

# Resolution Independent Picture Based Coding

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## 1.0 Overview

This document provides an overview of resolution independent still and motion image coding techniques, using the MPEG-2 toolbox. The intent of this technical overview is to demonstrate the inherent flexibility of the MPEG-2 video encoding tools, and how they can be used to support the coding of visual objects and image streams of arbitrary spatial, temporal and color resolution.

One obvious application of these concepts is the ability to preserve the original aspect ratio and scene composition of all source material, permitting the viewer to choose between the original composition—in letterbox mode when the source and display aspect ratios are different—or a cropped pan & scan presentation to fill the display.

A less obvious application of these concepts is the ability to use an MPEG-2 decoder, to deliver visual objects and image streams to the display buffer, where they can be composed with other objects and streams to support new forms of interactive digital media content.

Local image composition, fades and dissolves, and MPEG-2 stream switching will enable a digital television decoder to effectively become a downstream mixer/keyer. This approach has numerous advantages over the insertion of localization information at the broadcast facility:

1. In many cases it eliminates the need for the splicing of MPEG-2 streams to insert commercials. By enabling stream switching in the receiver, it is possible to present multiple commercials within a break—the commercials may be selected on the basis of the geographic location of the receiver (e.g. by zip code) or based on a user profile (e.g. demographics or special interests).
2. Fades and dissolves, used in transitions between program and commercial elements can be performed in the receiver—this eliminates a major source of MPEG-2 compression artifacts, cause by trying to encode transitions between two uncorrelated images.
3. It eliminates the need for decoding and re-encoding MPEG-2 program streams to overlay identification bugs, commercial tags, and emergency messages.
  - Logos can be inserted by the decoder, with proper positioning for the local display aspect ratio.
  - Commercial tags can be inserted with zip code accuracy for the local dealer, by associating a table of tags/zip codes, with the zip code programmed in a local receiver.
  - Emergency messaging and closed captions can be inserted locally, either within or outside the program picture area—if a receiver is monitoring a broadcast channel, emergency messages could be inserted over non-broadcast programs, such as a movie from tape or DVD-ROM.

## 2.0 The Missing JPEG Profiles

The fundamental basis for many of the compression algorithms in use today is the DCT (discrete cosine transform). This transform takes image information in the spatial domain and converts it into the frequency domain, so that higher frequencies, to which the human visual system is less sensitive, can be quantized, when higher levels of image compression are required to meet channel bandwidth limitations. The image is typically divided into 8 x 8 pixel blocks prior to application of the DCT, so as to localize the effects of the transform.

The first widespread use of the DCT has been for the encoding of still images using compression tools developed by the Joint Photographic Experts Group (JPEG). As video streams are simply sequences of frames (or fields), JPEG was adapted for the encoding of video; this application of the tools has become known as Motion-JPEG (M-JPEG).

The Moving Picture Experts Group (MPEG) has developed a family of video encoding tools based on the DCT, which provide the ability to remove additional redundancy in sequences of image frames (fields). These techniques divide the image into regions of four DCT blocks in a 16 x 16 pixel array. These regions are called macroblocks, and form the basis for motion compensated prediction, used to create a predicted image from frames both before and after the predicted frame. The prediction are subtracted from the actual frame information and the DCT is used to encode the differences.

Thus, JPEG uses an 8 x 8 block as its fundamental basis, while MPEG uses a 16 x 16 block as its basis. The developers of the MPEG and MPEG-2 video encoding tools went a step further, developing the notion of video encoding profiles. These profiles are directly related to the *dated* notion of video formats; they specify fixed spatial resolutions, aspect ratios and frame rates for the source images that are encoded. It is not surprising that these profiles codify existing video industry practices, the formats that are currently in widespread use, and new formats that video equipment manufacturers wish to promote for the future, including HDTV.

The notion that video must be constrained by rigid formats dates back to the practices required to build today's analog video distribution systems, NTSC, PAL and SECAM. In these standards the image acquisition, transmission and display components of the system are tightly coupled, often operating in a synchronous fashion. The display component, typically a CRT, has a fixed aspect ratio, and it is assumed that the screen will always be completely filled.

The Joint Photographic Experts Group did not constrain the JPEG tools with profiles for a simple reason. Still images come in all shapes, sizes and resolutions. To encode an image we simply state the horizontal and vertical size.

