CCITT SGXV
Working Party XV/1
Expert Group for ATM Video Coding

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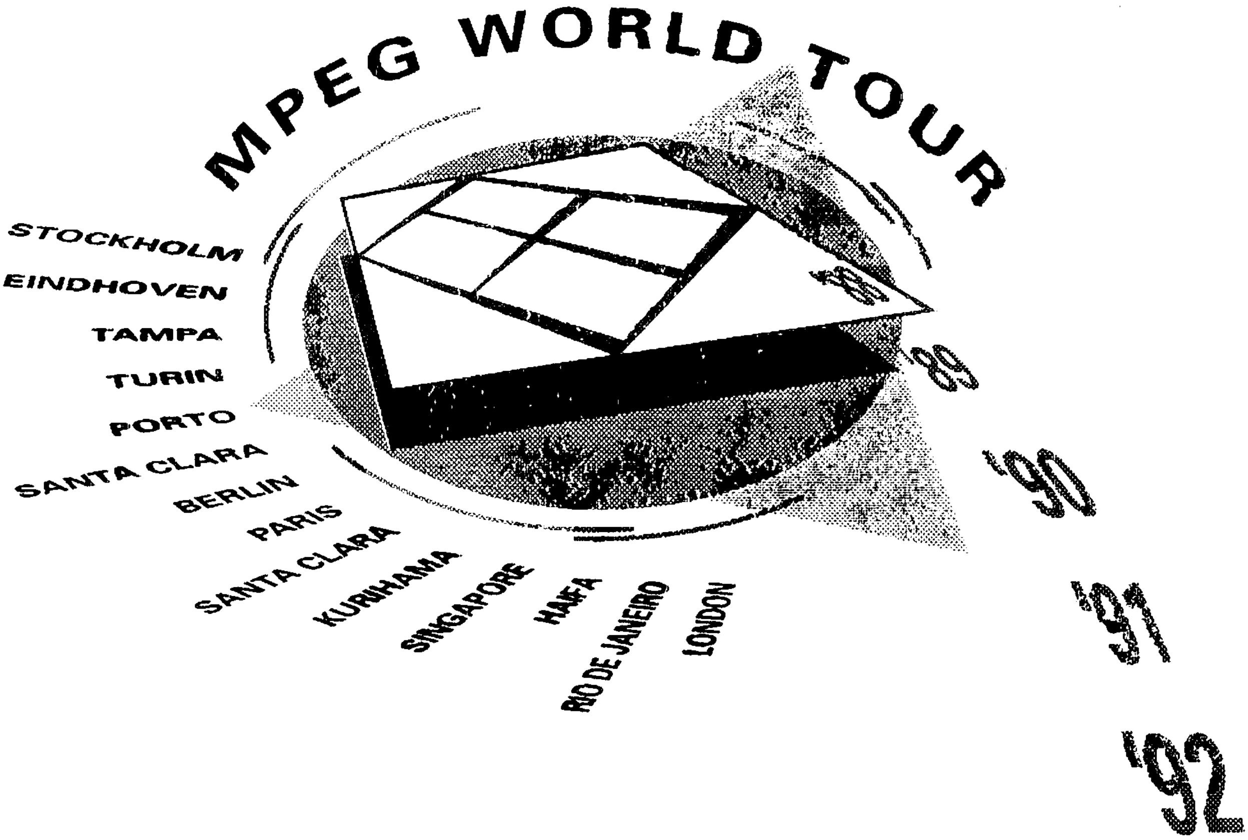
MUPCOS



Description of the multi purpose coding scheme

Algorithm description and implementation evaluation of
proposal number 18 and 19

ISO/IEC JTC1/SC2/WG11
MPEG 91/
November 1991, Kurihama

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ORGANIZATION INTERNATIONALE DE NORMALISATION

ISO/IEC JTC1/SC2/WG 11

CODED REPRESENTATION OF PICTURE AND AUDIO INFORMATION

ISO/IEC JTC1/SC2/WG 11
MPEG 91/
November 1991, Kurihama

Title: Description of the Multi Purpose Coding Scheme

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Purpose: Algorithm description and implementation evaluation of proposal number 18 and 19

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Abstract

The MUPCOS is a high performance, low complexity, fully MPEG1 compatible video coding scheme, and can be made H.261 compatible after some modifications. The scheme enables full control over the 'low' and 'high resolution' bit stream by a block based prediction switching mechanism. Resolution splitting is carried out in the transform domain, this gives a significant saving in complexity of the decoder and reduces the end to end delay significantly. In H.261 compatible mode or in the forward predict only mode of MPEG1 the system can operate with low end to end delays. Applications not having the need for full compatibility are not required to use the compatible modes, so a saving in cost can be made for these applications. By selecting the proper prediction modes further savings can be made for certain applications, especially for the memory and the processing performance requirements.

Conclusion: the MUPCOS is a highly flexible, generic coding system that suits the needs for many different applications.

Summary

1 General features

- Full backwards and forwards compatibility with MPEG
- 4:2:0 Coding format
- 704 pixels by 576 lines in 50 Hz interlaced mode
- 704 pixels by 480 lines in 60 Hz interlaced mode
- Entry points every 10 frames in 50Hz mode and every 12 frames in 60Hz mode
- Motion vector range +/- 8 pixels per frame period in simulations

2 Odd field coding

2.1 Inner loop

- Fully MPEG1 core

2.2 Outer loop

- Sequence, GOP and Picture layers are in MPEG1
- Modified slice layer for additional quantiser scale
- 16 x 8 DCT
- Macroblock types as in MPEG1 (32 x 16 Y and 16 x 8 U and 16 x 8 V)
- Block based selection of "low resolution" prediction
- 4 additional vectors per macroblock
- Specific VLC tables for high frequency prediction errors

3 Even field coding

- Sequence, GOP, Picture and Slice layer as MPEG1
- 8 x 8 DCT
- Macroblocks are 16 x 16 Y and 8 x 8 U and 8 x 8 V
- Macroblock types as in MPEG1 B-Pictures + "Copy Mode"
- 2 Vectors per macroblock

4 Claimed Features

- Full MPEG1 core compatibility, 1 Mbit/s - 1.5 Mbit/s in MPEG1 bit stream, surplus in enhancement data channel
- Low codec delay, in low delay mode
- H.261 compatibility when mode is implemented
- ATM Cell loss resilience
- Scalebility
- Entry points every 0.4 second
- Fast forward and fast backward support

Chapter 1

General introduction to compatible reference models

Different degrees of compatibility, such as forwards and backwards compatibility and upwards and downwards compatibility have been defined and are described in the MPEG Proposal Package Description [MPEG 81/100 Aug 1991]. It is desirable that MPEG2 (respectively H.26X) should be fully compatible with MPEG1 (respectively H.261). Full compatibility will allow service providers and manufactures an easier entry into the market reaching a larger number of customers more rapidly. It also has the benefit to customers and manufacturers that their investment in decoding equipment and software is protected, and allows manufacturers to develop a range of different products with different prices and performances that will all work with the same coding material.

There are different degrees of compatibility, the already defined forward and backward compatibility and the upward and downward compatibility. Upward and downward compatibility are sometimes called scalability. A fully compatible system will fulfil all four types of compatibility completely.

To ensure full compatibility the MPEG2 bit stream needs to include a MPEG1 bit stream. Then, two coding loops are needed, one to encode the SIF compatible picture, the second one to enhance the quality with a higher resolution (CCIR 601/Super CIF/EDTV etc). This can be done by including a MPEG1 encoder in the MPEG2 scheme.

