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

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```
R, G, B, Range: 0-1
                                                                                            HSV
Y = 0.299 \times Red + 0.587 \times Green + 0.114 \times Blue
                                                                                            Hue
      0.492111 \times (B - Y)
                                                                             U #2900FC 249.76°
                             (0.4921110411)
                                                                             V #FF0056 339.76°
      0.877283 \times (R - Y)
                              (0.8772832199)
                                            Phase inverted @ 1/2H
W = -0.509370 \times (R - Y) - 0.194208 \times (B - Y) \in [G - Y]
                                                                             W #1BFA00 113.52°
     (-0.5093696834)
                              (-0.1942078377)
      0.595901×Red - 0.274557×Green - 0.321344×Blue
                                                                             I #FC6600
                                                                                         24.29°
      (0.5959007249)
                       (-0.2745567667)
                                           (-0.3213439582)
      0.211537×Red - 0.522736×Green + 0.311200×Blue
                                                                             0 #8900FE 272.36°
      (0.2115366883)
                       (-0.5227362571)
                                            (0.3111995688)
                       IRE=1V/140
Luma (Y) Level:
                        98
                                              For more information on signal levels,
                               700mV
                       -42
Svnc:
                               300mV
                                              Luma/Chroma matrixing, composite
                              ±150mV
ColorBurst:
                       ±21
                                              & vector scope images and other info
                               1.23V
Max (Yl & Cy)
                       130€
                                              see NTSC Specifications.
Min (Rd & Bl)
                       -32⅓
                               66₹mV
                        1931 CIE
Rec.709 sRGB Gamut
                       X
                                        nm
                                                   PAL On Screen Vector Rotation/Shift & V Switch Phases
                       0.64
                               0.33
Red
                                        ~607
Green
                       0.30
                               0.60
                                        ~556
                                                       135°
Blue
                       0.15
                               0.06
                                        ~467
White Point
                       0.3127 0.329
                                        6504°K
```

#### **Colorburst & Carrier**

Gamma 2.4

Contrast 212:1

The **PAL** line phase alternation signal for **V** uses the standard **135**°(+) / **225**°(–) phase toggling of the colorburst. Using synchronous detection with a reduced carrier level will increase coverage and signal quality. The sound is placed on the ¼MHz data **Q** channel of the main carrier with additional data possible while the composite video signal modulates the **I** channel.

#### Claims:

- Using a **3:1** interlace with the **4** phase states of **PAL Chroma** produces a **Luma/Chroma** fine mesh harmonic spacing of ½ the frame rate of **12**Hz 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 up ½ horizontal field line per field instead of ½ 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 advanced 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.



**Standard Definition** 

24PsF

432i72

**WVGA** 

417:**208**½:139

NTSC +113/3%, PAL-B/G -213/2% in a 4MHz Channel Space 22½"×13½" → 26¼" Diag, 794µm Line Pitch 2.34MHz Chroma

| 57 <del>15</del> ×34 <sup>3</sup> 0  | cm ⇒ <b>66</b> <sup>2</sup> ⁄₃ Diag                                   | PAL+ Std. Def. Com                            | patible Resolution Format  |
|--|---|---|--|
| General:  Aspect Ratio Total Picture Pixels ( <b>D</b> igital Kell Factor ( <b>A</b> nalog Resolution Maximum @-9dB  | n) 509×305 ; 1  | 11040 Pixels<br>55520 Pixels<br>12768 Pixels  | Fair Contrast<br>151:108 ≈ 1.3970<br>604×432 ; 260928<br>427×305 ; 130464<br><b>A:</b> 512×305 ; 156384<br>xel Aspect 1.193:1  |
| Vertical:     Frames Per Second     Total Lines Per Frame     Fields Per Second     Total Lines Per Field     Field Picture Lines     Lines Per Blank     Blank     Sync | 24Hz<br>470<br>72Hz<br>156⅔<br>144<br>12⅔<br>1.123ms<br>177µs ; 2 Lin |   | Aspect Super Pixel Ratio Pixel Resolution $\begin{bmatrix} 15 \\ 9 \end{bmatrix} \times \begin{bmatrix} 48 \\ 48 \end{bmatrix} = \begin{bmatrix} 720 \\ 432 \end{bmatrix}$ |
| Horizontal: Lines Per Second Period (HP) Picture Total Picture Pixels Viewable Picture Pixels/Line Blank (HB) Front Porch Sync Back Porch                                |   | 2)<br>-HB) ; (426¾+14¼):<br>(360×2 Dot Clock) | 9dB:512<br>≈3¼%/2 <u>56</u> μs OverScan  |
| Luma & Chroma on I Ch. Main Carrier Luma (Y) Bandwidth @-3dB  Chroma: Sub-Carrier  | (512) 3⅓MHz Corner<br>Vestigial –⅓N<br>Sub-Sampling                   | MHz, Corner –⅓MHz                             | with TruColor™<br>2.35188MHz   |

Sub-Carrier ⅓H Odd Harmonic V Bandwidth **U** Bandwidth Color Burst Duration Baseband Guard

 $2.34342MHz ; 8x \Rightarrow 18.74736MHz$ 415½:**207**¾:138½

(254) 1%MHz (USB +1MHz & LSB -1%MHz) (254)  $1\frac{4}{3}MHz$  (USB +1MHz & LSB -1 $\frac{4}{3}MHz$ ) 2.987 $\mu$ s; 7 cycles 2×(1+7+3)=22 426/533ns 1.28/1.17μs ¹∕₂MHz

Sound Sub-Carriers on Q Ch. of Main Carrier: Armstrong PM<sup>2</sup> ±120°

Sub-Carrier Frequencies: L+R: 129.72kHz, L-R: 208.68kHz, SAP: 50.76kHz 11½×H

Harmonic Peak PSNs 2×1ms

Frequency Response: Equalization:

Alternative Digital COFDM: Processing:

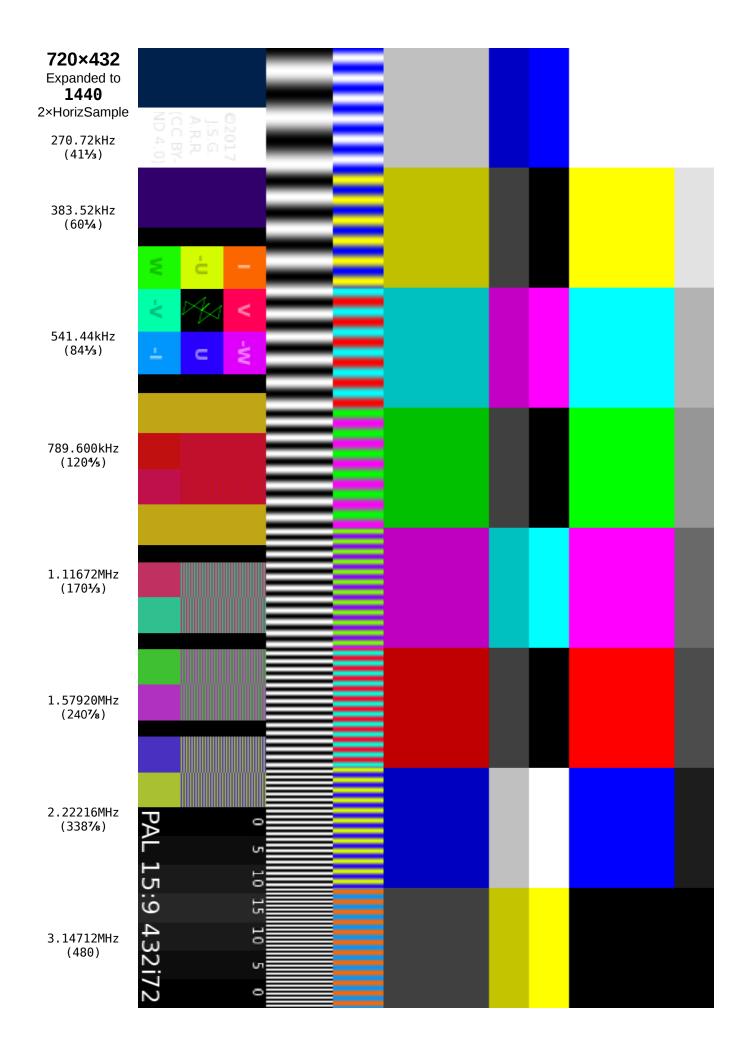
32 Scan Lines / Inch

50Hz-15kHz @ -3dB (Harmonic Peak PSNs 2×1ms) 50μs Pre-Emphasis, Pole at 13kHz (12¼μs) 23/ms Pre-Emphasis, Pole at 180Hz (884µs)
5.1 Surround & SAP (Opus) with analog only L+R 50Hz-121/2kHz (21/2×H 28.2kHz)

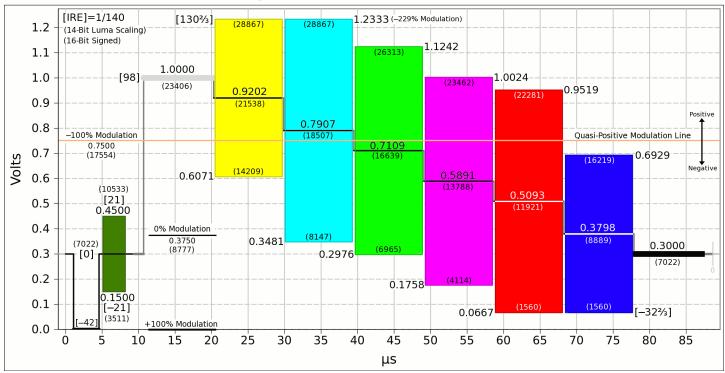
2:1 Linear Compression, Attack: 1ms, Decay: 60ms

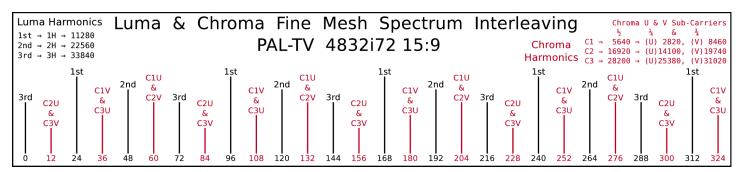
All the advanced processing for both encoding and decoding that has been developed for **PAL** and **NTSC** some of it described in NTSC Specifications should be used along with any additional techniques available to improve signal quality, TX/RX robustness e.g. GCR, and image resolution maximization.

↓↓ **Chroma** LoR/Freq: 945/8 / 5/8MHz, 1891/4 / 11/4MHz



PAL-TV 432i72 Composite Luma/Chroma 720×432 Test Pattern

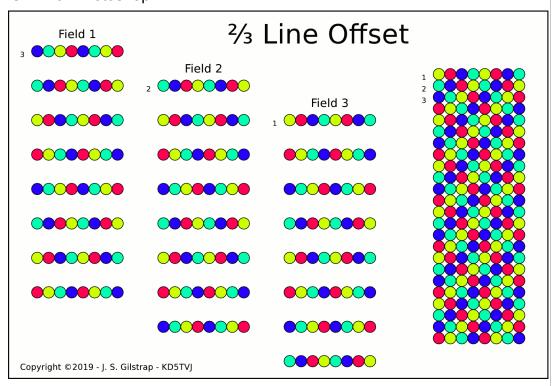




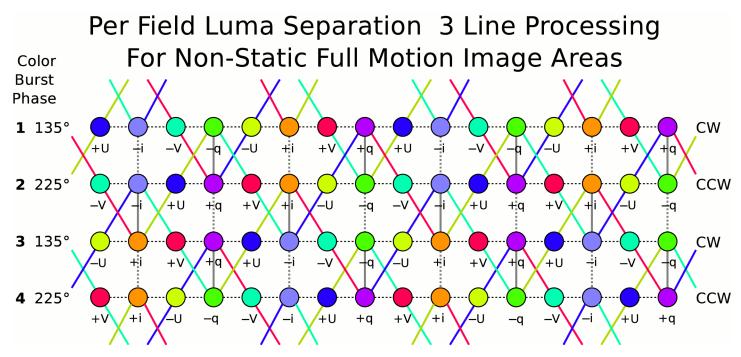
In the image above using a 3:1 interlace the normalized spectrum distribution of Luma with PAL Chroma is shown at the fine mesh level. The 3:1 interlace with a 72Hz field rate ending with \( \frac{1}{3} \) line causes the Luma and Chroma harmonics to be placed at 24Hz intervals which is also the frame rate. When a 3:1 interlace is used with PAL Chroma the sub-carrier is placed at  $3\times H\times [Integer + \frac{1}{2}] \div 2$  (H = Horizontal Sweep) so at the coarse mesh level the U & V Chroma clusters will lie on the ¼ & ¾ 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 ¼ mark, and that H/2 is evenly divisible by 24 means that all **Chroma** harmonics are shifted by ±12Hz off center thus moving them away from interference with the Luma and placing them exactly centered in between them. The \( \frac{1}{4} \bullet \) & \( \frac{3}{4} \bullet \) 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 **470** line format using a  $\frac{7}{3}$  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 **470** 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.



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 cpmplimentary 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  $\pm \frac{1}{4}$ : $\frac{1}{4}$ :

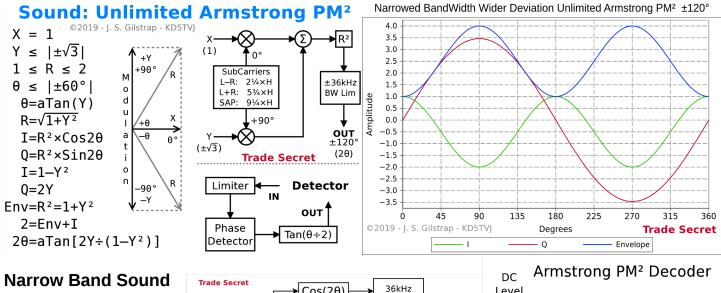
Since Luma sample recovery on U or V sample points is all additive it provides noise reduction but Luma sample recovery on I or q sample points have some S/N loss since adjacent lines are subtracted nullifing Luma but additive for the complimentary color that cancels out Chroma on the current line leaving only the Luma from the curent 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  $\frac{1}{2}$ : $\frac{1}{4}$  ratio or 5 points in a  $\frac{4}{5}$ ×( $\frac{1}{4}$ : $\frac{1}{4}$ : $\frac{1}{4}$ : $\frac{1}{4}$ ) ratio. This averaging has minimal effect on sharpness since the sample rate is ~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 1/4:1/2:1/4 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  $4-3 \& 2-3 \Rightarrow -i$ ;  $2-1 \& 4-3 \Rightarrow -q$ 

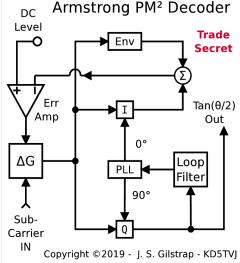
Since the **Chroma** sub-carrier is inverted 180° from frame to frame to average out **Luma** brightness two frames can be added or subtracted to obtain the **Luma** or **Chroma** respectively so motion free static image areas will produce full **Luma/Chroma** separation without any artifacts. This will 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.



The sub-carriers which can contain up to 12dB of amplitude modulation can be

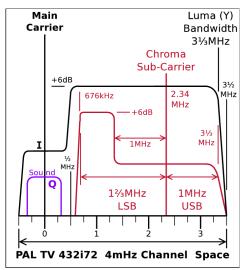
 $Cos(2\theta)$ θ Low Pass aTan(M) FIR Filter To Limited Sub-Carriers' Armstrong PM<sup>2</sup> Ouadrature Modulation In **Digital Generation** Modulators 36kHz  $\pm\sqrt{3}$  p-p Max. **→** Q Low Pass  $Sin(2\theta)$ FIR Filter ©2022 J. S. Gilstrap KD5TVJ

compressed down to 6dB, possibly following the peak amplitude prior to the squaring of the signal. A full 12dB of compression could be employed but signal quality might be noticeability affected or a 9dB reduction could be a good choice. The over easy compression should have an attack of ~1ms and a decay of ~60ms with the proper amount of compression already achieved prior to the signal modulation,



i.e. the compression action should happen ~1ms sooner than the signal modulation. The actual compression modulation should not widen the signal bandwidth any since the attack and decay filtering will only contain low frequency modulation information. This compression will not affect the phase deviation but only lower the S/N ratio by a maximum of 6dB. This will allow twice the headroom and stronger un-modulated carrier levels for all three sound signals on the

main Q channel. For detection an alternative to hard limiting and  $Tan(\theta/2)$  wave shaping a similar process used in a C-QUAM® decoder can be employed. The Env and I signals are identical but phase inverted to each other. If the signal doesn't contain any amplitude noise the sum of the two will contain no information, only a DC level. The decoding process will un-modulate any amplitude noise by using the  $\Delta G$  modulator controlled by the sum of the Env and I signals being compared to a DC reference through a feedback path. This effectively functions as a limiter while also outputting  $Tan(\theta/2)$  eliminating the need for wave shaping and will also remove any amplitude compression applied.



# Cable Band Plan — 4MHz Channel Spacing

### **Including Broadcast & Amateur Radio Overlapping Spectrum**

Cable must carry Broadcast & Ham Channels.

| Lower<br>MHz                                       | Carrier<br>MHz   | Chroma<br>MHz | Upper<br>MHz |    | Broad<br>Cast Ham<br>Channels——— | Lower<br>MHz | Carrier<br>MHz   | Chroma<br>MHz | Upper<br>MHz |    | Broad<br>e Cast<br>-Channel | Ham<br>s |
|--|------------------|---------------|--------------|----|----------------------------------|--------------|------------------|---------------|--------------|----|-----------------------------|----------|
| Compo  | site Line        | Input         |              | 00 |                                  | 620          | 620½             | 622.84342     | 624          | 80 | 48                          |          |
| 112  | 112½             | 114.84342     | 116          | 01 |                                  | 624          | $624\frac{1}{2}$ | 626.84342     | 628          | 81 | 49                          | 1        |
| 116  | $116\frac{1}{2}$ | 118.84342     | 120          | 02 |                                  | 628          | 628½             | 630.84342     | 632          | 82 | 50                          | 1        |
| 120  | $120\frac{1}{2}$ | 122.84342     | 124          | 03 |                                  | 632          | 632½             | 634.84342     | 636          | 83 | 51                          | 1        |
| 124  | $124\frac{1}{2}$ | 126.84342     | 128          | 04 |                                  | 636          | $636\frac{1}{2}$ | 638.84342     | 640          | 84 | 52                          | 1        |
| 128  | $128\frac{1}{2}$ | 130.84342     | 132          | 05 |                                  | 640          | $640\frac{1}{2}$ | 642.84342     | 644          | 85 | 53                          | 1        |
| 132  | $132\frac{1}{2}$ | 134.84342     | 136          | 06 |                                  | 644          | $644\frac{1}{2}$ | 646.84342     | 648          | 86 | 54                          |          |
| 136  | $136\frac{1}{2}$ | 138.84342     | 140          | 07 |                                  | 648          | 648 2            | 650.84342     | 652          | 87 | 55                          | 1        |
| 140  | $140\frac{1}{2}$ | 142.84342     | 144          | 08 |                                  | 652          | $652\frac{1}{2}$ | 654.84342     | 656          | 88 | 56                          | 1        |
| 144  | $144\frac{1}{2}$ | 146.84342     | 148          | 09 | 2M 0                             | 656          | $656\frac{1}{2}$ | 658.84342     | 660          | 89 | 57                          |          |
| 148  | $148\frac{1}{2}$ | 150.84342     | 152          | 0A | 211                              | 660          | $660\frac{1}{2}$ | 662.84342     | 664          | 8A | 58                          | 1        |
| 152  | $152\frac{1}{2}$ | 154.84342     | 156          | 0B |                                  | 664          | $664\frac{1}{2}$ | 666.84342     | 668          | 8B | 59                          | 1        |
| 156  | $156\frac{1}{2}$ | 158.84342     | 160          | 0C |                                  | 668          | $668\frac{1}{2}$ | 670.84342     | 672          | 8C | 60                          | -        |
| 160  | 160½             | 162.84342     | 164          | 0D |                                  | 672          | 672½             | 674.84342     | 676          | 8D | 61                          | 1        |
| 164  | 164½             | 166.84342     | 168          | 0E |                                  | 676          | 676½             | 678.84342     | 680          | 8E | 62                          |          |
| 168  | 168½             | 170.84342     | 172          | 0F |                                  | 680          | 680½             | 682.84342     | 684          | 8F | 63                          |          |
| 172  | 172½             | 174.84342     | 176          | 10 |                                  | 684          | 684½             | 686.84342     | 688          | 90 | 64                          |          |
| 176  | 176½             | 178.84342     | 180          | 11 | 1 ¬                              | 688          | 688½             | 690.84342     | 692          | 91 | 65                          |          |
| 180  | 180½             | 182.84342     | 184          | 12 | 2                                | 692          | 692½             | 694.84342     | 696          | 92 | 66                          |          |
| 184  | 184½             | 186.84342     | 188          | 13 | 3                                | 696          | 696½             | 698.84342     | 700          | 93 | 67                          |          |
| 188  | 188½             | 190.84342     | 192          | 14 | 4                                | 700          | 700½             | 702.84342     | 704          | 94 | 68                          |          |
| 192  | 192½             | 194.84342     | 196          | 15 | 5                                | 704          | 704½             | 706.84342     | 708          | 95 | 69                          |          |
| 196  | 196½             | 198.84342     | 200          | 16 | 6 VHF2                           | 708          | 704/2            | 710.84342     | 712          | 96 | 70                          |          |
| 200  | 200½             | 202.84342     | 204          | 17 | 7                                | 712          | 712½             | 714.84342     | 716          | 97 | 71                          |          |
| 204  | 204½             | 206.84342     | 208          | 18 | 8                                | 716          | 716½             | 718.84342     | 720          | 98 | 72                          |          |
| 208  | 208½             | 210.84342     | 212          | 19 | 9                                | 720          | 720½             | 722.84342     | 724          | 99 | 73                          |          |
| 212  | 212½             | 214.84342     | 216          | 1A | 10                               | 724          | 724½             | 726.84342     | 728          | 9A | 74                          |          |
| 216  | 216½             | 218.84342     | 220          | 1B | 10                               | 728          | 728½             | 730.84342     | 732          | 9B | 75                          |          |
| 220  | 220½             | 222.84342     | 224          | 1C |                                  | 732          | 732½             | 734.84342     | 736          | 9C |                             | UHF      |
| 224  | 224½             | 226.84342     | 228          | 1D |                                  | 736          | 736½             | 738.84342     | 740          | 9D |                             | Lost     |
| 228  | 228½             | 230.84342     | 232          | 1E |                                  | 740          | 740½             | 742.84342     | 744          | 9E | 78                          | to       |
| 232  | 232½             | 234.84342     | 236          | 1F |                                  | 744          | 744½             | 746.84342     | 748          | 9F |                             | Chan.    |
| 236  | 236½             | 238.84342     | 240          | 20 |                                  | 748          | 748½             | 750.84342     | 752          | A0 |                             | Repak    |
| 240  | 240½             | 242.84342     | 244          | 21 |                                  | 752          | 752½             | 754.84342     | 756          | A1 | 81                          |          |
| 244  | 244½             | 246.84342     | 248          | 22 |                                  | 756          | 756½             | 758.84342     | 760          | A2 | 82                          |          |
| 248  | 248½             | 250.84342     | 252          | 23 |                                  | 760          | 760½             | 762.84342     | 764          | A3 | 83                          |          |
| 252  | 252½             | 254.84342     | 256          | 24 |                                  | 764          | 764½             | 766.84342     | 768          | A4 | 84                          |          |
| 256  | 256½             | 258.84342     | 260          | 25 |                                  | 768          | 768½             | 770.84342     | 772          | A5 | 85                          |          |
| 260  | 260½             | 262.84342     | 264          | 26 |                                  | 772          | 772½             | 774.84342     | 776          | A6 | 86                          |          |
| 264  | 264½             | 266.84342     | 268          | 27 |                                  | 776          | 776½             | 778.84342     | 780          | A7 | 87                          |          |
| 268  | 268½             | 270.84342     | 272          | 28 |                                  | 780          | 780½             | 782.84342     | 784          | A8 | 88                          |          |
| 272  | 272½             | 274.84342     | 276          | 29 |                                  | 784          | 784½             | 786.84342     | 788          | A9 | 89                          |          |
| 276  | 276½             | 278.84342     | 280          | 2A |                                  | 788          | 788½             | 790.84342     | 792          | AA | 90                          |          |
| 280  | 280½             | 282.84342     | 284          | 2B |                                  | 792          | 792½             | 794.84342     | 796          | AB | 91                          |          |
| 284  | 284½             | 286.84342     | 288          | 2C |                                  | 796          | 796½             | 798.84342     | 800          | AC | 92                          |          |
| 288  | 288½             | 290.84342     | 292          | 2D |                                  | 800          | 800½             | 802.84342     | 804          | AD | 93                          |          |
| 292  | 292½             | 294.84342     | 296          | 2E |                                  | 804          | 804½             | 806.84342     | 808          | AE | 94                          |          |
| 296  | 296½             | 298.84342     | 300          | 2F |                                  | 808          | 808½             | 810.84342     | 812          | AF | 95                          |          |
| 300  | 300½             | 302.84342     | 304          | 30 |                                  | 812          | 812½             | 814.84342     | 816          | B0 | 96                          |          |
| 304  | 304½             | 306.84342     | 308          | 31 |                                  | 816          | 816½             | 818.84342     | 820          | B1 | 97                          |          |
| 308  | 308½             | 310.84342     | 312          | 32 |                                  | 820          | 820½             | 822.84342     | 824          | B2 | 98                          |          |
| 312  | 312½             | 314.84342     | 316          | 33 |                                  | 824          | 824½             | 826.84342     | 828          | B3 | 99                          |          |
| 316  | 316½             | 318.84342     | 320          | 34 |                                  | 828          | 828½             | 830.84342     | 832          | В4 | 100                         |          |
| 320  | 320½             | 322.84342     | 324          | 35 |                                  | 832          | 832½             | 834.84342     | 836          | B5 | 101                         |          |
| 324  | 324½             | 326.84342     | 328          | 36 |                                  | 836          | 836½             | 838.84342     | 840          | В6 | 102                         |          |
| 328  | 328½             | 330.84342     | 332          | 37 |                                  | 840          | 840½             | 842.84342     | 844          | B7 | 103                         |          |
| 332  | 332½             | 334.84342     | 336          | 38 |                                  | 844          | 844½             | 846.84342     | 848          | В8 | 104                         |          |
| 336  | 336½             | 338.84342     | 340          | 39 |                                  | 848          | 848½             | 850.84342     | 852          | В9 | 105                         |          |
| 340  | 340½             | 342.84342     | 344          | 3A |                                  | 852          | 852½             | 854.84342     | 856          | BA | 106                         |          |
| 344  | 344½             | 346.84342     | 348          | 3B |                                  | 856          | 856½             | 858.84342     | 860          | BB | 107                         |          |
| 348  | 348½             | 350.84342     | 352          | 3C |                                  | 860          | 860½             | 862.84342     | 864          | BC | 108                         |          |
| Broad<br>Lower Carrier Chroma Upper Cable Cast Ham |                  |               |              |    |                                  |              |                  |               |              |    | Broad                       | llo      |
| ∟ower<br>MHz                                       | Carrier<br>MHz   | Chroma<br>MHz | Upper<br>MHz |    | Cast Ham<br>Channels———          | Lower<br>MHz | Carrier<br>MHz   | Chroma<br>MHz | Upper<br>MHz |    | e Cast<br>-Channel:         | Haı<br>  |

| 352 352W 358 48442 386 3E 868 888 888 86 86 86 86 86 86 86 86 86   | Lower<br>MHz | Carrier<br>MHz | Chroma<br>MHz | Upper<br>MHz |    | Broad<br>Cast Ham<br>Channels——— | Lower<br>MHz | Carrier<br>MHz | Chroma<br>MHz | Upper<br>MHz | Cable | road<br>Cast<br>annels | Ham      |
|--|--------------|----------------|---------------|--------------|----|----------------------------------|--------------|----------------|---------------|--------------|-------|------------------------|----------|
| Section   Sect   | 352          | 352½           | 354.84342     | 356          | 3D |                                  | 864          | 864½           | 866.84342     | 868          | BD    | 109                    |          |
| 384 3644, 366,84342 386 49  386 368, 370,84342 372 41  387 376 376, 377,84342 372 41  388 388 389, 380,84342 380 43  380 380,8432,84342 380 43  380 380,8432,84342 380 43  380 380,8432,84342 380 43  380 380,8432,84342 380 43  380 380,84342 380,44342 380 43  380 380,8432,84342 380 43  380 380,84342 380,44342 380 43  380 380,84342 380,44342 380 46  380 380,84342 380,44342 380 46  380 380,84342 380,44342 380 46  380 380,84342 380,44342 380 46  380 380,84342 380,44342 380 46  380 380,84342 380,44342 380 47  390 390,940 390,84342 380,447  480 480,440,440,84342 480 48  480 480,440,84342 480 49  480 480,440,84342 480 49  490 912,912,84342 924 CB  420 420,4444 426,84342 428 46  420 420,4444 426,84342 436 46  420 420,444 426,84342 428 46  421 424 426,84342 428 48  422 428 428,444 426,84342 428 48  428 428,444 426,84342 428 48  429 380,84342 380 CC  380 400,440,440,440,440,440,440,440,540,440,540,440,4   | 356          | 356½           | 358.84342     | 360          | 3E |                                  | 868          | 868½           | 870.84342     | 872          | BE    | 110                    |          |
| 388 3689 370.84342 372 41 888 889 889 882.84342 886 C1 113 376 3769 376.84342 380 43 888 884 886 889.84342 886 C1 114 -   376 3769 3768 84342 380 43 888 888 889.84342 880 C1 113 380 3809 382.84342 380 44  882 8829 889 884342 880 C2 1   384 3649 386.645432 380 45  886 886 886 886 888.84342 880 C3   385 364 364 364 364 364 364 364 364 364 364   |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 376 376 378 378 374 83432 376 42 888 88 884 886 83432 886 C2 114 — 376 376 378 378 374 8342 380 43 380 380 380 380 380 380 380 380 380 38  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| Section   Sect   |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 380 389h 382.84342 384 44 89.2 892. 594.84342 896 C4 384 384, 386.84342 384 45 896 896k 898 89 84342 996 C5 388 388h 380.84342 392 46 990 900 900k 902.84342 994 C6 386 396h 388.84342 409 48 386 396h 388.84342 409 48 402 400k 402.84342 412 48 406 400k 410.84342 4112 48 406 400k 410.84342 4112 48 406 400k 410.84342 412 48 406 400k 410.84342 416 40 406 400k 410.84342 416 40 407 412.84342 416 40 408 400k 410.84342 416 40 409 412.84342 416 40 400 400k 410.84342 416 40 400 410k 410k 410k 410k 410k 410k 410k 4   |              |                |               |              |    |                                  | !            |                |               |              |       | 114 —                  | _        |
| 384 384% 386. 84342 388 45 896 896% 598. 84342 990 CS 388 38384342 396 47 990 690% 990. 84342 990 CS 392. 332% 394. 84342 396 47 990 690% 990. 84342 990 CS 392. 84342 490 48 9968 9968 910. 84342 912 CS 400 400 4000% 402. 84342 404 49 996 9968 9968 910. 84342 912 CS 400 400 4000% 402. 84342 404 404 404 404 405. 84342 416 48 9968 9968 910. 84342 912 CS 400 400 4000% 402. 84342 416 48 9968 9968 910. 84342 912 CS 400 400 4000% 402. 84342 416 48 9968 9968 912. 812. 81342 920 CC 400 416 416 416 416 416 416 416 416 416 416  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 388 388% 398.84342 392 46 990 990% 992.83342 994 C6 336 396.8342 396 C7 36 396.8342 396 C7 36 396.8342 396 C7 36 396.8342 396 C7 396 396 396.8342 396 C7 396 396 396.8342 396 C7 396 396 396 396 396 396 396 396 396 396   |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 386 396k 398, 84342 400 48 49 988 998k 910, 84342 912 CB 400 400, 400, 44342 408 47 49 912 12k 914, 84342 915 CD 33CM 404 404 404 404 404 404 404 404 406, 84342 416 4C 926 416, 418, 84342 416 4C 926 420 420 420 420 420 420 420 420 420 420   |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 400 400% 400% 402.84342 404 49 404 404% 406.84342 405 4A 404 404% 406.84342 406 4A 408 408% 410.84342 412 48 408 408% 410.84342 412 48 412 412% 414.84342 416 4C 420 420% 422.84342 426 4D 421 412% 414.84342 416 4C 420 420% 422.84342 426 4D 421 412% 414.84342 416 4C 420 420% 422.84342 426 4D 421 412% 414.84342 416 416 416% 418.84342 426 4D 428 420% 422.84342 428 4F 428 420% 430.84342 428 4F 428 420% 430.84342 428 4F 430 430.84342 429 40 430 430.84342 436 51 760M 4 944 944% 946.84342 936 CF 432 432% 433.84342 436 51 760M 4 944 944% 946.84342 949 4D 440 440% 446.84342 440 52 45 440 440% 446.84342 440 52 45 441 440% 446.84342 456 56 456 456% 458.84342 466 57 460 460% 460% 462.84342 464 58 468 466% 466.84342 466 59 468 466% 466.84342 486 59 476 476% 478.84342 472 5A 488 486% 482.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 486 50 486 466% 466.84342 486 59 972 972% 972% 978.84342 980 00 488 486% 482.84342 486 50 476 476% 478.84342 472 5A 488 486% 482.84342 486 50 476 476% 478.84342 472 5A 488 486% 482.84342 486 50 476 476% 478.84342 486 50 476 476% 478.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 486 50 488 486% 482.84342 566 61 504 504% 506.84342 506 61 504 504% 506.84342 506 61 504 504% 506.84342 506 61 505 506% 506% 502.84342 506 61 507 506% 506% 506.84342 506 61 507 506% 506% 506.84342 506 61 507 506% 506% 506.84342 506 67 508 506% 506.84342 506 67 508 506% 506.84342 506 67 508 506% 506.84342 506 67 509 506% 506.84342 506 67 509 506% 506.84342 506 67 509 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 500 506% 506.84342 506 67 507 507 507 507 507 507 507 507 507 507  | 392          | 392½           | 394.84342     | 396          | 47 |                                  | 904          | 904½           | 906.84342     | 908          | C7    |                        | 8        |
| 404 4084 4086 43142 408 4A 916 81342 42 88 48 48 916 916 916 916 91 818 81342 22 924 CB 412 412 412 412 412 412 412 412 412 412  |              |                |               |              |    |                                  | l .          |                |               |              |       |                        | 9        |
| 408 408% 410.84342 412 48 62 920 92.98% 922.84342 924 CB 416 416% 418.84342 426 40   |              |                |               |              |    |                                  |              |                |               |              |       |                        | 10       |
| 412 412% 414,84342 416 4C 924 924 924% 926,84342 928 CC 420 420% 422,84342 424 4E 1 932 928% 938,84342 936 CE 424 424 424 426,84342 428 4F 2 932 928% 938,84342 936 CE 428 426% 430,84342 432 50 70 4 944 944% 9442,84342 944 00 942,84342 438 430,84342 436 51 70 4 944 944% 9442,84342 948 01 948 434,84342 446 52 5 948 948% 950,84342 956 02 444 444 444% 446,84342 444 53 6 95 952 952% 952% 958,434342 956 03 444 444 444% 446,84342 445 55 96 966 966% 9698 958,84342 966 05 446 464 464 464 464 464 464 464 464 46   |              |                |               |              |    |                                  | 1            |                |               |              |       | 33CM                   | 11       |
| 416 416% 418.84342 420 4D 928 928% 938.84342 936 CE 420 420 420 420 420 420 420 420 420 420  |              |                |               |              |    |                                  | !            |                |               |              |       |                        | 12<br>13 |
| 429 429% 422.84342 424 4E  |              |                |               |              |    |                                  | !            |                |               |              |       | _                      | 13       |
| 428 428 438 430 4342 426 50 3 936 936 938 84342 940 CF 428 428 438 430 4342 436 51 780M 4 944 944 942 84342 944 D0 432 432 432 434 84342 436 51 780M 4 944 944 946 84342 944 D0 436 436 438 4342 444 53 6 5 5 950 952 952 952 952 952 952 952 952 952 952  |              |                |               |              |    | <b>–</b> 1                       | !            |                |               |              |       |                        |          |
| 432 432 434 84342 446 52 55  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 436 436 436 438 4342 440 52 5 5 948 948% 956 .84342 956 D3  444 444 444% 45 84342 448 54 7 956 952 952 954 954 .84342 956 D3  444 444 444% 45 848 458 .84342 446 55 56 960 960 962 .84342 960 D4  448 448 458 84342 456 56  960 960 962 983 .84342 960 D5  452 452% 454 84342 456 56  964 964% 966 .84342 968 D6  456 456% 458 .84342 466 57  968 968 970 .84342 976 D8  469 469% 462 .84342 464 58  972 972% 974 .84342 976 D8  468 468% 470 .84342 476 58 11  984 984% 986 .84342 988 D9  468 468% 478 .84342 476 58 11  984 984% 986 .84342 980 D9  468 468% 478 .84342 480 5C 12  988 989 980 982 .84342 982 DC  476 476% 478 .84342 488 5C 12  988 988 980 .84342 992 DC  480 469% 480 480 480 480 5C 12  988 988 980 .84342 992 DC  480 469% 480 482 .84342 488 5C 14  996 969 98 .84342 992 DC  480 469% 480 48342 486 5C 12  988 988 980 .84342 1000 DE  488 488% 489 .84342 580 60 16  1000 1000 1000 1000 1000 1000  | 428          |                |               | 432          | 50 | 3                                | 940          | 940½           | 942.84342     |              |       |                        |          |
| 440  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 4444 444½ 446, 84342 448 54 7 956 956; 958,84342 960 D4 4488 448½ 458, 84342 456 56 452 452½ 452½ 454,84342 456 56 456 458,84342 460 57 460 460½ 462,84342 464 58 464 464 466,84342 468 59 468 468½ 470,84342 472 5A 472 472½ 474,84342 476 5B 476 476½ 478,84342 480 5C 12 8480 480½ 482,84342 480 5C 12 8480 480½ 480,4842 480 5C 12 8480 480½ 490,484342 480 5C 12 8490 490½ 490½ 490½ 490½ 490½ 490½ 490½ 4  |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 448 448 45 450, 84342 452 555  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 452 452 452 454 84342 456 56   |              |                |               |              |    | _ /                              | !            |                |               |              |       |                        |          |
| 456 456 456 458 84342 469 57 968 968 972 978 84342 972 D7 460 460 460 460 460 460 460 460 460 460  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 460 460% 462.84342 464 58  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 468  |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 476 476% 478.84342 480 5C 12 988 988% 990.84342 992 DC 480 4804 480% 482.84342 480 5C 12 988 988% 990.84342 992 DC 480 4804 482.84342 484 5D 13 992 992% 994.84342 996 DD 48484 484% 486.84342 492 5F 15 1000 1000% 1002.84342 1004 DF 492 492% 494.84342 496 60 16 1004 10064% 1006.84342 1004 DF 496 496% 498.84342 500 61 17 1008 1008% 1010.84342 1012 E1 500 500% 502.84342 504 62 18 1012 1012% 1014.84342 1016 E2 504 504% 506.84342 508 63 19 1016 1016% 1018.84342 1020 E3 508 508% 510.84342 550 66 21 1020 1020% 1022.84342 1020 E3 508 508% 510.84342 512 64 20 1020 1020% 1028.84342 1020 E3 516 516% 518.84342 520 66 22 1028 1028 1028% 1038.84342 1032 E5 524% 526.84342 528 68 24 1036 1036% 1038.84342 1032 E6 522 520% 522.84342 526 60 22 1028 1028% 1038.84342 1032 E6 522 524% 526.84342 528 68 24 1036 1036% 1038.84342 1034 E8 532 532% 534.84342 532 69 25 1040 1040% 1040% 1042.84342 1040 E8 532 532% 534.84342 540 68 27 1040 1040% 1040.84342 1040 E8 536 536% 538.84342 540 68 27 1040 1040% 1040.84342 1040 E8 540 540% 542.84342 556 67 23 1040 1040% 1040.84342 1040 E8 552 552% 554.84342 556 67 23 1040 1040% 1040.84342 1040 E8 552 552% 554.84342 556 67 23 1040 1040% 1040.84342 1040 E8 556 560% 562.84342 556 67 31 1060 1060% 1060% 1060.84342 1066 EC 544 544% 566.84342 556 67 31 1066 1066% 1066.84342 1068 EF 556 566% 562.84342 556 67 31 1066 1066% 1066.84342 1068 EF 556 566% 562.84342 566 70 32 1068 1068% 1070.84342 1068 EF 560 560% 562.84342 556 67 31 1066 1066% 1066.84342 1068 EF 560 560% 562.84342 556 67 31 1066 1066% 1060.84342 1068 EF 560 560% 562.84342 556 67 31 1066 1066% 1060.84342 1068 EF 560 560% 568.84342 560 70 32 1068 1060.84342 1068 EF 560 560% 562.84342 560 70 32 1068 1060.84342 1068 EF 560 560% 568.84342 560 70 32 1068 1060.84342 1068 EF 560 560% 568.84342 560 70 32 1068 1060.84342 1068 EF 560 560% 568.84342 560 70 32 1068 1060.84342 1068 EF 560 560% 568.84342 560 70 32 1068 1060.84342 1068 EF 560 560% 560.84342 560 70 32 1068 1060.84342 1060 FC 1060.84342 1060 FC 1060.84342 1060 FC 1060.84342 1060 FC 1060.84342 1060  | 464          | 464½           | 466.84342     | 468          | 59 |                                  | 976          |                | 978.84342     | 980          | D9    |                        |          |
| 476 476 476 478 84342 484 5D 13 998 998 998 84342 992 DC 4848 484 484 5D 13 992 992 992 992 994 84342 996 DD 4848 484 4848 486 84342 488 5E 14 996 996 998 998 84342 1000 DE 488 488 488 490 84342 496 60 16 1004 10004 1006 84342 1008 E0 496 496 496 496 496 504 504 504 504 504 504 504 504 504 504   |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| 480  |              |                |               |              |    | !                                | !            |                |               |              |       |                        |          |
| 484 484% 486.84342 492 5F 15 1000 1000% 1002.84342 1004 DF 492 492% 494.84342 496 60 16 1004 1000% 1000% 1002.84342 1004 DF 496 496% 498.84342 500 61 17 1008 1008% 1010.84342 1012 E1 500 500% 502.84342 504 62 18 1012 1012 1012% 1014.84342 1016 E2 504 504% 506.84342 508 63 19 1016 1016% 1018.84342 1010 E2 504 504% 510.84342 512 64 20 1020 1020% 1022.84342 1024 E4 512 512% 514.84342 520 66 22 1 1024 1024% 1026.84342 1026 E3 502 520% 522.84342 520 66 22 1028 1032 1032 1032 1032 1032 1032 1032 1032  |              |                |               |              |    |                                  | ı            |                |               |              |       |                        |          |
| 488  |              |                |               |              |    |                                  | ı            |                |               |              |       |                        |          |
| 492 492% 494.843422 500 61 17 500 500% 502.84342 500 61 17 500 500% 502.84342 500 62 18 504 504 506.84342 501 64 20 508 508% 510.84342 512 64 20 512 512% 514.84342 512 64 20 512 512% 514.84342 520 66 22 516 516% 518.84342 520 66 22 520 520% 522.84342 524 67 23 524 524% 526.84342 532 69 25 528 528% 530.84342 532 69 25 532 532% 534.84342 532 69 25 540 536% 536% 538.84342 540 68 27 544 544% 546.84342 546 67 23 545 546 548% 550.84342 556 6F 31 556 556% 558.84342 556 6F 31 556 556% 558.84342 556 6F 31 556 56% 558.84342 568 70 528 528% 558.84342 568 70 529 527 524% 526.84342 544 66 28 540 546% 546.84342 546 67 556 556% 558.84342 556 6F 31 556 556% 558.84342 568 70 568 568% 570.84342 568 72 544 544% 546.84342 568 72 545 566 568% 570.84342 568 72 546 566% 562.84342 568 72 547 566 568% 570.84342 570 570 570 570 58342 588 77 570 570 578 84342 588 77 570 576% 578 84342 588 77 570 576% 578 84342 588 77 570 576% 578 84342 588 77 570 576% 578 84342 588 77 570 576% 578 84342 588 77 571 572 572% 574.84342 576 74 572 572 572% 574.84342 576 74 574 588 588% 599.84342 588 77 575 576 576% 578 84342 588 77 576 576% 578 84342 588 77 577 579 579 878 84342 588 77 578 579 878 84342 588 77 579 579 879 884342 588 77 570 570 578 84342 588 77 570 576% 578 84342 588 77 571 572 572 878 84342 588 77 572 572 572 878 84342 588 77 573 576 576% 578 84342 588 77 574 578 84342 588 77 575 576 576% 578 84342 588 77 576 576% 578 84342 588 77 577 579 878 84342 588 77 579 579 879 84342 596 79 580 580% 580 84342 600 7A 580 580% 580 84342 600 7A 580 580% 680 84342 600 7A 580 580 680 680 600 84342 600 7A 580 580 680 680 84342 616 78 580 580 680 680 610.84342 616 78 580 580 680 610.84342 616 78 580 580 680 610.84342 616 78 580 580 680 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610.84342 616 78 580 580 610. |              |                |               |              |    |                                  | l .          |                |               |              |       |                        |          |
| 496       4968       498.84342       500       61       17       1008       1008%       1010.84342       1012       E1         500       500       502.84342       504       62       18       1012       1012%       1014.84342       1016       E2         508       508%       510.84342       512       64       20       1020       1020       1022       84342       102       E5         512       512.84       518.84342       520       66       22       1024       10244       1026.84342       1028       E5         516       516%       518.84342       520       66       22       1028       10244       1026.84342       1032       E6         520       520%       522.84342       524       67       23       1032       1032%       1034.84342       1036       E7         524       524%       530.84342       532       69       25       1040       1040%       1042.84342       1040       E8         528       528%       530.84342       536       6A       26       UHF       1044       1040%       1042.84342       1044       E9         532       532% <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td>l .</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>  |              |                |               |              |    |                                  | l .          |                |               |              |       |                        |          |
| 504         504½         506.84342         508         63         19         1016         1016½         1018.84342         1020         E3           508         508½         510.84342         512         64         20         1020         1020½         1022.84342         1024         E4           516         516½         514.84342         520         66         22         1028         1030.84342         1032         E6           520         520½         522.84342         524         67         23         1032         1032½         1030.84342         1036         E7           524         526         66         22         1028         1028½         1030.84342         1032         E6           528         528½         524         526         66         22         1040         1040½         1044         1044         E9           532         532%         534.84342         540         68         27         1048         1044½         1044         1044         E9           532         532%         534.84342         540         68         27         1048         1044½         1044         1044         1044         E9 <td>496</td> <td>496½</td> <td>498.84342</td> <td>500</td> <td>61</td> <td>17</td> <td>1008</td> <td>1008½</td> <td></td> <td>1012</td> <td>E1</td> <td></td> <td></td>  | 496          | 496½           | 498.84342     | 500          | 61 | 17                               | 1008         | 1008½          |               | 1012         | E1    |                        |          |
| 508         508%         510.84342         512         64         20         1020         1020%         1022.84342         1024         E4           512         512%         514.84342         520         66         521         1024         1024         1022.84342         1028         E5           516         516         518.84342         520         66         22         1028         1030.84342         1030.84342         1036         E7           524         524%         526.84342         524         67         23         1032         1032%         1034.84342         1036         E7           524         524%         526.84342         532         69         25         1040         1040%         1042.84342         1040         E8           532         532%         534.84342         540         68         27         1044         1044%         1046.84342         1048         EA           540         540%         542.84342         544         6C         28         1052         1052%         1054.8432         1052         EB           544         544%         546.84342         556         6F         31         1066         1056%  |              |                |               |              |    |                                  | l .          |                |               |              |       |                        |          |
| 512         512k         514, 84342         516         65         21         1024         1024kk         1026, 84342         1032         E5           516         516kk         518, 84342         520         66         22         1032         1030, 84342         1036         E7           524         524kk         526, 84342         528         68         24         1036         1032kk         1034, 84342         1040         E8           528         528kk         530, 84342         536         6A         26         UHF         1044         1040kk         1042, 84342         1048         EA           532         532kk         534, 84342         540         6B         27         1044         1044kk         1048, 84342         1048         EA           540         540kk         542, 84342         544         6C         28         1052         1054, 84342         1056         EC           544         544kk         546, 84342         548         6D         29         1056         1056kk         1058, 84342         1066         EC           548         548kk         550, 84342         556         6F         31         1060         1060kk   |              |                |               |              |    |                                  | !            |                |               |              |       |                        |          |
| S16   S16   S18   S18   S4342   S20   66   22     1028   1028   1030   84342   1030   E6   S20   |              |                |               |              |    | ,                                | 1            |                |               |              |       |                        |          |
| 520   520%   522.84342   524   67   23   1032   1032%   1034.84342   1036   E7   524   524%   526.84342   528   68   24   1036   1036%   1038.84342   1040   E8   528   530.84342   532   69   25   1040   1040%   1042.84342   1044   E9   532   532%   534.84342   540   68   27   1048   1048%   1050.84342   1048   EA   536   536%   538.84342   544   6C   28   1052%   1052%   1054.84342   1056   EC   544   546.84342   548   6D   29   1056   1056%   1058.84342   1060   ED   548   548%   550.84342   552   6E   30   1060   1060%   1062.84342   1064   EE   552   552%   554.84342   556   6F   31   1064   1066%   1062.84342   1076   EF   556   556%   558.84342   566   70   32   1068   1068%   1070.84342   1077   F0   560   560%   562.84342   564   71   33   1072   1072%   1074.84342   1076   F1   564   564%   566.84342   5572   73   35   1080   1080%   1082.84342   1084   F3   572   572%   574.84342   576   74   36   1084   1084%   1086.84342   1084   F3   572   572%   574.84342   586   75   37   1088   1088%   1090.84342   1092   F5   580   580%   582.84342   584   76   38   1092   1092%   1094.84342   1096   F6   584   584   586.84342   588   77   39   1096   1096%   1098.84342   1100   F7   588   588%   590.84342   596   79   41   1104   1104   1106.84342   1100   F7   588   588%   590.84342   596   79   41   1104   1104   1104   1104   1104   1106   1408   1102   1102   1122   1124   112   F6   616   616%   618.84342   608   70   44   1116   1116   1116   1116   1118   1124   1124   1124   1124   1124   1124   1124   1124   1124   1124   1124   1124   1124   1124   1124   1125   1128   1128   1128   1128   1130   84342   1132   FF   5004    |              |                |               |              |    |                                  | l .          |                |               |              |       |                        |          |
| 524         524 b         526 b         84342 b         528 b         68 b         24 b         1036 b         1036 b         1038 b         84342 b         1040 b         E8           528 b         528 b         530 b         534 b         536 b         6A b         26 b         1040 b         1040 b         1042 b         1044 b         1048 b         1048 b         1048 b         1044 b         1044 b         1044 b         1048 b         1050 b <td></td>  |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 528         528½         530.84342         532         69         25         1040         1040½         1042.84342         1044         E9           532         532½         534.84342         540         68         26         UHF         1044         1046.84342         1048         EA           536         536½         538.84342         544         6C         28         1052         1050.84342         1056         EC           544         540½         542.84342         544         6C         28         1052         1052½         1058.84342         1056         EC           544         544½         546.84342         548         6D         29         1056         1056½         1058.84342         1060         ED           548         548½         550.84342         556         6F         31         1060         1060½         2062.84342         1064         EE         552         558.84342         566         70         32         1068         1068½         1070.84342         1072         F0           560         560½         558.84342         568         72         34         1072         1072½         1074.84342         1076         F1   |              |                |               |              |    | l l                              |              |                |               |              |       |                        |          |
| 536         536½         538.84342         540         6B         27         1048         1048½         1050.84342         1052         EB           540         540½         542.84342         544         6C         28         1052         1052½         1054.84342         1056         EC           544         544½         546.84342         548         6D         29         1056         1056½         1058.84342         1060         ED           548         548½         550.84342         552         6E         30         1060         1060½         1062.84342         1064         EE           552         552½         554.84342         560         70         32         1064         1064½         1066.84342         1072         F0           560         560½         568.4342         564         71         33         1072         1072½         1074.84342         1076         F1           564         564½         566.84342         572         73         35         1080         1080½         1082.84342         1080         F2           572         572½         574.84342         576         74         36         1080         1080½  | 528          | 528½           |               | 532          | 69 |                                  | 1040         |                |               | 1044         | E9    |                        |          |
| 540         540½         542.84342         544         6C         28         1052         1052½         1054.84342         1056         EC           544         544½         546.84342         548         6D         29         1056         1056½         1058.84342         1060         ED           548         548½         550.84342         552         6E         30         1060         1060½         1062.84342         1064         EE           552         552½         554.84342         556         6F         31         1064         10664½         1066.84342         1068         EF           560         560½         558.84342         560         70         32         1068         1068½         1070.84342         1072         F0           564         564         564         568         72         34         1076         1076½         1078.84342         1076         F1           568         568½         570.84342         576         74         36         1080         1080%         1082.84342         1080         F2           572         572½         574.84342         580         75         37         1088         1088½ <t< td=""><td>532</td><td>532½</td><td>534.84342</td><td>536</td><td>6A</td><td>26 UHF</td><td>1044</td><td>1044½</td><td>1046.84342</td><td>1048</td><td></td><td></td><td></td></t<>  | 532          | 532½           | 534.84342     | 536          | 6A | 26 UHF                           | 1044         | 1044½          | 1046.84342    | 1048         |       |                        |          |
| 544       544½       546.84342       548       6D       29         548       548½       550.84342       552       6E       30       1060       1060½       1062.84342       1064       EE         552       552½       554.84342       556       6F       31       1064       1064½       1066.84342       1068       EF         556       556½       558.84342       560       70       32       1068       1066%½       1070.84342       1072       F0         564       564       568.84342       568       72       34       1076       1076½       1078.84342       1076       F1         564       564.568½       570.84342       572       73       35       1080       1080½       1082.84342       1080       F2         572       572½       574.84342       576       74       36       1084       1084½       1086.84342       1084       F3         576       576       578.84342       580       75       37       1088       1088½       1090.84342       1092       F5         580       580½       582.84342       584       76       38       1092       1096½       1098.84342 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>   |              |                |               |              |    |                                  | 1            |                |               |              |       |                        |          |
| 548         548½         550.84342         552         6E         30         1060         1060½         1062.84342         1064         EE           552         552½         554.84342         560         70         32         1068         1064½         1066.84342         1068         EF           560         560½         562.84342         564         71         33         1072         1072½         1074.84342         1076         F1           564         564½         566.84342         568         72         34         1076         1076½         1078.84342         1076         F1           568         568½         570.84342         572         73         35         1080         1080½         1082.84342         1080         F2           568         568½         570.84342         576         74         36         1080         1080½         1082.84342         1084         F3           572         572½         574.84342         580         75         37         1088         1084½         1084.84342         1088         F4           576         576½         582.84342         584         76         38         1092         1092½   |              |                |               |              |    |                                  | 1            |                |               |              |       |                        |          |
| 552         552½         554.84342         556         6F         31         1064         1064½         1066.84342         1068         EF           556         556½         558.84342         560         70         32         1068         1068½         1070.84342         1072         F0           560         560½         562.84342         564         71         33         1072         1072½         1074.84342         1076         F1           564         564½         566.84342         568         72         34         1076         1078.84342         1080         F2           568         568½         570.84342         576         74         36         1080         1080½         1082.84342         1084         F3           576         576½         578.84342         580         75         37         1080         1080½         1084.84342         1084         F3           580         580½         582.84342         584         76         38         1092         1092½         1094.84342         1096         F6           584         584½         586.84342         588         77         39         1096         1096½         1098.84342  |              |                |               |              |    |                                  | 1            |                |               |              |       |                        |          |
| 556         556½         558.84342         560         70         32         1068         1068½         1070.84342         1072         F0           560         560½         562.84342         564         71         33         1072         1072½         1074.84342         1076         F1           564         564½         566.84342         568         72         34         1076         1076½         1078.84342         1080         F2           568         568½         570.84342         572         73         35         1080         1080½         1082.84342         1084         F3           576         576½         578.84342         580         75         37         1088         1088½         1090.84342         1088         F4           580         580½         582.84342         584         76         38         1092         1092½         1094.84342         1096         F6           584         584½         586.84342         588         77         39         1096         1096½         1098.84342         100         F7           588         588½         590.84342         596         79         41         1100         1100½  |              |                |               |              |    |                                  | 1            |                |               |              |       |                        |          |
| 560       560½       562.84342       564       71       33         564       564½       566.84342       568       72       34         568       568½       570.84342       572       73       35         572       572½       574.84342       576       74       36         576       576½       578.84342       580       75       37         580       580½       582.84342       584       76       38         584       584½       586.84342       584       76       38         584       584½       586.84342       588       77       39         588       588½       590.84342       596       79       41         592       592½       594.84342       596       79       41         596       596½       598.84342       600       7A       42         600       600½       602.84342       604       7B       43         604       604½       606.84342       608       7C       44         602       612½       614.84342       616       7E       46         612       612½       614.84342       616   |              |                |               |              |    |                                  | 1            |                |               |              |       |                        |          |
| 564       564½       566.84342       568       72       34         568       568½       570.84342       572       73       35         572       572½       574.84342       576       74       36         576       576½       578.84342       580       75       37         580       580½       582.84342       584       76       38         584       584½       586.84342       588       77       39         588       588½       590.84342       592       78       40         592       592½       594.84342       596       79       41         596       596½       598.84342       600       7A       42         600       600½       602.84342       604       7B       43         604       604½       606.84342       608       7C       44         612       612½       614.84342       616       7E       46         612       612½       614.84342       616       7E       46         616       616½       618.84342       620       7F       47             Broad  |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 572       572½       574.84342       576       74       36         576       576½       578.84342       580       75       37         580       580½       582.84342       584       76       38         584       584½       586.84342       588       77       39         588       588½       590.84342       592       78       40         592       592½       594.84342       596       79       41         596       596½       598.84342       600       7A       42         600       600½       602.84342       604       7B       43         604       604½       606.84342       608       7C       44         608       608½       610.84342       612       7D       45         612       612½       614.84342       616       7E       46         616       616½       618.84342       620       7F       47              Broad       Broad       Broad   |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 576       576½       578.84342       580       75       37         580       580½       582.84342       584       76       38         584       584½       586.84342       588       77       39         588       588½       590.84342       592       78       40         592       592½       594.84342       596       79       41         596       596½       598.84342       600       7A       42         600       600½       602.84342       604       7B       43         604       604½       606.84342       608       7C       44         608       608½       610.84342       612       7D       45         612       612½       614.84342       616       7E       46         616       616½       618.84342       620       7F       47     Broad  1098 1098 1098 1098 1098 1098 1098 109   |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 580     580½     582.84342     584     76     38       584     584½     586.84342     588     77     39       588     588½     590.84342     592     78     40       592     592½     594.84342     596     79     41       596     596½     598.84342     600     7A     42       600     600½     602.84342     604     7B     43       604     604½     606.84342     608     7C     44       608     608½     610.84342     612     7D     45       612     612½     614.84342     616     7E     46       616     616½     618.84342     620     7F     47    Broad  1092     1092½     1094.84342     1096     F6       1096     1096½     1098.84342     1100     F7       1100     1100½     1100½     1102.84342     1108     F9       1110     1104½     1104 <td></td>   |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 584     584½     586.84342     588     77     39       588     588½     590.84342     592     78     40       592     592½     594.84342     596     79     41       596     596½     598.84342     600     7A     42       600     600½     602.84342     604     7B     43       604     604½     606.84342     608     7C     44       608     608½     610.84342     612     7D     45       612     612½     614.84342     616     7E     46       616     616½     618.84342     620     7F     47    Broad  1096½  1098.84342  1100  1100½  1100.84342  1106.84342  1108  FF  1100     1100½  1100.84342  1106.84342  1108  FF       1108     1108½  1110.84342  1110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  11110.84342  1110.8   |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 588     588½     590.84342     592     78     40       592     592½     594.84342     596     79     41       596     596½     598.84342     600     7A     42       600     600½     602.84342     604     7B     43       604     604     606.84342     608     7C     44       608     608½     610.84342     612     7D     45       612     612½     614.84342     616     7E     46       616     616½     618.84342     620     7F     47       Broad         Broad         1100     1100½     1102.84342     1108     F8       1104     1104½     1106.84342     1108     F9       1108     1108½     1110.84342     1112     FA       1112     1112½     1114.84342     1116     FB       1116     1116½     1118.84342     1120     FC       1120     1120½     1122.84342     1124     FD       612     614.84342     616     7E     46       616     616½     618.84342     620     7F     47       1124     1128½     1130.84342  |              |                |               |              |    | ,                                |              |                |               |              |       |                        |          |
| 592     592½     594.84342     596     79     41       596     596½     598.84342     600     7A     42       600     600½     602.84342     604     7B     43       604     604½     606.84342     608     7C     44       608     608½     610.84342     612     7D     45       612     612½     614.84342     616     7E     46       616     616½     618.84342     620     7F     47    Broad  Broad  Broad  |              |                |               |              |    |                                  | 1            |                |               |              |       |                        |          |
| 596       596½       598.84342       600       7A       42         600       600½       602.84342       604       7B       43         604       604½       606.84342       608       7C       44         608       608½       610.84342       612       7D       45         612       612½       614.84342       616       7E       46         616       616½       618.84342       620       7F       47            Broad       Broad   |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 600 600½ 602.84342 604 7B 43   |              |                |               |              |    | !                                | !            |                |               |              |       |                        |          |
| 608       608½       610.84342       612       7D       45       1120       1120½       1122.84342       1124       FD         612       612½       614.84342       616       7E       46       1124       1124½       1126.84342       1128       FE         616       616½       618.84342       620       7F       47       1128       1128½       1130.84342       1132       FF    Broad  |              |                |               | 604          | 7B | 43                               | 1112         | 1112½          |               | 1116         | FB    |                        |          |
| 612 612½ 614.84342 616 7E 46 1124 1124½ 1126.84342 1128 FE 616 616½ 618.84342 620 7F 47 1128 1128½ 1130.84342 1132 FF Broad  |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| 616 616½ 618.84342 620 7F 47   1128 1128½ 1130.84342 1132 FF  Broad Broad  |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
| Broad Broad  |              |                |               |              |    |                                  |              |                |               |              |       |                        |          |
|  | 010          | O ± O /2       |               | 020          | 1  | 71                               | 1120         | ±±2U72         |               | 1132         | ı T   |                        |          |
|  |              |                |               |              |    | Broad                            |              |                |               |              | Е     | road                   |          |
|  |              |                |               |              |    | Cast Ham                         |              |                |               |              |       |                        | Ham      |
| MHz MHz MHz MHz ——Channels—— MHz MHz MHz MHz ——Channels  | MHZ          | MHZ            | MHZ           | MHZ          |    | Channels——                       | MHZ          | MHZ            | MHZ           | MHZ          | Ch    | annels                 |          |