Like JPEG, the MPEG encoding tools are not constrained by format limitations. They simply encode arbitrary images subdivided into macroblocks. A properly designed MPEG decoder can produce still images (I frames) and video streams (I, P and B frames) of arbitrary size, frame rate and color resolution. Current MPEG-2 MP@HL decoder implementations, however, may place unnecessary constraints on the use of the MPEG tools in order to reduce manufacturing costs. Some of the potential limitations include:

1. Fixed resolution image scaling capabilities, which constrain the available resolutions of the source or the target display. For example, a scaling filter can be designed to deal only with the hierarchy of formats defined by Table 3 of the ATSC digital television standard. These formats are based on an image heirarchy with 480, 720 or 1080 lines; the resolution increases by a factor of 1.5:1 at each step up in resolution. Filters optimized for the 1.5:1 scaling factor may not be capable --or may not provide visually pleasing results--if a different scaling factor is desired.
2. Fixed color resolution implementations, optimized for 4:2:0 color resolution.
3. Buffer management techniques optimized for the decoding of single MPEG streams rather than multiple objects and streams.

The ability to support the flexible use of the MPEG tools provides a path to resolution independence, and the ability to decode multiple visual objects for local composition at the television appliance.

### 3.0 Performance Based MPEG Profiles

A better way to look at the notion of MPEG profiles is to create a performance target; an upper limit on the decoder performance required for a family of applications such as digital television broadcasting.

An **MPEG performance profile** can be characterized using two parameters:

- The maximum **frame size** supported by the available decoder buffer memory--stated in terms of the available luminance and color resolution.
- The maximum number of macroblocks that can be decoded over a given period of time; this is typically stated as the **decoder's pixel clock**, in millions of pixels per second (Mpels/sec).

Any arbitrary **image object** can be defined with four parameters:

- **H** = Horizontal resolution (preferably in multiples of 16 pixels)
- **V** = Vertical resolution (preferably in multiples of 16 pixels)
- **C** = color resolution (4:4:4, 4:2:2, 4:1:1 or 4:2:0)
- **T** = temporal rate in frames or fields

Based on these parameters an MPEG encoded object is only constrained by the limits of the decoder buffer memory; if B-Frames are not supported more buffer memory is available for larger objects.

An **MPEG coded object** can be represented with the equation:

**$H \times V \times C = \text{an MPEG coded object}$**

The product should not exceed the size of the available buffer memory.

An **MPEG coded stream** can be represented with the equation:

**$H \times V \times C \times T = \text{an MPEG coded stream}$**

The product should not exceed the pixel decoder clock.

Once the frame memory and decoder clock are established, they provide an upper limit on the performance profile. Within this limit, any combinations of MPEG objects and streams can be decoded as the sum does not exceed the available buffer memory or decoder clock limitations. To fully utilize this approach it is assumed that these objects and streams are delivered to a display buffer for composition. It is also desirable to place a image scaling function between the MPEG decoder and the display memory to facilitate image scaling for objects that exceed the size of the local display.

### 4.0 Examples of Performance Based Image Objects/Streams

The charts which follow provide information about the required frame sizes and pixel decoder clocks, required to support families of images with constant vertical resolution. While this is an arbitrary limitation, it conforms to established MPEG-2 profiles which are based on the number of lines in a video format. These charts demonstrate how the MPEG tools can be used to support variable aspect ratios and frame rates at several levels of vertical resolution. For purposes of the calculations, the use of square pixels and macroblock increments are assumed. The charts do not address variation in color resolution, which may impact buffer memory requirements.

# Formats Optimized for A Common Picture Height

V Lines in Format Family 368

V Mblocks 23

**H size @1.33:1** 496  
**H Mblocks@1.33:1** 31  
**Pixels per frame 1.33:1** 182,528  
**Mpix 1.33:1 @ 24** 4.38  
**Mpix 1.33:1 @ 36** 6.57  
**Mpix 1.33:1 @ 50** 9.13  
**Mpix 1.33:1 @ 60** 10.95  
**Mpix 1.33:1 @ 72** 13.14

**H size @1.78:1** 656  
**H Mblocks@1.78:1** 41  
**Pixels per frame 1.78:1** 241,408  
**Mpix 1.78:1 @ 24** 5.79  
**Mpix 1.78:1 @ 36** 8.69  
**Mpix 1.78:1 @ 50** 12.07  
**Mpix 1.78:1 @ 60** 14.48  
**Mpix 1.78:1 @ 72** 17.38

**H size @ 1.5:1** 560  
**H Mblocks@1.5:1** 35  
**Pixels per frame 1.5:1** 206,080  
**Mpix 1.5:1 @ 24** 4.95  
**Mpix 1.5:1 @ 36** 7.42  
**Mpix 1.5:1 @ 60** 12.36  
**Mpix 1.5:1 @ 72** 14.84

**H size @1.85:1** 688  
**H Mblocks@1.85:1** 43  
**Pixels per frame 1.85:1** 253,184  
**Mpix 1.85:1 @ 24** 6.08  
**Mpix 1.85:1 @ 36** 9.11  
**Mpix 1.85:1 @ 60** 15.19  
**Mpix 1.85:1 @ 72** 18.23

**H size @ 1.66:1** 608  
**H Mblocks@1.66:1** 38  
**Pixels per frame 1.66:1** 223,744  
**Mpix 1.66:1 @ 24** 5.37  
**Mpix 1.66:1 @ 36** 8.05  
**Mpix 1.66:1 @ 60** 13.42  
**Mpix 1.66:1 @ 72** 16.11

**H size @ 2:1** 736  
**H Mblocks@2:1** 46  
**Pixels per frame 2:1** 270,848  
**Mpix 2:1 @ 24** 6.50  
**Mpix 2:1 @ 36** 9.75  
**Mpix 2:1 @ 60** 16.25  
**Mpix 2:1 @ 72** 19.50

**H size @ 2.4:1** 880  
**H Mblocks@2.4:1** 55  
**Pixels per frame 2.4:1** 323,840  
**Mpix 2.4:1 @ 24** 7.77  
**Mpix 2.4:1 @ 36** 11.66  
**Mpix 2.4:1 @ 60** 19.43  
**Mpix 2.4:1 @ 72** 23.32

# Formats Optimized for A Common Picture Height

V Lines in Format Family 384

V Mblocks 24

**H size @1.33:1** 512  
**H Mblocks@1.33:1** 32  
**Pixels per frame 1.33:1** 196,608  
**Mpix 1.33:1 @ 24** 4.72  
**Mpix 1.33:1 @ 36** 7.08  
**Mpix 1.33:1 @ 50** 9.83  
**Mpix 1.33:1 @ 60** 11.80  
**Mpix 1.33:1 @ 72** 14.16

**H size @1.78:1** 688  
**H Mblocks@1.78:1** 43  
**Pixels per frame 1.78:1** 264,192  
**Mpix 1.78:1 @ 24** 6.34  
**Mpix 1.78:1 @ 36** 9.51  
**Mpix 1.78:1 @ 50** 13.21  
**Mpix 1.78:1 @ 60** 15.85  
**Mpix 1.78:1 @ 72** 19.02

**H size @ 1.5:1** 576  
**H Mblocks@1.5:1** 36  
**Pixels per frame 1.5:1** 221,184  
**Mpix 1.5:1 @ 24** 5.31  
**Mpix 1.5:1 @ 36** 7.96  
**Mpix 1.5:1 @ 60** 13.27  
**Mpix 1.5:1 @ 72** 15.93

**H size @1.85:1** 704  
**H Mblocks@1.85:1** 44  
**Pixels per frame 1.85:1** 270,336  
**Mpix 1.85:1 @ 24** 6.49  
**Mpix 1.85:1 @ 36** 9.73  
**Mpix 1.85:1 @ 60** 16.22  
**Mpix 1.85:1 @ 72** 19.46

**H size @ 1.66:1** 640  
**H Mblocks@1.66:1** 40  
**Pixels per frame 1.66:1** 245,760  
**Mpix 1.66:1 @ 24** 5.90  
**Mpix 1.66:1 @ 36** 8.85  
**Mpix 1.66:1 @ 60** 14.75  
**Mpix 1.66:1 @ 72** 17.69

**H size @ 2:1** 768  
**H Mblocks@2:1** 48  
**Pixels per frame 2:1** 294,912  
**Mpix 2:1 @ 24** 7.08  
**Mpix 2:1 @ 36** 10.62  
**Mpix 2:1 @ 60** 17.69  
**Mpix 2:1 @ 72** 21.23

**H size @ 2.4:1** 928  
**H Mblocks@2.4:1** 58  
**Pixels per frame 2.4:1** 356,352  
**Mpix 2.4:1 @ 24** 8.55  
**Mpix 2.4:1 @ 36** 12.83  
**Mpix 2.4:1 @ 60** 21.38  
**Mpix 2.4:1 @ 72** 25.66

# Formats Optimized for A Common Picture Height

V Lines in Format Family 480

V Mblocks 30

**H size @1.33:1** 640

**H Mblocks@1.33:1** 40

**Pixels per frame 1.33:1** 307,200

**Mpix 1.33:1 @ 24** 7.37

**Mpix 1.33:1 @ 36** 11.06

**Mpix 1.33:1 @ 50** 15.36

**Mpix 1.33:1 @ 60** 18.43

**Mpix 1.33:1 @ 72** 22.12

**H size @1.78:1** 864

**H Mblocks@1.78:1** 53

**Pixels per frame 1.78:1** 407,040

**Mpix 1.78:1 @ 24** 9.77

**Mpix 1.78:1 @ 36** 14.65

**Mpix 1.78:1 @ 50** 20.35

**Mpix 1.78:1 @ 60** 24.42

**Mpix 1.78:1 @ 72** 29.31

**H size @ 1.5:1** 720

**H Mblocks@1.5:1** 45

**Pixels per frame 1.5:1** 345,600

**Mpix 1.5:1 @ 24** 8.29

**Mpix 1.5:1 @ 36** 12.44

**Mpix 1.5:1 @ 60** 20.74

**Mpix 1.5:1 @ 72** 24.88

**H size @1.85:1** 896

**H Mblocks@1.85:1** 56

**Pixels per frame 1.85:1** 430,080

**Mpix 1.85:1 @ 24** 10.32

**Mpix 1.85:1 @ 36** 15.48

**Mpix 1.85:1 @ 60** 25.80

**Mpix 1.85:1 @ 72** 30.97

**H size @ 1.66:1** 800

**H Mblocks@1.66:1** 50

**Pixels per frame 1.66:1** 384,000

**Mpix 1.66:1 @ 24** 9.22

**Mpix 1.66:1 @ 36** 13.82

**Mpix 1.66:1 @ 60** 23.04

**Mpix 1.66:1 @ 72** 27.65

**H size @ 2:1** 960

**H Mblocks@2:1** 60

**Pixels per frame 2:1** 460,800

**Mpix 2:1 @ 24** 11.06

**Mpix 2:1 @ 36** 16.59

**Mpix 2:1 @ 60** 27.65

**Mpix 2:1 @ 72** 33.18

**H size @ 2.4:1** 1152

**H Mblocks@2.4:1** 72

**Pixels per frame 2.4:1** 552,960

**Mpix 2.4:1 @ 24** 13.27

**Mpix 2.4:1 @ 36** 19.91

**Mpix 2.4:1 @ 60** 33.18

**Mpix 2.4:1 @ 72** 39.81

# Formats Optimized for A Common Picture Height

V Lines in Format Family 512

V Mblocks 32

**H size @1.33:1** 688  
**H Mblocks@1.33:1** 43  
**Pixels per frame 1.33:1** 352,256  
**Mpix 1.33:1 @ 24** 8.45  
**Mpix 1.33:1 @ 36** 12.68  
**Mpix 1.33:1 @ 50** 17.61  
**Mpix 1.33:1 @ 60** 21.14  
**Mpix 1.33:1 @ 72** 25.36

**H size @ 1.5:1** 768  
**H Mblocks@1.5:1** 48  
**Pixels per frame 1.5:1** 393,216  
**Mpix 1.5:1 @ 24** 9.44  
**Mpix 1.5:1 @ 36** 14.16  
**Mpix 1.5:1 @ 60** 23.59  
**Mpix 1.5:1 @ 72** 28.31

**H size @ 1.66:1** 848  
**H Mblocks@1.66:1** 53  
**Pixels per frame 1.66:1** 434,176  
**Mpix 1.66:1 @ 24** 10.42  
**Mpix 1.66:1 @ 36** 15.63  
**Mpix 1.66:1 @ 60** 26.05  
**Mpix 1.66:1 @ 72** 31.26

**H size @1.78:1** 912  
**H Mblocks@1.78:1** 57  
**Pixels per frame 1.78:1** 466,944  
**Mpix 1.78:1 @ 24** 11.21  
**Mpix 1.78:1 @ 36** 16.81  
**Mpix 1.78:1 @ 50** 23.35  
**Mpix 1.78:1 @ 60** 28.02  
**Mpix 1.78:1 @ 72** 33.62

**H size @1.85:1** 944  
**H Mblocks@1.85:1** 59  
**Pixels per frame 1.85:1** 483,328  
**Mpix 1.85:1 @ 24** 11.60  
**Mpix 1.85:1 @ 36** 17.40  
**Mpix 1.85:1 @ 60** 29.00  
**Mpix 1.85:1 @ 72** 34.80

**H size @ 2:1** 1024  
**H Mblocks@2:1** 64  
**Pixels per frame 2:1** 524,288  
**Mpix 2:1 @ 24** 12.58  
**Mpix 2:1 @ 36** 18.87  
**Mpix 2:1 @ 60** 31.46  
**Mpix 2:1 @ 72** 37.75

**H size @ 2.4:1** 1232  
**H Mblocks@2.4:1** 77  
**Pixels per frame 2.4:1** 630,784  
**Mpix 2.4:1 @ 24** 15.14  
**Mpix 2.4:1 @ 36** 22.71  
**Mpix 2.4:1 @ 60** 37.85  
**Mpix 2.4:1 @ 72** 45.42

# Formats Optimized for A Common Picture Height

V Lines in Format Family 544

V Mblocks 34

**H size @1.33:1** 720

**H Mblocks@1.33:1** 45

**Pixels per frame 1.33:1** 391,680

**Mpix 1.33:1 @ 24** 9.40

**Mpix 1.33:1 @ 36** 14.10

**Mpix 1.33:1 @ 50** 19.58

**Mpix 1.33:1 @ 60** 23.50

**Mpix 1.33:1 @ 72** 28.20

**H size @1.78:1** 976

**H Mblocks@1.78:1** 61

**Pixels per frame 1.78:1** 530,944

**Mpix 1.78:1 @ 24** 12.74

**Mpix 1.78:1 @ 36** 19.11

**Mpix 1.78:1 @ 50** 26.55

**Mpix 1.78:1 @ 60** 31.86

**Mpix 1.78:1 @ 72** 38.23

**H size @ 1.5:1** 816

**H Mblocks@1.5:1** 51

**Pixels per frame 1.5:1** 443,904

**Mpix 1.5:1 @ 24** 10.65

**Mpix 1.5:1 @ 36** 15.98

**Mpix 1.5:1 @ 60** 26.63

**Mpix 1.5:1 @ 72** 31.96

**H size @1.85:1** 1008

**H Mblocks@1.85:1** 63

**Pixels per frame 1.85:1** 548,352

**Mpix 1.85:1 @ 24** 13.16

**Mpix 1.85:1 @ 36** 19.74

**Mpix 1.85:1 @ 60** 32.90

**Mpix 1.85:1 @ 72** 39.48

**H size @ 1.66:1** 912

**H Mblocks@1.66:1** 57

**Pixels per frame 1.66:1** 496,128

**Mpix 1.66:1 @ 24** 11.91

**Mpix 1.66:1 @ 36** 17.86

**Mpix 1.66:1 @ 60** 29.77

**Mpix 1.66:1 @ 72** 35.72

**H size @ 2:1** 1088

**H Mblocks@2:1** 68

**Pixels per frame 2:1** 591,872

**Mpix 2:1 @ 24** 14.20

**Mpix 2:1 @ 36** 21.31

**Mpix 2:1 @ 60** 35.51

**Mpix 2:1 @ 72** 42.61

**H size @ 2.4:1** 1312

**H Mblocks@2.4:1** 82

**Pixels per frame 2.4:1** 713,728

**Mpix 2.4:1 @ 24** 17.13

**Mpix 2.4:1 @ 36** 25.69

**Mpix 2.4:1 @ 60** 42.82

**Mpix 2.4:1 @ 72** 51.39

# Formats Optimized for A Common Picture Height

V Lines in Format Family 576

V Mblocks 36

**H size @1.33:1** 768  
**H Mblocks@1.33:1** 48  
**Pixels per frame 1.33:1** 442,368  
**Mpix 1.33:1 @ 24** 10.62  
**Mpix 1.33:1 @ 36** 15.93  
**Mpix 1.33:1 @ 50** 22.12  
**Mpix 1.33:1 @ 60** 26.54  
**Mpix 1.33:1 @ 72** 31.85

**H size @1.78:1** 1024  
**H Mblocks@1.78:1** 64  
**Pixels per frame 1.78:1** 589,824  
**Mpix 1.78:1 @ 24** 14.16  
**Mpix 1.78:1 @ 36** 21.23  
**Mpix 1.78:1 @ 50** 29.49  
**Mpix 1.78:1 @ 60** 35.39  
**Mpix 1.78:1 @ 72** 42.47

**H size @ 1.5:1** 864  
**H Mblocks@1.5:1** 54  
**Pixels per frame 1.5:1** 497,664  
**Mpix 1.5:1 @ 24** 11.94  
**Mpix 1.5:1 @ 36** 17.92  
**Mpix 1.5:1 @ 60** 29.86  
**Mpix 1.5:1 @ 72** 35.83

**H size @1.85:1** 1072  
**H Mblocks@1.85:1** 67  
**Pixels per frame 1.85:1** 617,472  
**Mpix 1.85:1 @ 24** 14.82  
**Mpix 1.85:1 @ 36** 22.23  
**Mpix 1.85:1 @ 60** 37.05  
**Mpix 1.85:1 @ 72** 44.46

**H size @ 1.66:1** 960  
**H Mblocks@1.66:1** 60  
**Pixels per frame 1.66:1** 552,960  
**Mpix 1.66:1 @ 24** 13.27  
**Mpix 1.66:1 @ 36** 19.91  
**Mpix 1.66:1 @ 60** 33.18  
**Mpix 1.66:1 @ 72** 39.81

**H size @ 2:1** 1152  
**H Mblocks@2:1** 72  
**Pixels per frame 2:1** 663,552  
**Mpix 2:1 @ 24** 15.93  
**Mpix 2:1 @ 36** 23.89  
**Mpix 2:1 @ 60** 39.81  
**Mpix 2:1 @ 72** 47.78

**H size @ 2.4:1** 1376  
**H Mblocks@2.4:1** 86  
**Pixels per frame 2.4:1** 792,576  
**Mpix 2.4:1 @ 24** 19.02  
**Mpix 2.4:1 @ 36** 28.53  
**Mpix 2.4:1 @ 60** 47.55  
**Mpix 2.4:1 @ 72** 57.07

# Formats Optimized for A Common Picture Height

V Lines in Format Family 720

V Mblocks 45

**H size @1.33:1** 960  
**H Mblocks@1.33:1** 60  
**Pixels per frame 1.33:1** 691,200  
**Mpix 1.33:1 @ 24** 16.59  
**Mpix 1.33:1 @ 36** 24.88  
**Mpix 1.33:1 @ 50** 34.56  
**Mpix 1.33:1 @ 60** 41.47  
**Mpix 1.33:1 @ 72** 49.77

**H size @1.78:1** 1280  
**H Mblocks@1.78:1** 80  
**Pixels per frame 1.78:1** 921,600  
**Mpix 1.78:1 @ 24** 22.12  
**Mpix 1.78:1 @ 36** 33.18  
**Mpix 1.78:1 @ 50** 46.08  
**Mpix 1.78:1 @ 60** 55.30  
**Mpix 1.78:1 @ 72** 66.36

**H size @ 1.5:1** 1088  
**H Mblocks@1.5:1** 68  
**Pixels per frame 1.5:1** 783,360  
**Mpix 1.5:1 @ 24** 18.80  
**Mpix 1.5:1 @ 36** 28.20  
**Mpix 1.5:1 @ 60** 47.00  
**Mpix 1.5:1 @ 72** 56.40

**H size @1.85:1** 1328  
**H Mblocks@1.85:1** 83  
**Pixels per frame 1.85:1** 956,160  
**Mpix 1.85:1 @ 24** 22.95  
**Mpix 1.85:1 @ 36** 34.42  
**Mpix 1.85:1 @ 60** 57.37  
**Mpix 1.85:1 @ 72** 68.84

**H size @ 1.66:1** 1200  
**H Mblocks@1.66:1** 75  
**Pixels per frame 1.66:1** 864,000  
**Mpix 1.66:1 @ 24** 20.74  
**Mpix 1.66:1 @ 36** 31.10  
**Mpix 1.66:1 @ 60** 51.84  
**Mpix 1.66:1 @ 72** 62.21

**H size @ 2:1** 1440  
**H Mblocks@2:1** 90  
**Pixels per frame 2:1** 1,036,800  
**Mpix 2:1 @ 24** 24.88  
**Mpix 2:1 @ 36** 37.32  
**Mpix 2:1 @ 60** 62.21  
**Mpix 2:1 @ 72** 74.65

**H size @ 2.4:1** 1728  
**H Mblocks@2.4:1** 108  
**Pixels per frame 2.4:1** 1,244,160  
**Mpix 2.4:1 @ 24** 29.86  
**Mpix 2.4:1 @ 36** 44.79  
**Mpix 2.4:1 @ 60** 74.65  
**Mpix 2.4:1 @ 72** 89.58

# Formats Optimized for A Common Picture Height

V Lines in Format Family 768

V Mblocks 48

**H size @1.33:1** 1024  
**H Mblocks@1.33:1** 64  
**Pixels per frame 1.33:1** 786,432  
**Mpix 1.33:1 @ 24** 18.87  
**Mpix 1.33:1 @ 36** 28.31  
**Mpix 1.33:1 @ 50** 39.32  
**Mpix 1.33:1 @ 60** 47.19  
**Mpix 1.33:1 @ 72** 56.62

**H size @ 1.5:1** 1152  
**H Mblocks@1.5:1** 72  
**Pixels per frame 1.5:1** 884,736  
**Mpix 1.5:1 @ 24** 21.23  
**Mpix 1.5:1 @ 36** 31.85  
**Mpix 1.5:1 @ 60** 53.08  
**Mpix 1.5:1 @ 72** 63.70

**H size @ 1.66:1** 1280  
**H Mblocks@1.66:1** 80  
**Pixels per frame 1.66:1** 983,040  
**Mpix 1.66:1 @ 24** 23.59  
**Mpix 1.66:1 @ 36** 35.39  
**Mpix 1.66:1 @ 60** 58.98  
**Mpix 1.66:1 @ 72** 70.78

**H size @1.78:1** 1360  
**H Mblocks@1.78:1** 85  
**Pixels per frame 1.78:1** 1,044,480  
**Mpix 1.78:1 @ 24** 25.07  
**Mpix 1.78:1 @ 36** 37.60  
**Mpix 1.78:1 @ 50** 52.22  
**Mpix 1.78:1 @ 60** 62.67  
**Mpix 1.78:1 @ 72** 75.20

**H size @1.85:1** 1424  
**H Mblocks@1.85:1** 89  
**Pixels per frame 1.85:1** 1,093,632  
**Mpix 1.85:1 @ 24** 26.25  
**Mpix 1.85:1 @ 36** 39.37  
**Mpix 1.85:1 @ 60** 65.62  
**Mpix 1.85:1 @ 72** 78.74

**H size @ 2:1** 1536  
**H Mblocks@2:1** 96  
**Pixels per frame 2:1** 1,179,648  
**Mpix 2:1 @ 24** 28.31  
**Mpix 2:1 @ 36** 42.47  
**Mpix 2:1 @ 60** 70.78  
**Mpix 2:1 @ 72** 84.93

**H size @ 2.4:1** 1840  
**H Mblocks@2.4:1** 115  
**Pixels per frame 2.4:1** 1,413,120  
**Mpix 2.4:1 @ 24** 33.91  
**Mpix 2.4:1 @ 36** 50.87  
**Mpix 2.4:1 @ 60** 84.79  
**Mpix 2.4:1 @ 72** 101.74

# Formats Optimized for A Common Picture Height

V Lines in Format Family 960

V Mblocks 60

**H size @1.33:1** 1280  
**H Mblocks@1.33:1** 80  
**Pixels per frame 1.33:1** 1,228,800  
**Mpix 1.33:1 @ 24** 29.49  
**Mpix 1.33:1 @ 36** 44.24  
**Mpix 1.33:1 @ 50** 61.44  
**Mpix 1.33:1 @ 60** 73.73  
**Mpix 1.33:1 @ 72** 88.47

**H size @1.78:1** 1712  
**H Mblocks@1.78:1** 107  
**Pixels per frame 1.78:1** 1,643,520  
**Mpix 1.78:1 @ 24** 39.44  
**Mpix 1.78:1 @ 36** 59.17  
**Mpix 1.78:1 @ 50** 82.18  
**Mpix 1.78:1 @ 60** 98.61  
**Mpix 1.78:1 @ 72** 118.33

**H size @ 1.5:1** 1440  
**H Mblocks@1.5:1** 90  
**Pixels per frame 1.5:1** 1,382,400  
**Mpix 1.5:1 @ 24** 33.18  
**Mpix 1.5:1 @ 36** 49.77  
**Mpix 1.5:1 @ 60** 82.94  
**Mpix 1.5:1 @ 72** 99.53

**H size @1.85:1** 1776  
**H Mblocks@1.85:1** 111  
**Pixels per frame 1.85:1** 1,704,960  
**Mpix 1.85:1 @ 24** 40.92  
**Mpix 1.85:1 @ 36** 61.38  
**Mpix 1.85:1 @ 60** 102.30  
**Mpix 1.85:1 @ 72** 122.76

**H size @ 1.66:1** 1600  
**H Mblocks@1.66:1** 100  
**Pixels per frame 1.66:1** 1,536,000  
**Mpix 1.66:1 @ 24** 36.86  
**Mpix 1.66:1 @ 36** 55.30  
**Mpix 1.66:1 @ 60** 92.16  
**Mpix 1.66:1 @ 72** 110.59

**H size @ 2:1** 1920  
**H Mblocks@2:1** 120  
**Pixels per frame 2:1** 1,843,200  
**Mpix 2:1 @ 24** 44.24  
**Mpix 2:1 @ 36** 66.36  
**Mpix 2:1 @ 60** 110.59  
**Mpix 2:1 @ 72** 132.71

**H size @ 2.4:1** 2304  
**H Mblocks@2.4:1** 144  
**Pixels per frame 2.4:1** 2,211,840  
**Mpix 2.4:1 @ 24** 53.08  
**Mpix 2.4:1 @ 36** 79.63  
**Mpix 2.4:1 @ 60** 132.71  
**Mpix 2.4:1 @ 72** 159.25

# Formats Optimized for A Common Picture Height

V Lines in Format Family 1024

V Mblocks 64

**H size @1.33:1** 1360  
**H Mblocks@1.33:1** 85  
**Pixels per frame 1.33:1** 1,392,640  
**Mpix 1.33:1 @ 24** 33.42  
**Mpix 1.33:1 @ 36** 50.14  
**Mpix 1.33:1 @ 50** 69.63  
**Mpix 1.33:1 @ 60** 83.56  
**Mpix 1.33:1 @ 72** 100.27

**H size @1.78:1** 1824  
**H Mblocks@1.78:1** 114  
**Pixels per frame 1.78:1** 1,867,776  
**Mpix 1.78:1 @ 24** 44.83  
**Mpix 1.78:1 @ 36** 67.24  
**Mpix 1.78:1 @ 50** 93.39  
**Mpix 1.78:1 @ 60** 112.07  
**Mpix 1.78:1 @ 72** 134.48

**H size @ 1.5:1** 1536  
**H Mblocks@1.5:1** 96  
**Pixels per frame 1.5:1** 1,572,864  
**Mpix 1.5:1 @ 24** 37.75  
**Mpix 1.5:1 @ 36** 56.62  
**Mpix 1.5:1 @ 60** 94.37  
**Mpix 1.5:1 @ 72** 113.25

**H size @1.85:1** 1888  
**H Mblocks@1.85:1** 118  
**Pixels per frame 1.85:1** 1,933,312  
**Mpix 1.85:1 @ 24** 46.40  
**Mpix 1.85:1 @ 36** 69.60  
**Mpix 1.85:1 @ 60** 116.00  
**Mpix 1.85:1 @ 72** 139.20

**H size @ 1.66:1** 1712  
**H Mblocks@1.66:1** 107  
**Pixels per frame 1.66:1** 1,753,088  
**Mpix 1.66:1 @ 24** 42.07  
**Mpix 1.66:1 @ 36** 63.11  
**Mpix 1.66:1 @ 60** 105.19  
**Mpix 1.66:1 @ 72** 126.22

**H size @ 2:1** 2048  
**H Mblocks@2:1** 128  
**Pixels per frame 2:1** 2,097,152  
**Mpix 2:1 @ 24** 50.33  
**Mpix 2:1 @ 36** 75.50  
**Mpix 2:1 @ 60** 125.83  
**Mpix 2:1 @ 72** 150.99

**H size @ 2.4:1** 2464  
**H Mblocks@2.4:1** 154  
**Pixels per frame 2.4:1** 2,523,136  
**Mpix 2.4:1 @ 24** 60.56  
**Mpix 2.4:1 @ 36** 90.83  
**Mpix 2.4:1 @ 60** 151.39  
**Mpix 2.4:1 @ 72** 181.67

# Formats Optimized for A Common Picture Height

V Lines in Format Family 1088

V Mblocks 68

**H size @1.33:1** 1456  
**H Mblocks@1.33:1** 91  
**Pixels per frame 1.33:1** 1,584,128  
**Mpix 1.33:1 @ 24** 38.02  
**Mpix 1.33:1 @ 36** 57.03  
**Mpix 1.33:1 @ 50** 79.21  
**Mpix 1.33:1 @ 60** 95.05  
**Mpix 1.33:1 @ 72** 114.06

**H size @ 1.5:1** 1632  
**H Mblocks@1.5:1** 102  
**Pixels per frame 1.5:1** 1,775,616  
**Mpix 1.5:1 @ 24** 42.61  
**Mpix 1.5:1 @ 36** 63.92  
**Mpix 1.5:1 @ 60** 106.54  
**Mpix 1.5:1 @ 72** 127.84

**H size @ 1.66:1** 1808  
**H Mblocks@1.66:1** 113  
**Pixels per frame 1.66:1** 1,967,104  
**Mpix 1.66:1 @ 24** 47.21  
**Mpix 1.66:1 @ 36** 70.82  
**Mpix 1.66:1 @ 60** 118.03  
**Mpix 1.66:1 @ 72** 141.63

**H size @1.78:1** 1936  
**H Mblocks@1.78:1** 121  
**Pixels per frame 1.78:1** 2,106,368  
**Mpix 1.78:1 @ 24** 50.55  
**Mpix 1.78:1 @ 36** 75.83  
**Mpix 1.78:1 @ 50** 105.32  
**Mpix 1.78:1 @ 60** 126.38  
**Mpix 1.78:1 @ 72** 151.66

**H size @1.85:1** 2016  
**H Mblocks@1.85:1** 126  
**Pixels per frame 1.85:1** 2,193,408  
**Mpix 1.85:1 @ 24** 52.64  
**Mpix 1.85:1 @ 36** 78.96  
**Mpix 1.85:1 @ 60** 131.60  
**Mpix 1.85:1 @ 72** 157.93

**H size @ 2:1** 2176  
**H Mblocks@2:1** 136  
**Pixels per frame 2:1** 2,367,488  
**Mpix 2:1 @ 24** 56.82  
**Mpix 2:1 @ 36** 85.23  
**Mpix 2:1 @ 60** 142.05  
**Mpix 2:1 @ 72** 170.46

**H size @ 2.4:1** 2608  
**H Mblocks@2.4:1** 163  
**Pixels per frame 2.4:1** 2,837,504  
**Mpix 2.4:1 @ 24** 68.10  
**Mpix 2.4:1 @ 36** 102.15  
**Mpix 2.4:1 @ 60** 170.25  
**Mpix 2.4:1 @ 72** 204.30