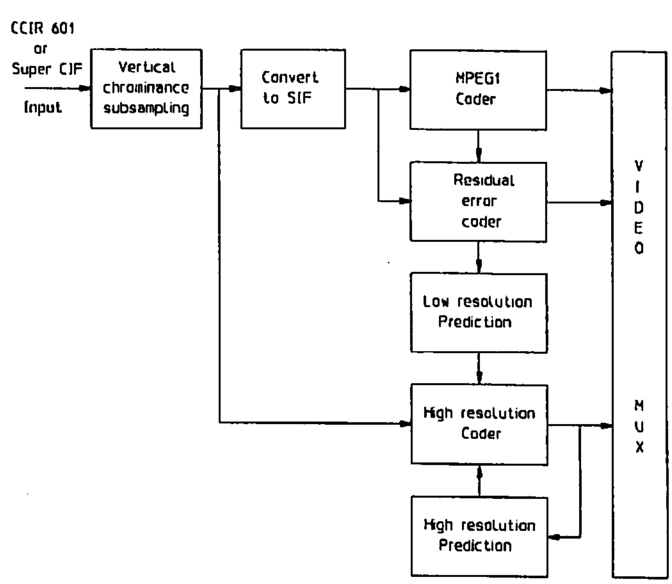

Figure 1.1 : Compatible reference encoder

In section 1.1 fully compatible coding schemes are described in a general way. In the subsequent sections the MUPCOS scheme is described in detail.

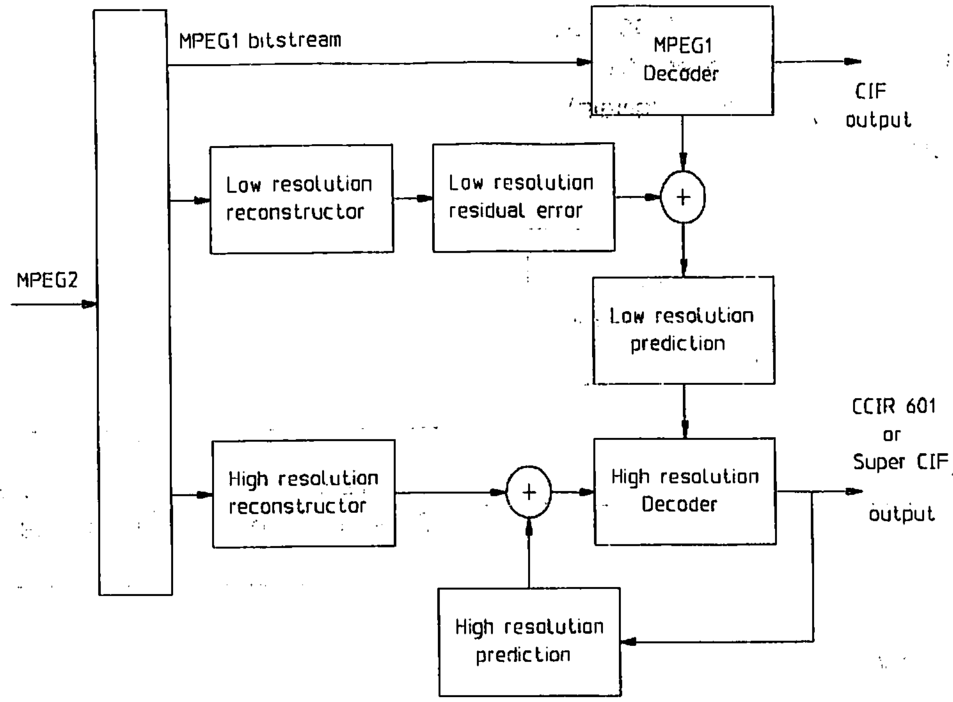

Figure 1.2 : Compatible reference decoder

1.1 Main features

Figure 1.2 shows the compatible reference decoder. Its input is a MPEG2 bitstream, which is demultiplexed and splitted into several bitstreams, one of these is a true MPEG1 core bitstream. The output of the total reference decoder is CCIR 601 or some other format. The second output format is optional and can be the MPEG1 'SIF or CIF' output.

Super CIF is currently under consideration by the CCITT SG XV expert group on ATM. The considered parameters are progressive scan format, 720 x 576 pixels and 60Hz.

The coder and decoder schemes for the general compatible reference model are given in figure 1.1 and 1.2. A scheme for a compatible simulcast system is trivial and therefore not given.
The main features are given below:

- The compatibility is ensured by the MPEG1 bit stream which is included in the MPEG2 bit stream. Several methods to obtain the SIF picture from the CCIR format can be proposed: linear filtering/subsampling, 16 x 8 DCT - 8 x 8 IDCT / decimation, etc.
- The "High Resolution" enhancement encoder can use two predictions: "Low Resolution" prediction and "High Resolution" prediction or no prediction at all from "low" to "high resolution" in case of simulcast. The final prediction error is obtained by subtracting the two prediction signals or by selecting the more efficient prediction.
- The "Low Resolution" prediction is derived from the basic decoded difference signal or with some schemes from the basic decoded picture.
- The "Low Resolution" picture can be enhanced by the residual error encoding.
- In some schemes the compatibility is reached by compatible odd field coding, while for the even field no compatibility is needed.

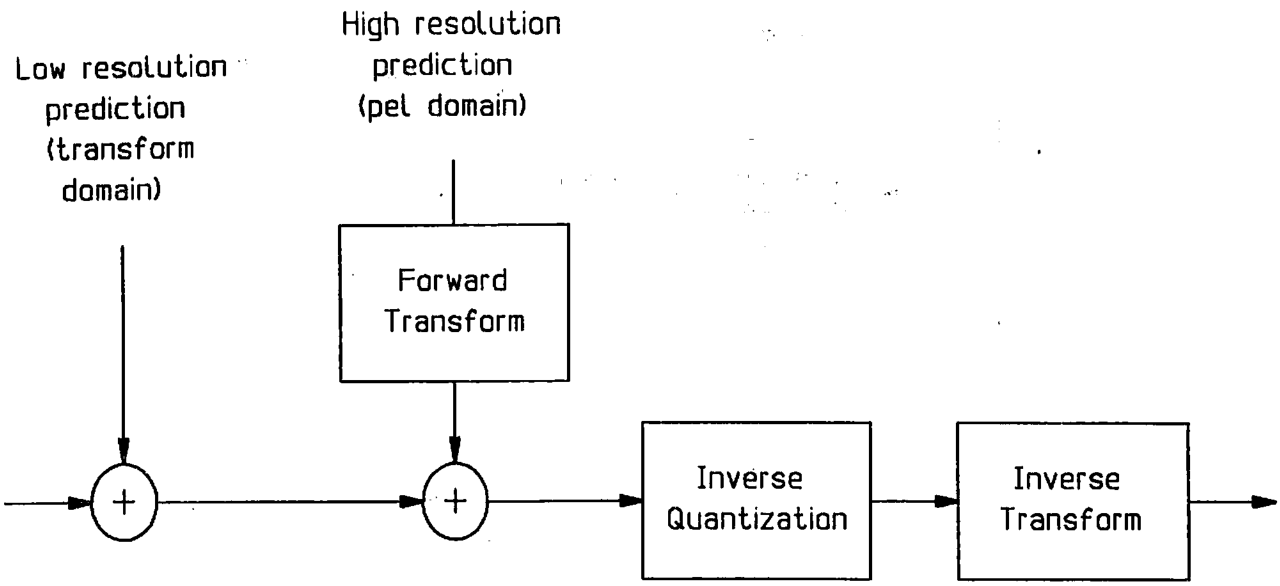

Figure 1.3 : Transform domain prediction

Figure 1.3 shows the general transform domain prediction block diagram. The prediction is entirely performed in the transform domain. The block diagram is part of the general transform encoder and decoder block diagrams.

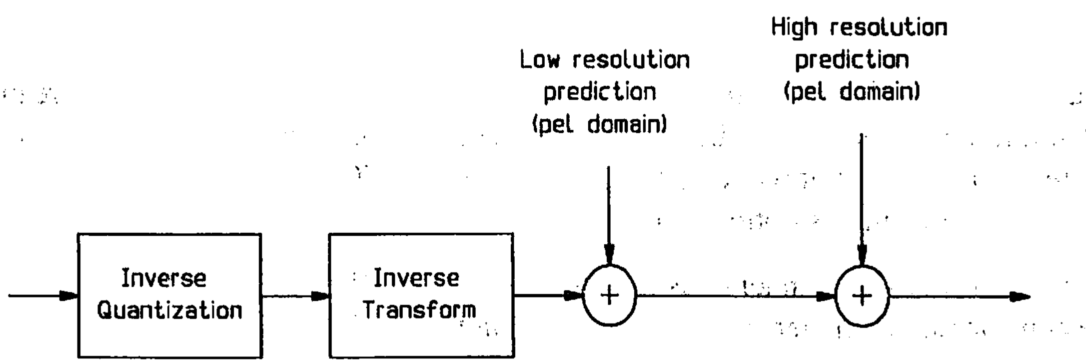

Figure 1.4 : Pel domain prediction

Figure 1.4 shows the general pel domain prediction block diagram. The prediction is entirely carried out in the pel domain. This block diagram can fit in the encoder and the decoder.

— The "High Resolution" prediction is made in the pel domain or in the transform domain as shown in figure 1.3 and 1.4. This prediction can be different for even and odd fields in case of interlaced format.

Figure 1.3 shows the reconstruction process with a prediction in the transformed domain. In figure 1.4, the prediction is carried out in the pel domain. These schemes are obviously equivalent, the nature of the data is the same, only the way to extract it is different.

The "High Resolution" enhancement coder is a hybrid transform coder with motion compensation. The blocksize of the transformation depends on the scheme and the "High Resolution" 8 x 8, 16 x 8 or 16 x 16. The size of 16 x 8 or 16 x 16 is used in case the prediction is made in the transform domain.

1.1.1 PEL SPLIT

The Pel Split algorithm down samples the CCIR 601 signal in the pixel domain. Then it codes the down sampled SIF signal with a MPEG1 coder and the CCIR 601 signal with a Hybrid DCT coder, which also takes the upsampled SIF signal as a prediction, see figure 1.4.

1.1.2 DCT SPLIT

The odd fields of the 4:2:0 format are first processed by a 16 x 8 DCT. The 16 x 8 DCT makes the encoder able to downconvert the 4:2:0 format to the SIF format by skipping the 8 x 8 High Frequency coefficients. The 8 x 8 Low Frequency coefficients will provide a 352 x 288 field for each odd field of the 4:2:0, when used in 50Hz, and a 352 x 240 field for 60 Hz. The odd field encoder (see figure 1.3) contains a MPEG1 encoder shown in the inner loop of the block diagram. The outside loop is a 4:2:0 format encoder, in principle very similar to a MPEG1 encoder, except it works on 16 x 8 DCT blocks, see for example figure 2.2.

1.1.3 SIMULCAST

In a Simulcast system the high and low resolution data are coded independently. For the "low resolution" MPEG1 core is used. For the "high resolution" MPEG1, for instance, can be used again.

1.2 MUPCOS

In the following chapter the Multi Purpose algorithm is described. The MUPCOS algorithm can be classified as a DCT Split algorithm. Features of the scheme are:

- Forward compatibility: the MPEG2 (H.26x) decoder can decode pictures from MPEG1 (H.261) encoder bit streams.
- Backward compatibility: the MPEG1 (H.261) decoder can decode pictures from a part of the bit stream of a MPEG2 (H.26x) encoder.
- Scalability in resolution: low and high resolution pictures are available at the decoder.
- Differing aspect ratios: the input picture could be of 16 by 9 aspect ratio. The SIF/CIF windows this to 4 by 3 and down converts it. The upconverted prediction picture is only 4 by 3. The side windows are set to, for instance, mid-grey. The second layer would then code the full 16 by 9 aspect ratio.
- Cell loss resilience: Two-layer coding for ATM networks is known to provide high cell loss resilience. The base layer is transmitted using high priority cells. The second layer is transmitted using low priority cells. For those cells in the layer that do not reach the decoder, the base picture is used to conceal the corrupted part of the picture.
- Flexibility in products: Manufacturers can provide a range of products from low cost to high cost with increasing performance all working from the same coded material.

Chapter 2

MUPCOS CCIR 601 TV to SIF compatibility

This section introduces the basic idea that we propose to use in order to provide a MPEG2 coding scheme compatible with a lower resolution decoder (MPEG1 decoder). The Rec.601 TV format is converted first to a 4:2:0 sampling standard before coding, compatible to the MPEG1 format. This processing is done by using vertical filtering and sub-sampling of the chrominance signals. Consequently, numbers of lines and pixels for 4/3 aspect ratio are given in table 2.1.

	Y signals	*U/V signals*
1 field 4:2:0 (50Hz)	720 x 288	360 x 144
1 field SIF 625	360 x 288	180 x 144
1 field 4:2:0 (60Hz)	720 x 240	360 x 120
1 field SIF 525	360 x 240	180 x 120

Table 2.1 : Processing formats

The field size of the 4:2:0 format is twice the field size of the SIF in horizontal direction.. Compatibility coding is achieved by splitting of the odd fields in the DCT domain. The constraints given in table 2.2 are respected to maintain compatibility with MPEG1.

SIF	*Odd Fields 4:2:0*
8 x 8 DCT	16 x 8 DCT
1 macroblock =	1 macroblock =
16 x 16 pels (Y)	32 x 16 pels (Y)
+ 8 x 8 pels (U)	+ 16 x 8 pels (U)
+ 8 x 8 pels (V)	+ 16 x 8 pels (V)

Table 2.2 : Macroblock sizes

The odd field coding overview is given in figure 2.1, where M = 3 is used.

The encoder block diagram is depicted in figure 2.2. The inner loop of the diagram is the MPEG1 encoding loop. The outside loop is the MPEG2 enhancement loop for the 4:2:0 odd field.

The decoder block diagram is given in figure 2.3. The two branches between the VLD and the left adder transport the MPEG1 and MPEG2 transformed difference data. **Note that no MPEG1 decoding loop is required.**

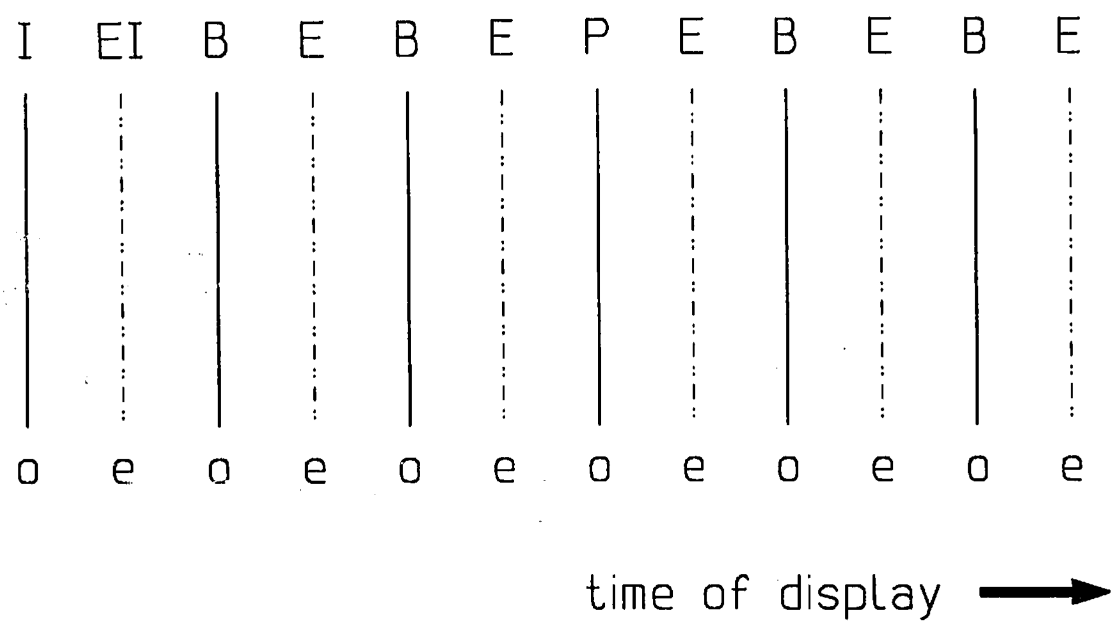

Figure 2.1 : Frame processing modes

Figure 2.1 shows the frame processing modes, in display order. The vertical bars represent the odd(o) and even(e) fiels. I indicates Intra coded, EI even after intra or refresh, B bi-directional interpolation, E even field codng and P forward prediction.

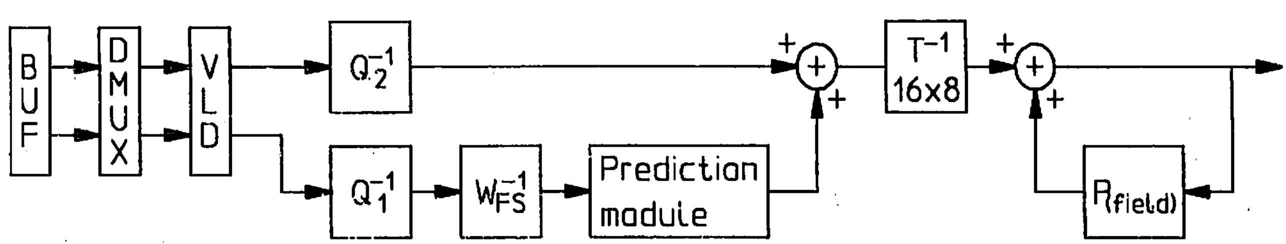

Figure 2.3 : Decoder block diagram

Figure 2.3 shows the decoder block diagram. The decoder block diagram is very close to the MPEG1 decoder block diagram. The difference is in the double branche from the input to the adder, and of course a 16 x 8 inverse DCT instead of an 8 x 8 inverse DCT.

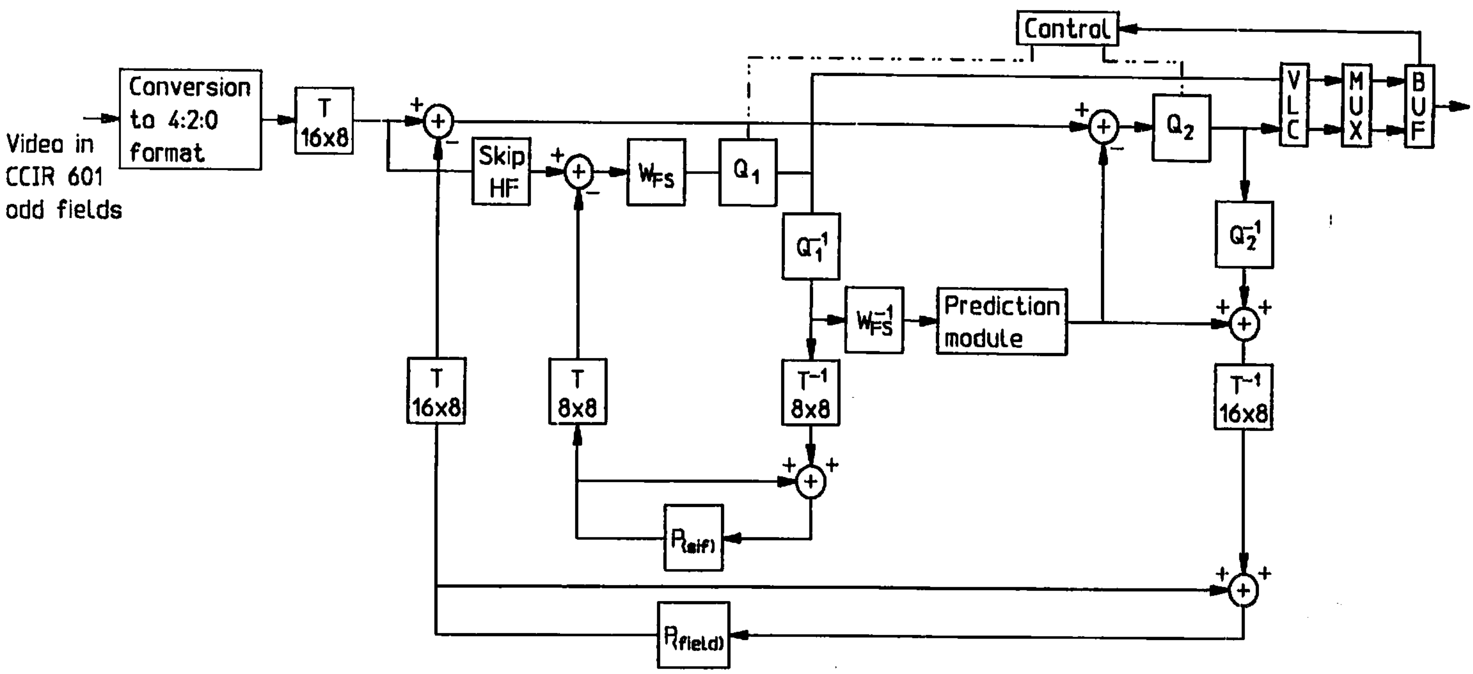

Figure 2.2 : Encoder block diagram

Figure 2.2 shows the encoder block diagram. Two loops can be determined, the so called inner loop and outer loop. The inner loop (with the 8 x 8 DCT) is the compatible MPEG1 prediction loop. The outer loop (with the 16 x 8 DCT) enables the scheme to operate on the higher resolution image. The inner loop gets the prediction via the High Frequency skip unit, this unit removes the 8*8 high frequencies. In the figure the normal MPEG1 building blocks are used. In the figure a block W_{fs} is shown and its inverse, this unit is currently not implemented, but from simulations is known that including this weighting filter the MPEG1 compatible image will improve, without affecting the CCIR 601 results.

Chapter 3

Principle of processing of 4:2:0 odd fields

In this coding scheme full compatibility is achieved by compatible coding of the odd field. This chapter outlines the mechanisms used for this. The compatible principle, a compatible zigzag scanning, the quantisation, coding and VLC techniques are described.

3.1 Compatibility

Compatibility with MPEG1 and potential compatibility with H.261 (not described in this document) are the main features of this algorithm.

3.1.1 Principle

Odd fields of the 4:2:0 format are first processed by a 16 x 8 DCT.

The use of 16 x 8 DCT coefficients makes the encoder able to downconvert the 4:2:0 format to the SIF format by skipping the 8 x 8 High Frequency coefficients. The 8 x 8 Low Frequency coefficients will provide a 352 x 288 field for each odd field of the 4:2:0, when used in 50Hz and a 352 x 240 field for 60 Hz. The odd field encoder (see figure 2.2) contains a MPEG1 encoder shown in the inner loop of the block diagram.

The outside loop is a 4:2:0 format encoder, in principle very similar to a MPEG1 encoder, except it works on 16 x 8 DCT blocks.

3.1.2 Compatibility for INTRA and INTER coded blocks

INTRA coded blocks

Low Frequency coefficients are quantised first by the inner loop(MPEG1), then the residual error for MPEG2 will be encoded by the outside loop. The inner loop thus provides a prediction for the outside loop for intra Low Frequency coefficients. Behaviour of the outside loop is explained in further details in the "Quantization with refinement technique" section.

INTER coded blocks (B or P blocks)

In principle, compatibility is achieved by prediction of the prediction error. The coded prediction error signal (after inverse quantisation) of the inner loop(MPEG1) is used as a prediction of the prediction error of the outside loop. This allows the reduction of the prediction error signal of the outside loop, as compared to simulcasting, so it enables to save bits. Efficiency of this technique is optimised, it takes into account the scarce cases when prediction of the prediction error is costly. A switch is introduced, which allows on a block basis the use of the prediction of the prediction error. In case the prediction error is not used, both encoded blocks, (MPEG1 and MPEG2) are quantised and transmitted separately (low resolution prediction mode).

For further studies a weighting box W is drawn in figure 2.2. The W box implements a weighting filter, which weights the DCT Low Frequency coefficients to provide a better MPEG1 picture quality. The W^{-1} box is the inverse weighting filter.

3.2 Coding modes and Motion vector range and accuracy

For the odd fields we have exactly the same coding modes as for MPEG1.

In the simulations the motion vector range is -8,+7 pels per frame period, with half pel accuracy.

3.3 Zigzag scanning of 16 x 8 DCT coefficients

The zigzag scanning of the 16 x 8 DCT coefficients is as follows. Low Frequency coefficients are scanned first, High Frequency coefficients afterwards. This enables the use of a specific VLC table for High Frequency coefficients.

1	2	6	7	15	16	28	29	65	66	70	71	79	80	92	93
3	5	8	14	17	27	30	43	67	69	72	78	81	91	94	107
4	9	13	18	26	31	42	44	68	73	77	82	90	95	106	108
10	12	19	25	32	41	45	54	74	76	83	89	96	105	109	118
11	20	24	33	40	46	53	55	75	84	88	97	104	110	117	119
21	23	34	39	47	52	56	61	85	87	98	103	111	116	120	125
22	35	38	48	51	57	60	62	86	99	102	112	115	121	124	126
36	37	49	50	58	59	63	64	100	101	113	114	122	123	127	128

Table 3.1: Scanning order for 16 x 8 blocks.

3.4 Quantization of INTER coded blocks

This quantization process is fully MPEG1 like. All coefficients are weighted with a factor 16 for inter coded blocks. