  $\frac{1}{4}$  &  $\frac{3}{4}$  offsets also creates overlapping Chroma harmonics from the U & V channels in a triad configuration of: C1V & C3U, C1U & C2V, and C3V & C2U. This is a repeating 3 cluster pattern even when shifting over 1 cluster at a time. A Fourier spectral analysis has not been done but for the overlapping harmonics it can be assumed that some may be constructive and increase in strength and others may be completely destructive and create Fukinuki holes. The most desirable outcome would be for Chroma harmonics which are from adjacent Chroma clusters and are centered within a Chroma cluster are constructive and those that are centered within the Luma clusters are destructive and are the ones creating the Fukinuki holes. For the Luma the reverse is not true as it is not sub-modulated. For both Luma and Chroma the harmonics for each cluster are spaced 72Hz apart and for a cluster triad there is a 24Hz offset between the 3 so a combined triad of harmonics creates the 24Hz interval. As with a 2:1 interlace the energy in between the Luma clusters is minimal and is where and why the Chroma clusters were placed there originally. The void of strong harmonics in between the Luma clusters for a 3:1 interlace is probably very similar to a 2:1 interlace. Even if the voids are not as defined as a 2:1 interlace the Luma/Chroma fine mesh harmonic separation at the 12Hz interval is as evenly spaced as NTSC's 15Hz interval which is FrameRate/2 for both.

To the right is the chroma dot sequence for a **526** line format using a  $\frac{1}{3}$  line offset. It shows the **2** frame repeat rate where the chroma dots are inverted on the even frames and the odd frames are non-inverted, or vice-versa, for an on screen per spot basis. The staggered vertical sync pulses cause the chroma dots to align diagonally on screen to create a uniform pattern. The dots are colored for the **U** & **V** axes where they each rotate **90°** per line in opposite directions. This also causes the axes close to **I** & **Q** to invert **180°** every **2** lines in a flip-switch manner. The directions that **U** & **V** rotate (shift) on screen will depend on whether the **H/2** multiplier ends with  $\frac{1}{4}$  or  $\frac{3}{4}$ , **625** PAL ends with  $\frac{3}{4}$  while **525** PAL-M & **625** PAL-N ends with  $\frac{1}{4}$  causing chroma dot patterns to be a mirror image of each other. Depending on whether  $\frac{1}{4}$  or  $\frac{3}{4}$  is used, in the image to the right the diagonal representation of the dots for **U** or **V** may or may not be mirror reversed along the vertical.

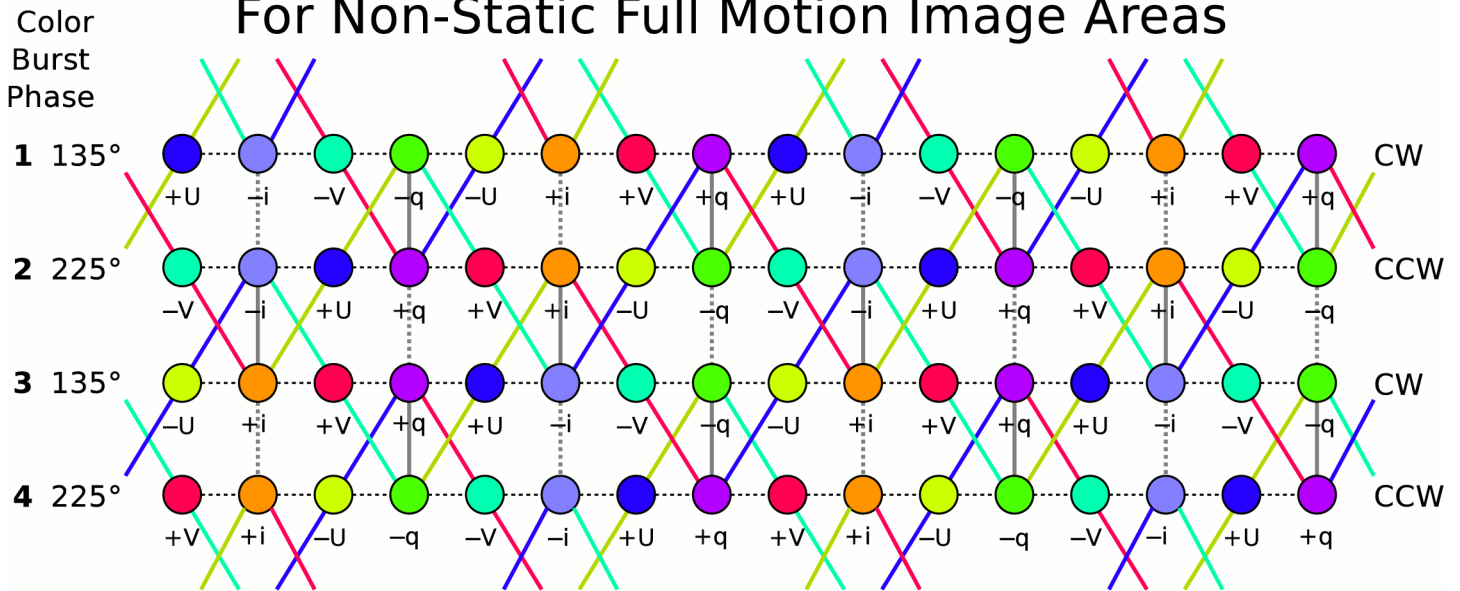
To view the full **526** lines of chroma rotation for **2** frames zoom in on the diagram to the right. You can also highlight the image within the pdf and copy it to the clipboard and then paste it onto an image editor like The GIMP or Photoshop.



In the diagram above are the **3** fields of chroma dots separated out and also combined revealing the uniform diagonal pattern. In the left half the separated fields are vertically staggered to each other so the **4** line chroma repeat pattern is aligned between the fields. Field **1** starts with line **1** of a frame, field **2** with line **2**, and field **3** with line **3**. When assembled and properly staggered vertically the pattern on the right is realized.



# Per Field Luma Separation 3 Line Processing For Non-Static Full Motion Image Areas



For **Luma** samples that fall on **U** or **V Chroma** Sample points there are 2 **Luma** samples from **i** & **q** sample points from adjacent lines on the diagonal that when added together will form the complimentary color to cancel out the **Chroma** on each **Luma** sample. The mapping is shown via the complimentary color lines connected to an **U** or **V** sample and the associated **i** & **q** samples. The ratio is  $(\sqrt{2}:2:\sqrt{2})/(1+\sqrt{2})/2$ .

For **Luma** samples that fall on **i** or **q** sample points **i** or **q** points directly above or below on adjacent lines are added or subtracted to cancel out **Chroma** on each **Luma** sample point. The mapping is shown via gray lines. Solid lines are additive and dotted lines are subtractive. The ratio is  $\pm\frac{1}{4}:\frac{1}{2}:\pm\frac{1}{4}$ .

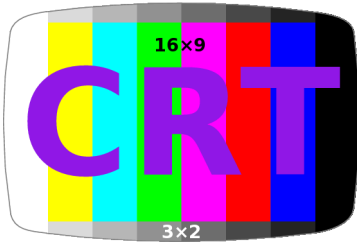
Since **Luma** sample recovery on **U** or **V** sample points is all additive it provides noise reduction but **Luma** sample recovery on **i** or **q** sample points have some S/N loss since adjacent lines are subtracted nullifying **Luma** but additive for the complimentary color that cancels out **Chroma** on the current line leaving only the **Luma** from the current line but also the noise from the adjacent lines.

To average out this noise variation between the **i** & **q** and **U** & **V** sample points the recovered **Luma** on a line can be a running average of 3 points in a  $\frac{1}{4}:\frac{1}{2}:\frac{1}{4}$  ratio or 5 points in a  $\frac{4}{5} \times (\frac{1}{8}:\frac{1}{4}:\frac{1}{2}:\frac{1}{4}:\frac{1}{8})$  ratio. This averaging has minimal effect on sharpness since the sample rate is  $\sim 3\frac{3}{4}$  times the image resolution.

To eliminate **Luma** and obtain **Chroma** it can be as simple as subtracting adjacent lines from the current line as in NTSC with the  $\frac{1}{4}:\frac{1}{2}:\frac{1}{4}$  ratio. Unlike NTSC the adjacent lines do not contribute any to **Chroma** levels but just nullify the **Luma**. The **Chroma** on the adjacent lines are inverted to each other so when they are added together the **Chroma** is nullified. Inverting these 2 summed lines will produce inverted **Luma** which will nullify the **Luma** on the current line Leaving only the quadrature **Chroma** signal to be used for **Chroma** decoding. However this method does not correct for hue phase errors and some lines of **Chroma** resolution are lost nor does it produce the best S/N ratio.

Subtracting one line, above or below from the current line will eliminate the **Luma** and either the **i** or **q Chroma** channel. This method will correct for hue phase errors and produce much better S/N ratio but the **Chroma** lines of resolution will be cut in half. Which **Chroma** channel that will be eliminated and which one will remain will depend on which chroma phase rotation the current line is using. 1: 1-4  $\Rightarrow$  +**i**, 1-2  $\Rightarrow$  +**q** ; 2: 2-1  $\Rightarrow$  -**q**, 2-3  $\Rightarrow$  -**i** ; 3: 3-2  $\Rightarrow$  +**i**, 3-4  $\Rightarrow$  +**q** ; 4: 4-3  $\Rightarrow$  -**q**, 4-1  $\Rightarrow$  -**i**. For positive values: 1-4 & 3-2  $\Rightarrow$  +**i** ; 1-2 & 3-4  $\Rightarrow$  +**q** and for negative 4-3 & 2-3  $\Rightarrow$  -**i** ; 2-1 & 4-3  $\Rightarrow$  -**q**

Since the **Chroma** sub-carrier is inverted 180° from frame to frame to average out **Luma** brightness two frames can be added or subtracted to obtain the **Luma** or **Chroma** respectively so motion free static image areas will produce full **Luma/Chroma** separation without any artifacts. This will produce the highest resolution and best S/N ratio but unless adjacent line **Chroma** information is incorporated with the current line any hue phase errors that exist will not be canceled out but will produce Hanover lines that may be visible and viewer must rely on visual blending for the correct hue.



enhanced Full Wide Definition

eFWVGA

**PAL-AR1½**

**24PsF**

**528i72**

**3:2**

+53½%+67¼% better than NTSC-M/PAL-M within a 6MHz Channel Space  
 +7½% better than PAL-B/G and -10½% worse than PAL-D/K

6560×40cm⇒76%72½cm/3028½" Diag, 758µm Line Pitch, 3.298MHz Chroma  
 ~16:9 Aspect (928×528, 58:33) 71×40cm ⇒ 81½cm/32" can be realized using a 7MHz channel space  
 NTSC-M/PAL-M +84%, PAL-B/G +29%, PAL-D/K +7½% ½ Contrast 1.4059

General:

Aspect Ratio	3:2 = 1½ (1.75)	679:528 ≈ 1.286 1.5398
Total Picture Pixels (Digital)	792×528 ; 418176 Pxls	742 813 679×528 ; 358512 429264
Kell Factor (Analog Resolution)	560×373 ; 209088 Pxls	525 575 480×373 ; 179256 214632
Maximum Digital Equiv. @-9dB	815×528 ; 430320 Pxls	576×373 ; 215160

Vertical:

Frames Per Second	24 Hz 24.047(+½%)	16:9 Stretched 1.382:1 (1.156:1)
Total Lines Per Frame	578	33½ ScanLines/Inch
Fields Per Second	72 Hz 72.142	
Total Lines Per Field	192½	858×528
Picture Lines	176	13:8 = 1% (1.625)
Lines Per Blank	16½	
Blank	1.201ms	(574%)
Sync	192µs ; 2½ Lines	(525)



Horizontal:

Resolution	Fair:480¼	Max@-9dB:576 (690) (634)
Lines Per Second	13.872kHz 13.899	(525+25) (5½%/2%µs)
Period (Hp)	72.088µs (475½)	(574%+32½%) (5.3%/3¼µs)
Picture	(62.862µs) (62.796µs) 62.840µs (414½) (490) (449%)	OverScan
Total Picture Pixels	(550) (607) 502¾ ≈ 1¾×YBW×(Hp-Hb) ; (480¼+22½) ≈ 4½%/2½µs	
Viewable Pixels/Line	(525) (574%) 480¼ ; 60.035µs (59.464µs) (59.99µs) (396×2) Dot	
Blank (Hb)	(9.23µs, 66) 9.248µs (61) (9.3µs, 72½)	(464×2) (429×2) Clock
Front Porch	(0.979µs, 7) 0.985µs (6½) (1µs, 8)	This mode uses ⅓ line offset
Sync	(3.496µs, 25) 3.487µs (23) (3.52µs, 27%)	so vertical sync in 1st field is
Back Porch	(4.755µs, 34) 4.776µs (31½) (4.74µs, 37)	advanced instead of being

(5¼MHz⇒5½MHz ; 150kHz VSB)

the ⅓ line offset mode.

Luma & Chroma:

Luma (Y) Bandwidth @-3dB	4½MHz ; Full Cut 5MHz	PAL-M Chroma
Vestigial Sideband	⅝MHz, Corner ⅜MHz	2%:1:1 515½ :257%:171½
Chroma:	Sub-Sampling 3½:1:1	3:1:1 3.575611MHz
Sub-Carrier	3.298068MHz ; 8× ⇒ 26.384544 MHz	3.9015MHz
½H Odd Harmonic	475½:237¾:158½	562½:281%:187% 8× ⇒ 31.212MHz
U Bandwidth	(1%) 1½MHz (USB +1½MHz & LSB -1½MHz)	USB 1%MHz
V Bandwidth	(1%) 1½MHz (USB +1½MHz & LSB -1½MHz)	LSB 1%MHz
Color Burst Duration	2.72µs ; 9 cycles	2×(2¾+9+4)=31½
Baseband Guard	(1%) 1½ MHz	10 9 2×(3½+10+5)=37 2×(3+9+5)=34

MTS Sound:

Sub-Carrier Frequency	(5.615343MHz) (6.193848MHz)	(L+R) (L-R) (SAP)
H Harmonic	5.195064MHz	FM ±25kHz, ±25kHz, ±15kHz
L+R Equalization	(404) 374½ (446½)	±73kHz Total peak modulation.
L-R Sub-Carrier	75 µs Pre-Emphasis	
Pilot Tone	(38.223) 38.148kHz DSB-SC AM	2¾×H
Encoding/Compression	(19.112) 19.074kHz	1⅜×H
	Zenith-dbx (THAT Corp.)	See NTSC Specifications

Rec.709 sRGB Gamut

White Point 0.3127 0.329 6504°K

Contrast 2<sup>22</sup>:1 Gamma ~2.4

↓ ↓ Chroma LoR/Freq: 74⅞/⅝MHz, 149⅞/1¼MHz



**792x528**

Expanded to  
**1584**

2x  
HorizSample

388.416kHz  
28x13872Hz  
( 46<sup>5</sup>/<sub>8</sub> Lines)

568.752kHz  
40x13872Hz  
( 66<sup>5</sup>/<sub>8</sub> Lines)

776.832kHz  
56x13872Hz  
( 93<sup>3</sup>/<sub>8</sub> Lines)

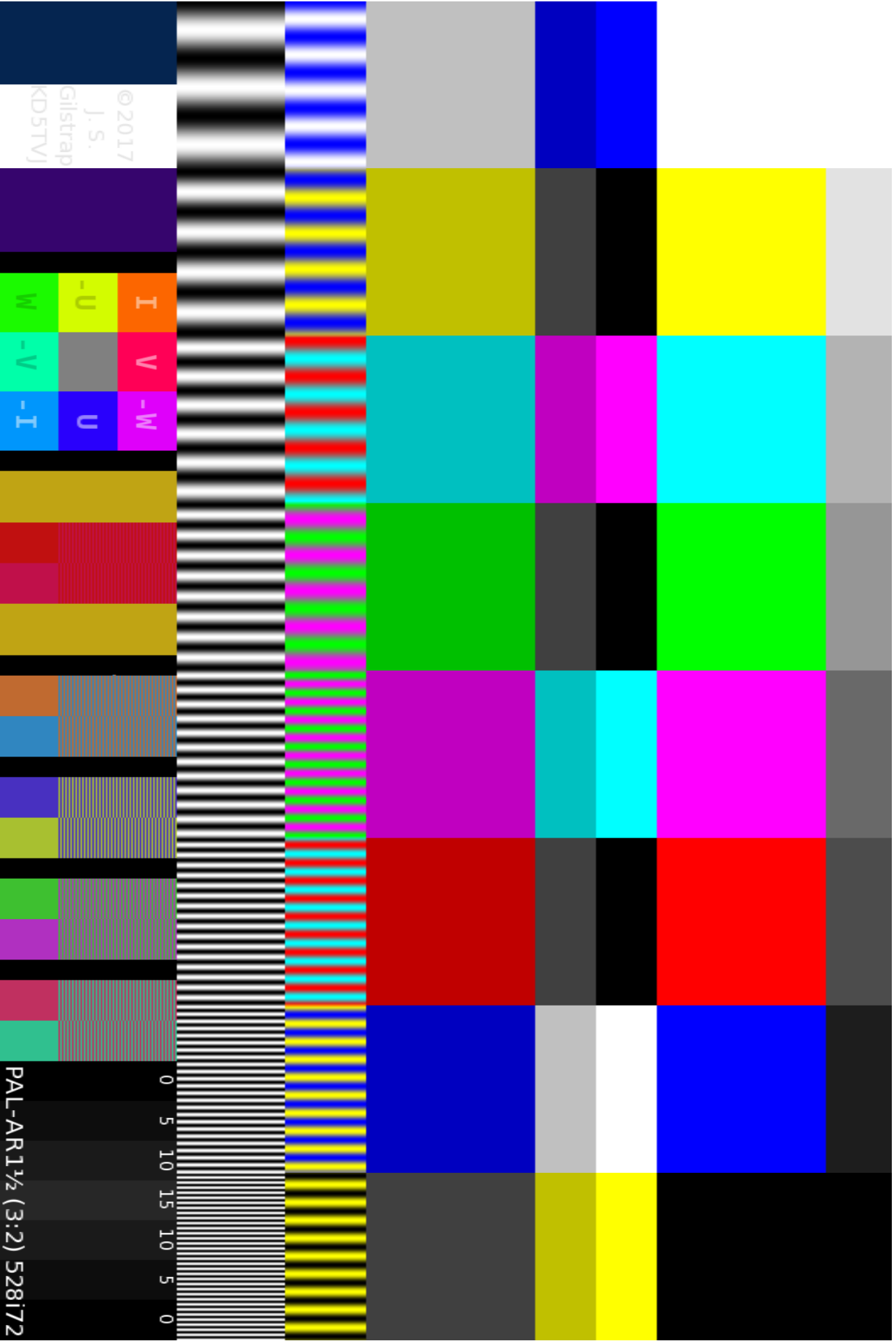
1.095888MHz  
79x13872Hz  
(131<sup>3</sup>/<sub>8</sub> Lines)

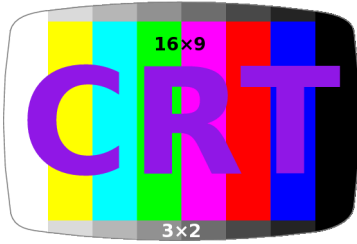
1.553644MHz  
112x13872Hz  
(186<sup>1</sup>/<sub>2</sub> Lines)

2.247264MHz  
158x13872Hz  
(263<sup>3</sup>/<sub>8</sub> Lines)

3.107328MHz  
229x13872Hz  
(373 Lines)

4.397424MHz  
317x13872Hz  
(528 Lines)





Full Definition

**PAL-DVD**

**24PsF**

**480i72**

FVGA

**3:2**

+36½%

+32% better than NTSC-M/PAL-M within a 5MHz Channel Space

22½"×15" ⇒ 27"/68.7cm Diag, 794µm Line Pitch, 2.679MHz Chroma

General:

Aspect Ratio	3:2 = 1½	½ Contrast	129:96 = 1.345
Total Picture Pixels (Digital)	720×480 ; 345600 Pixels		643×480 ; 308640
Kell Factor (Analog Resolution)	509×340 ; 172800 Pixels		455×340 ; 154320
Maximum Digital Equiv. @-9dB	772×480 ; 370560 Pixels		546×340 ; 185280
	(798)		(564) (1.083:1)

Vertical:

Frames Per Second	24 Hz	Pixel Aspect 1.120:1
Total Lines Per Frame	518	16:9 Stretched 1.328:1
Fields Per Second	72 Hz	32 ScanLines/Inch
Total Lines Per Field	172⅔	
Picture Lines	160	
Lines Per Blank	12⅔	
Blank	1.02ms	
Sync	188µs ; 2⅓ Lines	



Horizontal:

Resolution Fair:	454¾	Max@-9dB:545¾
Lines Per Second	12.432kHz	(564)
Period (HP)	80.438µs (424½)	
Picture	71.152µs (375½)	OverScan
Total Picture Pixels	474⅓ ≈ 1⅔ × BW × (HP-HB) ; (454¾ + 19⅓) ≈ 4⅛%	2.937µs
Viewable Picture Pixels/Line	454¾ ; 68.216µs (360×2 Dot Clock)	
Blank (HB)	9.285µs (49)	
Front Porch	1.042µs ( 5½)	
Sync	3.506µs (18½)	
Back Porch	4.737µs (25)	

Luma & Chroma:

Luma (Y) Bandwidth @-3dB	4⅓ ⇒ 4⅓ NTSC Luma/Sound Carrier Alignment w/½MHz VSB Reserve
	4MHz, Full Cut 4¼MHz
	Vestigial: ¾MHz, Corner ½MHz
Chroma:	Sub-Sampling 3:1:1 (2⅔:1:1)
Sub-Carrier	2.638692 MHz ; 8× ⇒ 21.109536MHz
½H Odd Harmonic	424½:212¼:141½
U Bandwidth	(1½) 1⅓MHz (USB +1⅓MHz & LSB -1⅓MHz)
V Bandwidth	(1½) 1⅓MHz (USB +1⅓MHz & LSB -1⅓MHz)
Color Burst Duration	2.653µs ; 7 cycles 2×(1¼+7+4¼)=25
Baseband Guard	(⅞) 1 MHz

5MHz BW Sound: On Q channel of main carrier w/NB Sound on pg.21 or 5.1 Digital: MP3/Vorbis/Opus COFDM-SC

6MHz BW MTS Sound:

	(L+R)	(L-R)	(SAP)
Sub-Carrier	4.500384MHz	FM ±25kHz, ±25kHz, ±15kHz	
H Harmonic	362	±73kHz Total peak modulation.	
L+R Equalization	75µs Pre-Emphasis		
L-R Sub-Carrier	37.872 kHz AM DSB-SC ; Pilot 18.936 kHz	1½×H	
Encoding/Compression	Zenith-dbx (THAT Corp.)	See NTSC Specifications	

Rec.709 sRGB Gamut x y  
 White Point 0.3127 0.329  
 Contrast 2<sup>12</sup>:1 Gamma ~2.4

Temp  
6504°K

↓↓ Chroma LoR/Freq: 74%/555kHz, 149¼/1.111MHz

720x480

315.60kHz  
(42<sup>3</sup>/<sub>8</sub>)

441.840kHz  
(59<sup>3</sup>/<sub>8</sub>)

631.200kHz  
(85<sup>1</sup>/<sub>2</sub>)

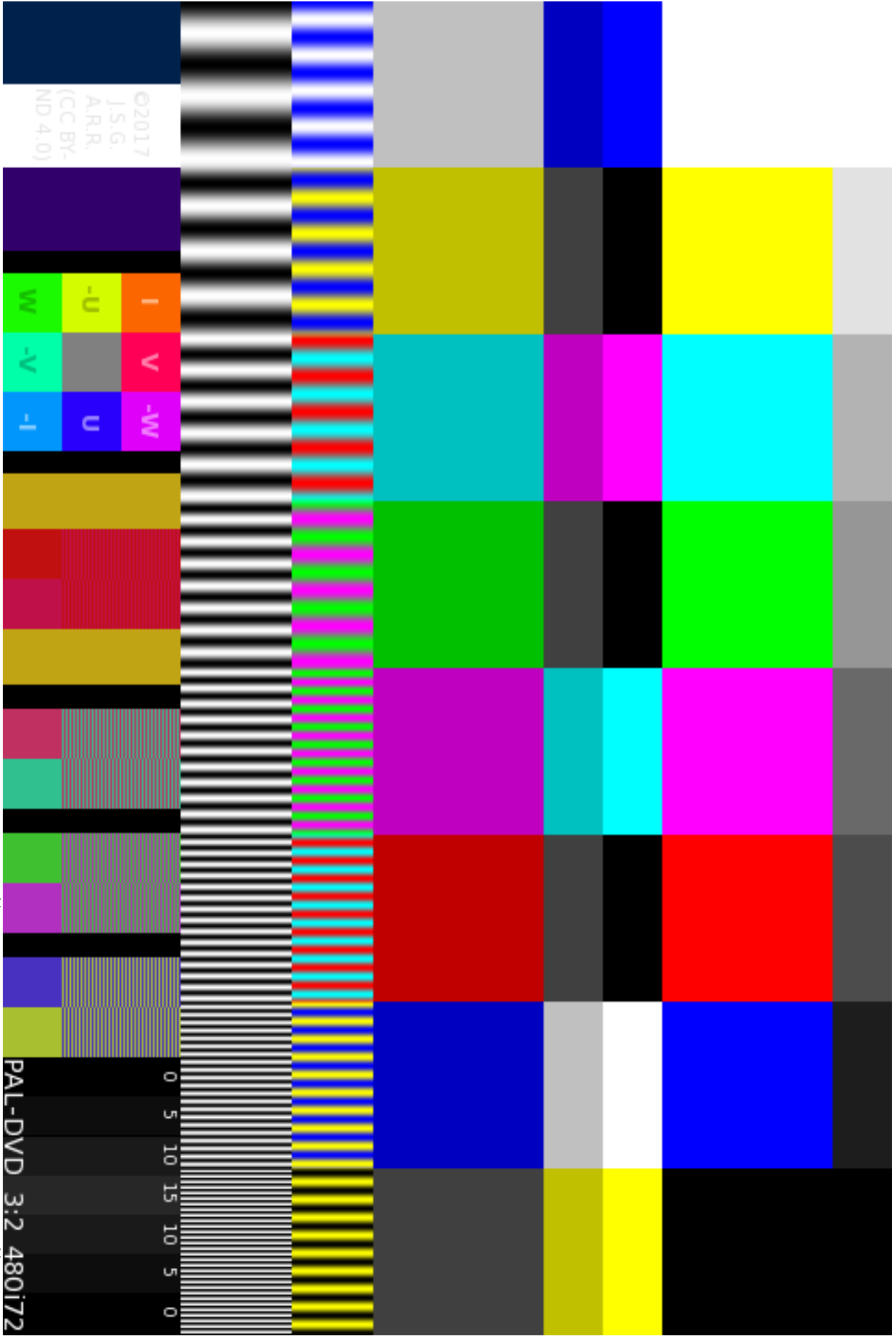
896.304kHz  
(120<sup>3</sup>/<sub>8</sub>)

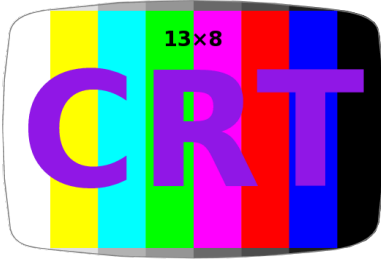
1.2624MHz  
(169<sup>3</sup>/<sub>8</sub>)

1.779984MHz  
(239<sup>1</sup>/<sub>2</sub>)

2.5248MHz  
(339<sup>1</sup>/<sub>4</sub>)

3.572592MHz  
(480)





Standard Definition

**PAL-TV**

**24PsF**

**432i72**

wVGA  
**13:8**

+12<sup>4</sup>/<sub>5</sub>% better than NTSC-M/PAL-M within a 4MHz Channel Space  
 52x32cm ⇒ 61cm Diag, 741µm Line Pitch  
 20<sup>1</sup>/<sub>2</sub>"x12<sup>3</sup>/<sub>5</sub>" ⇒ 24" Diag

2.293MHz **Chroma**

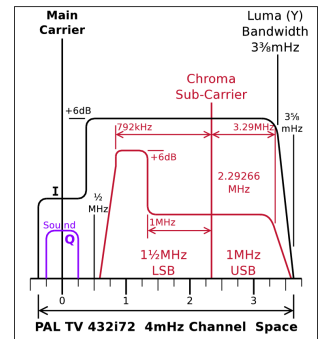
General:

Aspect Ratio	13:8 = 1 <sup>5</sup> / <sub>8</sub>	1/2 Contrast	305:216 ≈ 1.412
Total Picture Pixels (Digital)	704x432 ; 304128 Pixels		610x432 ; 263520
Kell Factor (Analog Resolution)	498x305 ; 152064 Pixels		432x305 ; 131760
Maximum Digital Equiv. @-9dB	732x432 ; 316224 Pixels		518x305 ; 158112

Vertical:

Frames Per Second	24 Hz
Total Lines Per Frame	470
Fields Per Second	72 Hz
Total Lines Per Field	156 <sup>2</sup> / <sub>3</sub>
Field Picture Lines	144
Lines Per Blank	12 <sup>2</sup> / <sub>3</sub>
Blank	1.123 ms
Sync	177 µs ; 2 Lines

Pixel Aspect 1.153:1  
 16:9 Stretched 1.306:1



Horizontal:

Resolution	Fair:431 <sup>4</sup> / <sub>5</sub>
Lines Per Second	11.280 kHz
Period (HP)	88.652 µs (406 <sup>1</sup> / <sub>2</sub> )
Picture	79.275 µs (363 <sup>1</sup> / <sub>2</sub> )
Total Picture Pixels	445 <sup>4</sup> / <sub>5</sub> ≈ 1 <sup>2</sup> / <sub>3</sub> xYBWx(HP-HB) ; (431 <sup>4</sup> / <sub>5</sub> +14)≈3 <sup>1</sup> / <sub>8</sub> %/2 <sup>1</sup> / <sub>2</sub> µs OverScan
Viewable Picture Pixels/Line	431 <sup>4</sup> / <sub>5</sub> ; 76.767 µs (352x2 Dot Clock)
Blank (HB)	9.378 (43)
Front Porch	1.090 ( 5)
Sync	3.489 (16)
Back Porch	4.798 (22)

Luma & Chroma on Main Carrier I Channel:

Luma (Y) Bandwidth @-3dB	3 <sup>3</sup> / <sub>8</sub> MHz FullCut 3 <sup>5</sup> / <sub>8</sub> MHz ; Vestigial 3 <sup>3</sup> / <sub>8</sub> MHz Corner 1 <sup>1</sup> / <sub>2</sub> MHz
Chroma:	Sub-Sampling 3 <sup>3</sup> / <sub>8</sub> :1 <sup>1</sup> / <sub>2</sub> :1
Sub-Carrier	2.29266 MHz ; 8x ⇒ 18.34128 MHz
1/2H Odd Harmonic	406 <sup>1</sup> / <sub>2</sub> :203 <sup>1</sup> / <sub>4</sub> :135 <sup>1</sup> / <sub>2</sub>
V Bandwidth	1 <sup>1</sup> / <sub>2</sub> MHz (USB +1MHz & LSB -1 <sup>1</sup> / <sub>2</sub> MHz)
U Bandwidth	1 <sup>1</sup> / <sub>2</sub> MHz (USB +1MHz & LSB -1 <sup>1</sup> / <sub>2</sub> MHz)
Color Burst Duration	3.053 µs ; 7 cycles 2x(1 <sup>1</sup> / <sub>4</sub> +7+2 <sup>3</sup> / <sub>4</sub> )=22
Baseband Guard	1/2 MHz 491/600ns 1.25/1.14µs

Sound: Sub-Carrier on Q Channel of Main Carrier. PM Deviation: ±7<sup>1</sup>/<sub>8</sub>π ±2<sup>3</sup>/<sub>4</sub>R ±157<sup>1</sup>/<sub>2</sub>°  
 Sub-Carrier Frequency: **Mono:** 10<sup>1</sup>/<sub>2</sub>xH 118.44kHz **Armstrong PM<sup>2</sup> Stereo** Hx3<sup>1</sup>/<sub>2</sub> & Hx10<sup>1</sup>/<sub>2</sub> pg20  
 Frequency Response: 50Hz-15kHz @ -3dB (Harmonic Peak PSNs 2x1ms)  
 Equalization: 50µs Pre-Emphasis, Pole at 13kHz (12<sup>1</sup>/<sub>4</sub>µs)  
 2<sup>2</sup>/<sub>3</sub>ms Pre-Emphasis, Pole at 180Hz (884µs)  
 Harmonic Peak PSNs 2x1ms  
 Processing: 2:1 Linear Compression, Attack: 1ms, Decay: 60ms

Rec.709 sRGB Gamut      x      y  
 White Point      0.3127 0.329  
 Contrast 2<sup>12</sup>:1      Gamma ~2.4

Temp      ScanLines  
 6504°K      /Inch



↓ Chroma LoR/Freq:106<sup>2</sup>/654kHz, 201<sup>2</sup>/<sub>5</sub>/1.308MHz

704x432

270.72kHz  
(41 $\frac{2}{3}$ )

383.52kHz  
(59)

541.44kHz  
(83 $\frac{1}{3}$ )

767.04kHz  
(118)

1.0716MHz  
(165)

1.5228MHz  
(234 $\frac{2}{5}$ )

2.15448MHz  
(331 $\frac{3}{5}$ )

3.0569MHz  
(469 $\frac{1}{3}$ )





Half Channel Ideal for 15" Laptop Displays, 486µm Line Pitch **wvga**

**PAL-1/2Ch** **24PsF** **384i72** **13:8**

+18% better than VHS & 86% of NTSC within a 3MHz Channel Space  
50<sup>4</sup>/<sub>5</sub>×31<sup>1</sup>/<sub>3</sub> ⇒ 59<sup>2</sup>/<sub>3</sub>cm Diag, ~788µm Line Pitch  
20"×12<sup>1</sup>/<sub>3</sub>" ⇒ 23<sup>1</sup>/<sub>2</sub>in. Diag **1.967MHz Chroma**

General:

Aspect Ratio	13:8 = 1 <sup>5</sup> / <sub>8</sub>	Fair Contrast
Total Picture Pixels (Digital)	624×384 ; 245760 Pixels	87:64 ≈ 1.3506
Kell Factor (Analog Resolution)	453×272 ; 122880 Pixels	518×384 ; 198912
Maximum Digital Equiv. @-9dB	622×384 ; 238848 Pixels	367×272 ; 99456
		440×272 ; 119424

Vertical:

Frames Per Second	24Hz
Total Lines Per Frame	422
Fields Per Second	72Hz
Total Lines Per Field	140 <sup>2</sup> / <sub>3</sub>
Field Picture Lines	128
Lines Per Blank	12 <sup>2</sup> / <sub>3</sub>
Blank	1.25ms
Sync	197 <sup>1</sup> / <sub>2</sub> µs ; 2 Lines

Pixel Aspect 1.203:1

$$\begin{matrix} \text{Aspect} \\ \text{Ratio} \end{matrix} \begin{bmatrix} 26 \\ 16 \end{bmatrix} \times \begin{matrix} \text{Super} \\ \text{Pixel} \end{matrix} \begin{bmatrix} 24 \\ 24 \end{bmatrix} = \begin{matrix} \text{Pixel} \\ \text{Resolution} \end{matrix} \begin{bmatrix} 624 \\ 384 \end{bmatrix}$$

Horizontal:

	Resolution Fair: 366 <sup>3</sup> / <sub>4</sub> Max @ -9dB:440
Lines Per Second	10.128kHz
Period (HP)	98.736µs (367 <sup>1</sup> / <sub>2</sub> )
Picture	87.183µs (324 <sup>1</sup> / <sub>2</sub> )
Total Picture Pixels	381 <sup>2</sup> / <sub>5</sub> ≈ 1 <sup>2</sup> / <sub>3</sub> ×YBW×(HP-HB) ; (369 <sup>1</sup> / <sub>4</sub> +14 <sup>2</sup> / <sub>3</sub> )≈385%/3 <sup>1</sup> / <sub>3</sub> µs OverScan
Viewable Picture Pixels/Line	366 <sup>3</sup> / <sub>4</sub> ; 83.825µs (312×2 Dot Clock)
Blank (HB)	11.553µs (43)
Front Porch	1.343µs ( 5)
Sync	4.030µs (15)
Back Porch	6.179µs (23)

Luma & Chroma:

<b>Luma</b> (Y) Bandwidth @-3dB	2 <sup>5</sup> / <sub>8</sub> MHz FullCut 2 <sup>3</sup> / <sub>4</sub> MHz ; Vestigial 1/4MHz Corner 1/5MHz
Chroma:	Sub-Sampling 2:1:1
Sub-Carrier	1.86102MHz ; 8× ⇒ 14.78688MHz
1/2H Odd Harmonic	367 <sup>1</sup> / <sub>2</sub> :183 <sup>3</sup> / <sub>4</sub> :122 <sup>1</sup> / <sub>2</sub>
V Bandwidth	1 <sup>1</sup> / <sub>3</sub> MHz (USB + <sup>3</sup> / <sub>4</sub> MHz & LSB -1 <sup>1</sup> / <sub>3</sub> MHz)
U Bandwidth	1 <sup>1</sup> / <sub>3</sub> MHz (USB + <sup>3</sup> / <sub>4</sub> MHz & LSB -1 <sup>1</sup> / <sub>3</sub> MHz)
Color Burst Duration	3.761µs ; 7 cycles 2×(1 <sup>1</sup> / <sub>2</sub> +7+3)=23
Baseband Guard	1/5MHz

Sound: Sub-Carrier on 'Q' Channel of Main Carrier. PM Deviation: ±7/8π ±2<sup>3</sup>/<sub>4</sub>R ±157<sup>1</sup>/<sub>2</sub>°  
Sub-Carrier Frequency: **Mono:** 8<sup>1</sup>/<sub>2</sub>×H 96.088kHz

**Armstrong PM<sup>2</sup> Stereo:** L+R 3<sup>1</sup>/<sub>2</sub>×H, L-R 8<sup>1</sup>/<sub>2</sub>×H, (pg20)  
Frequency Response: 50Hz-12<sup>1</sup>/<sub>2</sub>kHz @ -3dB 45.576kHz 96.088kHz  
Equalization: 50µs Pre-Emphasis, Pole at 13kHz (12<sup>1</sup>/<sub>4</sub>µs)  
2<sup>2</sup>/<sub>3</sub>ms Pre-Emphasis, Pole at 180Hz (884µs)  
Processing: Harmonic Peak PSNs 2×1ms  
2:1 Linear Compression, Attack: 1ms, Decay: 60ms

Rec.709 sRGB Gamut **x** **y** **Temp** 33<sup>1</sup>/<sub>3</sub>/<sub>15</sub>  
White Point 0.3127 0.329 6504°K ScanLines  
Contrast 2<sup>12</sup>:1 Gamma ~2.4



↓↓ **Chroma** LoR/Freq: 86<sup>3</sup>/<sub>8</sub>/1<sup>1</sup>/<sub>2</sub>MHz, 172<sup>3</sup>/<sub>4</sub>/1MHz

640x384

222.816kHz  
(38)

313.968kHz  
(53½)

445.632kHz  
(76)

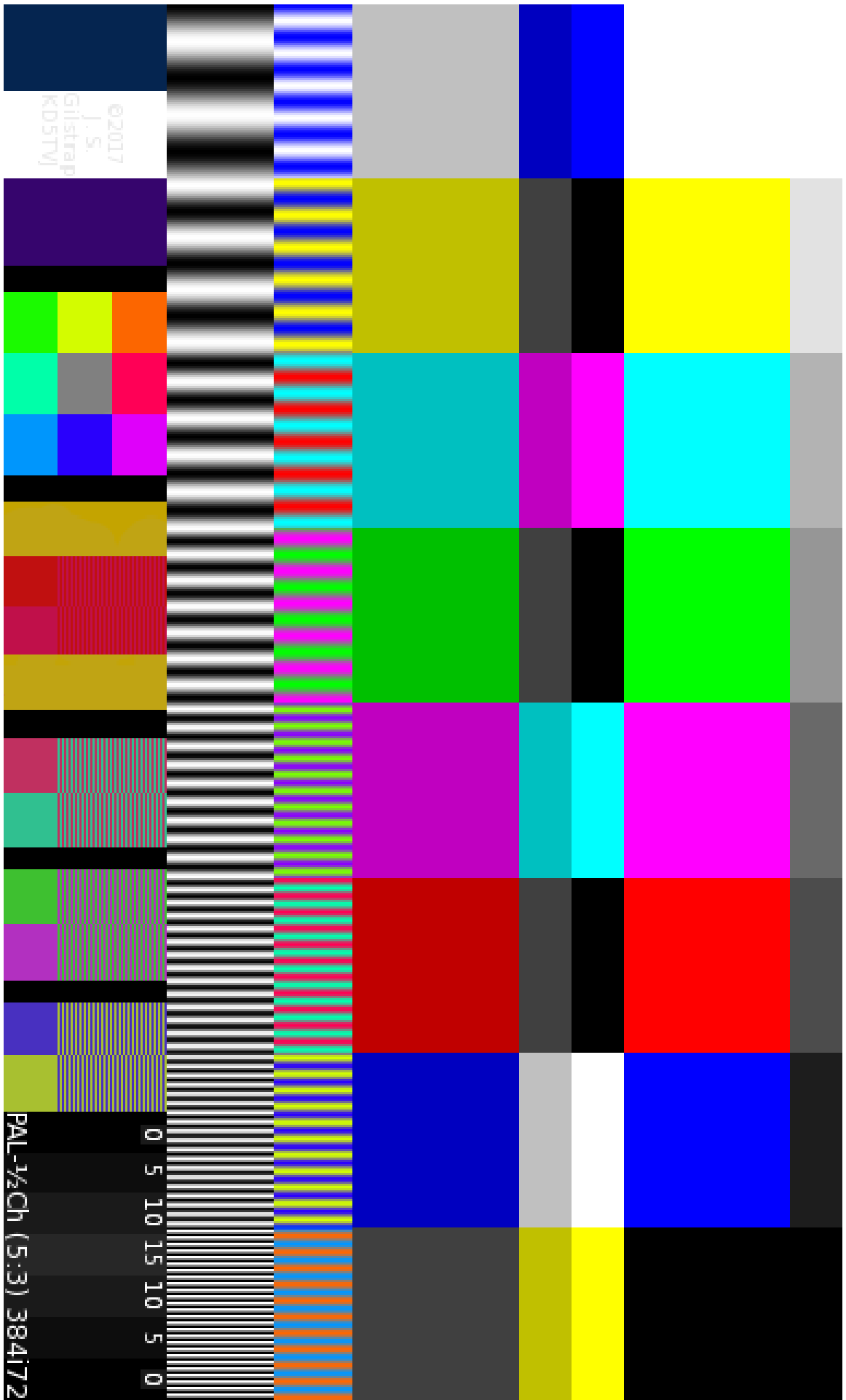
627.936kHz  
(107)

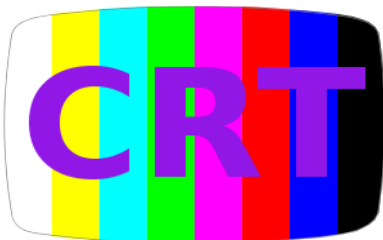
881.136kHz  
(150¼)

1.255872MHz  
(214⅔)

1.772400MHz  
(302¼)

2.501616MHz  
(426⅔)





Narrow Band Ideal for 11" (240x144mm) iPad/NetBook , 429µm LP

wvga

PAL-NB

24PsF

336i72

15:9

66 2/3% resolution of NTSC/PAL-M within a 2 1/2MHz Channel Space

44 1/2x26 2/3 => 51 7/8cm Diag, 794µm Line Pitch

VHS Quality

17 1/2"x10 1/2" => 20 2/5" Diag

1.432MHz Chroma

General:

Aspect Ratio	5:3 = 1 2/3	Fair Contrast
Total Picture Pixels (Digital)	560x336 ; 188160 Pixels	461:336 ≈ 1.3717
Kell Factor (Analog Resolution)	396x238 ; 94080 Pixels	461x336 ; 154896
Maximum Digital Equiv. @-9dB	553x336 ; 185808 Pixels	326x305 ; 77448
		391x305 ; 92904

Vertical:

Frames Per Second	24Hz	Pixel Aspect 1.215:1
Total Lines Per Frame	370	16:9 Stretched 1.259:1
Fields Per Second	72Hz	
Total Lines Per Field	123 1/2	
Field Picture Lines	112	
Lines Per Blank	11 1/3	
Blank	1.276ms	
Sync	338µs ; 2 Lines	

Horizontal:

Resolution	Fair:326 Max @ -9dB:391
Lines Per Second	8.88kHz
Period (HP)	112.613µs (322 1/2)
Picture	100.042µs (286 1/2)
Total Picture Pixels	333 1/2 ≈ 1 2/3 x YBW x (HP-HB) ; (326+7 1/2) ≈ 2 1/4 % / 2 1/4 µs OverScan
Viewable Picture Pixels/Line	326 ; 97.772µs (280x2 Dot Clock)
Blank (HB)	12.571 (36)
Front Porch	1.396 ( 4)
Sync	4.889 (14)
Back Porch	6.285 (18)

Luma & Chroma:

Luma (Y) Bandwidth @-3dB	2MHz FullCut 2 1/8MHz ; Vestigial 3/8MHz Corner 1/4MHz
Chroma:	Sub-Sampling 2 2/7:1:1
Sub-Carrier	1.4319MHz ; 8x => 11.4552MHz
1/2H Odd Harmonic	322 1/2:161 1/4:107 1/2
V Bandwidth	7/8MHz (USB +1/2MHz & LSB -7/8MHz)
U Bandwidth	7/8MHz (USB +1/2MHz & LSB -7/8MHz)
Color Burst Duration	3.492µs ; 5 cycles 2x(1 1/2+5+2 1/2)=18
Baseband Guard	3/8MHz

Sound: Sub-Carrier on Q Channel of Main Carrier. PM Deviation: ±7/8π ±2 3/4R ±157 1/2°

Sub-Carrier Frequency:	Mono: 12 1/2xH 111kHz
Frequency Response	Armstrong PM <sup>2</sup> Stereo: L+R 6 1/2xH, L-R 19 1/2xH
Equalization	50Hz-15kHz @ -3dB. 57.72kHz 173.16kHz (pg20)
Processing:	50µs Pre-Emphasis, Pole at 13kHz (12 1/4µs)
	2 2/3ms Pre-Emphasis, Pole at 180Hz (884µs)
	Harmonic Peak PSNs 2x1ms
	2:1 Linear Compression, Attack: 1ms, Decay: 60ms

32 ScanLines/Inch

Rec.709 sRGB Gamut	x y	Temp
White Point	0.3127 0.329	6504°K
Contrast 2 <sup>12</sup> :1	Gamma ~2.4	



↓↓ Chroma LoR/Freq:48 1/2/248 2/3kHz, 96 2/3/497 1/4kHz



560x336

168.720kHz  
(33)

239.760kHz  
(46<sup>7</sup>/<sub>8</sub>)

337.440kHz  
(60)

479.520kHz  
(93<sup>3</sup>/<sub>4</sub>)

674.880kHz  
(132)

959.080kHz  
(187<sup>1</sup>/<sub>2</sub>)

1.349760MHz  
(263<sup>7</sup>/<sub>8</sub>)

1.909200MHz  
(373<sup>1</sup>/<sub>2</sub>)





1/4 Channel

$\mu$ PAL-1/4

24PsF

240i72

3:2

32<sup>2</sup>/<sub>3</sub>% resolution of NTSC-M/PAL-M within a 1<sup>1</sup>/<sub>2</sub>MHz Channel Space  
26<sup>2</sup>/<sub>3</sub>×17<sup>4</sup>/<sub>5</sub> ⇒ 32cm Diag, 741μm Line Pitch      665<sup>1</sup>/<sub>2</sub>kHz Chroma  
10<sup>1</sup>/<sub>2</sub>"×7" ⇒ 12<sup>3</sup>/<sub>5</sub>" Diag

Ideal for 6" Smart Phone Displays @3:2, 311μm Line Pitch

Pillarboxed onto 16:9

General:

Aspect Ratio	3:2 = 1 <sup>1</sup> / <sub>2</sub>	Fair Contrast
Total Picture Pixels (Digital)	360×240 ; 86400 Pixels	101:80 ≈ 1.262
Kell Factor (Analog Resolution)	255×170 ; 43200 Pixels	303×240 ; 76320
Maximum Digital Equiv. @-9dB	382×240 ; 91680 Pixels	214×170 ; 38160
		270×192 ; 45840

Vertical:

Frames Per Second	24Hz
Total Lines Per Frame	266
Fields Per Second	72Hz
Total Lines Per Field	88 <sup>2</sup> / <sub>3</sub>
Field Picture Lines	80
Lines Per Blank	8 <sup>2</sup> / <sub>3</sub>
Blank	1.358ms
Sync	261μs ; 1 <sup>2</sup> / <sub>3</sub> Lines

Pixel Aspect 1.189:1

Horizontal:

Resolution	Fair:214 <sup>1</sup> / <sub>8</sub>	Max @ -9dB:257
Lines Per Second	6.384kHz	
Period (HP)	156.642μs (208 <sup>1</sup> / <sub>2</sub> )	
Picture	139.738μs (186)	
Total Picture Pixels	221 <sup>1</sup> / <sub>4</sub> ≈ 1 <sup>2</sup> / <sub>3</sub> ×YBW×(HP-HB) ; (214 <sup>1</sup> / <sub>8</sub> +7 <sup>1</sup> / <sub>8</sub> )≈3 <sup>3</sup> / <sub>4</sub> %/4 <sup>1</sup> / <sub>2</sub> μs OverScan	
Viewable Picture Pixels/Line	214 <sup>1</sup> / <sub>8</sub> ; 135.230μs (180×2 Dot Clock)	
Blank (HB)	16.904 (22 <sup>1</sup> / <sub>2</sub> )	
Front Porch	1.878 (2 <sup>1</sup> / <sub>2</sub> )	
Sync	6.386 (8 <sup>1</sup> / <sub>2</sub> )	
Back Porch	8.640 (11 <sup>1</sup> / <sub>2</sub> )	

Luma & Chroma:

Luma (Y) Bandwidth @-3dB	950kHz FullCut 1 <sup>1</sup> / <sub>8</sub> MHz ; Vestigial <sup>3</sup> / <sub>8</sub> MHz Corner <sup>1</sup> / <sub>4</sub> MHz
Chroma:	Sub-Sampling 3 <sup>1</sup> / <sub>3</sub> :1:1
Sub-Carrier	665.532kHz ; 8× ⇒ 5.332256MHz
1/2H Odd Harmonic	208 <sup>1</sup> / <sub>2</sub> :104 <sup>1</sup> / <sub>4</sub> :69 <sup>1</sup> / <sub>2</sub>
V Bandwidth	280kHz (USB +280kHz & LSB -280kHz)
U Bandwidth	280kHz (USB +280kHz & LSB -280kHz)
Color Burst Duration	6.01μs ; 4 cycles 2×(2 <sup>1</sup> / <sub>2</sub> +4+5)=23
Baseband Guard	<sup>3</sup> / <sub>8</sub> MHz

Sound: Sub-Carrier on Q Channel of Main Carrier.

Phase Modulation	Deviation: ± <sup>7</sup> / <sub>8</sub> π ±2 <sup>3</sup> / <sub>4</sub> R ±157 <sup>1</sup> / <sub>2</sub> °
Sub-Carrier Frequency:	Mono: 17 <sup>1</sup> / <sub>2</sub> ×H 111.72kHz
	Armstrong PM <sup>2</sup> Stereo: L+R 9 <sup>1</sup> / <sub>2</sub> ×H, L-R 19 <sup>1</sup> / <sub>2</sub> ×H
	(pg20) 60.648kHz 181.944kHz
Frequency Response:	50Hz-15kHz @ -3dB
Equalization:	50μs Pre-Emphasis, Pole at 13kHz (12 <sup>1</sup> / <sub>4</sub> μs)
	2 <sup>2</sup> / <sub>3</sub> ms Pre-Emphasis, Pole at 180Hz (884μs)
Processing:	Harmonic Peak PSNs 2×1ms
	2:1 Linear Compression, Attack: 1ms, Decay: 60ms

360x240

178.752kHz  
(48<sup>3</sup>/<sub>8</sub>)

223.440kHz  
(60<sup>2</sup>/<sub>5</sub>)

280.896kHz  
(76)

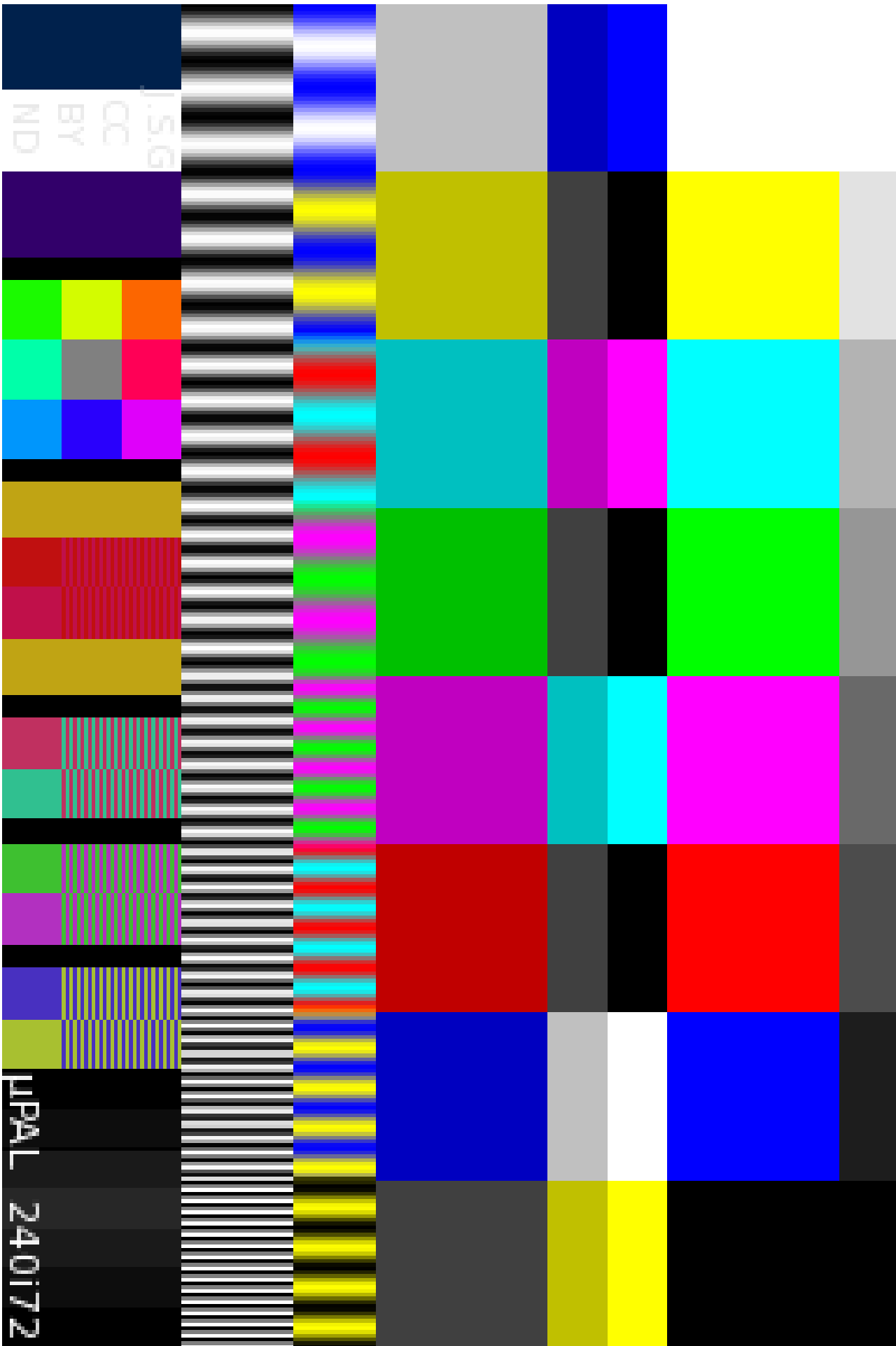
351.120kHz  
(95)

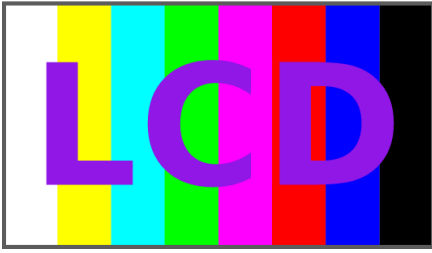
446.880kHz  
(120<sup>7</sup>/<sub>8</sub>)

561.792kHz  
(150)

702.240kHz  
(192)

887.376kHz  
(240)





1/6 Channel

**μPAL-1/6**

**24PsF**

**192i72**

**μwide  
7:4**

24 1/2% resolution of NTSC-M/PAL-M within a 1MHz Channel Space  
 $26^{3/5} \times 15^{1/5} \Rightarrow 31^{2/3}$  cm Diag, 793μm Line Pitch **496.9kHz Chroma**  
 $10^{1/2} \times 6'' \Rightarrow 12$  in. Diag Stretched

Ideal for 4 1/2" Smart Phone Displays @16:9, 292μm Line Pitch

**General:**

Aspect Ratio	7:4 = 1 3/4	1/2 Contrast
Total Picture Pixels (Digital)	336x192 ; 64512 Pixels	149:96 ≈ 1.556
Kell Factor (Analog Resolution)	237x136 ; 32256 Pixels	298x192 ; 57216
Maximum Digital Equiv. @-9dB	358x192 ; 68736 Pixels	211x136 ; 28608
		253x192 ; 34368

**Vertical:**

Frames Per Second	24 Hz
Total Lines Per Frame	214
Fields Per Second	72 Hz
Total Lines Per Field	71 1/3
Field Picture Lines	64
Lines Per Blank	7 1/3
Blank	1.428 ms
Sync	324 μs ; 1 2/3 Lines

Pixel Aspect 1.124:1

**Horizontal:**

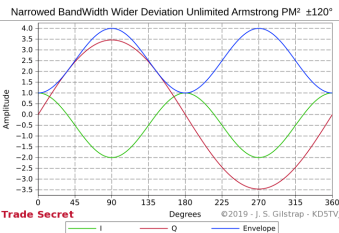
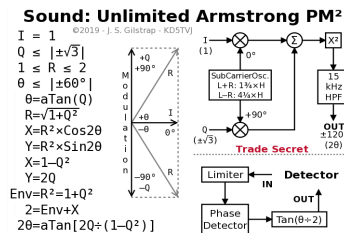
Resolution	Fair:211 1/3 Max @ -9dB:253
Lines Per Second	5.136 kHz
Period (HP)	194.704 μs (193 1/2)
Picture	174.076 μs (173)
Total Picture Pixels	$217^{2/3} \approx 1^{2/3} \times Y_{BW} \times (HP - HB)$ ; (211 1/3 + 6 1/3) ≈ 3%/5μs OverScan
Viewable Picture Pixels/Line	211 1/3 ; 169.045 μs (168x2 Dot Clock)
Blank (HB)	20.628 (20 1/2)
Front Porch	2.012 (2)
Sync	7.547 (7 1/2)
Back Porch	11.068 (11)

**Luma & Chroma:**

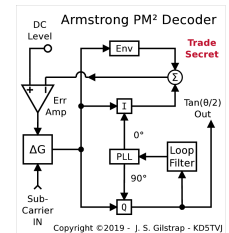
<b>Luma (Y)</b> Bandwidth @-3dB	3/4MHz FullCut 7/8MHz ; Vestigial 1/8MHz Corner 75kHz
<b>Chroma:</b>	Sub-Sampling 3:1:1
Sub-Carrier	496.908 kHz ; 8x ⇒ 3.975264 MHz
1/2H Odd Harmonic	193 1/2 : 96 3/4 : 64 1/2
<b>V</b> Bandwidth	1/4MHz (USB + 1/4MHz & LSB - 1/4MHz)
<b>U</b> Bandwidth	1/4MHz (USB + 1/4MHz & LSB - 1/4MHz)
Color Burst Duration	6.037 μs ; 3 cycles 2x(1+3+1 1/2)=11
Baseband Guard	1/6 MHz

**Sound: Sub-Carrier on 'Q' Channel of Main Carrier.**

Narrow Band Armstrong PM <sup>2</sup>	<b>Deviation:</b> ± 2/3π, ± 2.1R, ± 120°
Sub-Carrier Frequency:	<b>Mono:</b> 7 1/2 x H 38.52kHz
Frequency Response:	50Hz - 12 1/2kHz @ -3dB
Equalization:	50μs Pre-Emphasis, Pole at 13kHz (12 1/4μs) 2 2/3ms Pre-Emphasis, Pole at 180Hz (884μs)
Processing:	Harmonic Peak PSNs 2x1ms 2:1 Linear Compression, Attack: 1ms, Decay: 60ms

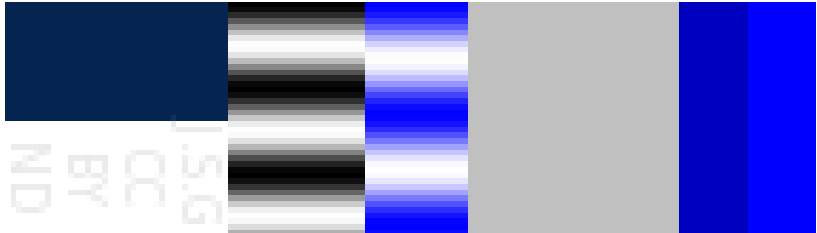


34 3/4 / 102 3/4 kHz, 65 1/2 / 205 1/2 kHz  
 ↓↓ **Chroma** LoR/Freq

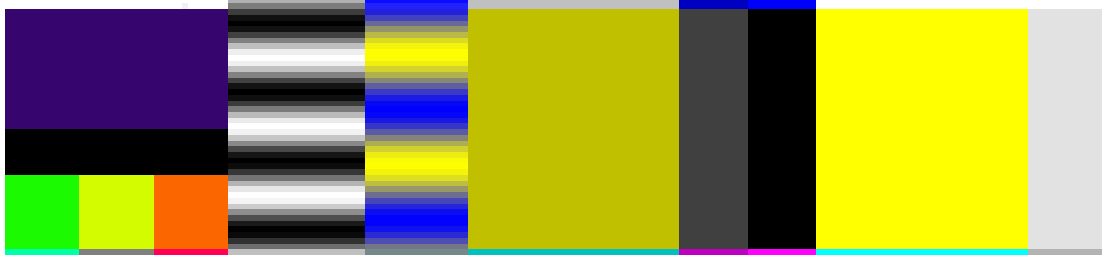


336×192

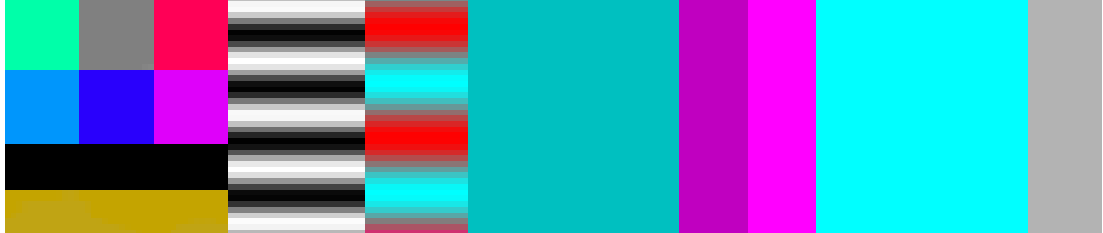
133.356kHz  
(45)



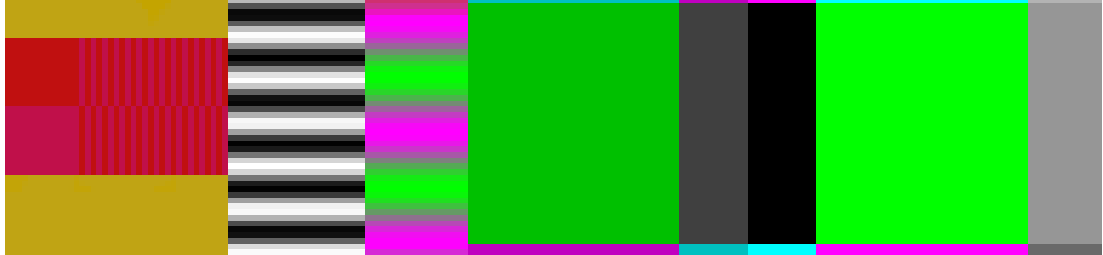
164.352kHz  
(55½)



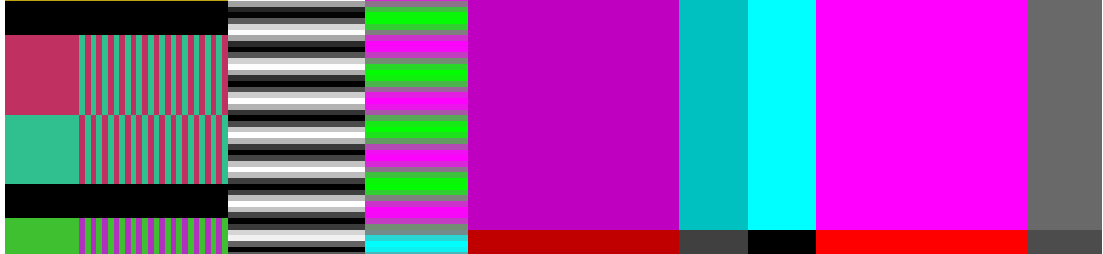
210.576kHz  
(71⅙)



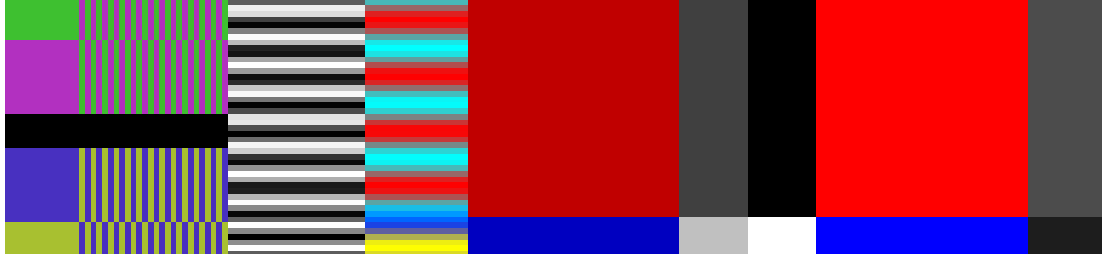
261.936kHz  
(88½)



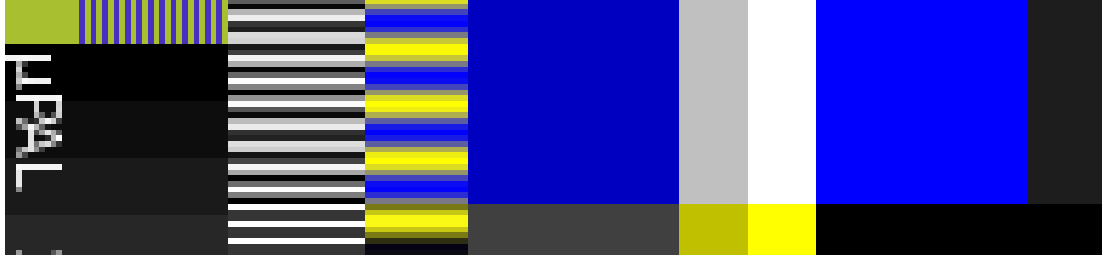
328.704kHz  
(111⅙)



416.016kHz  
(140⅔)



523.872Hz  
(177½)



662.544kHz  
(224)

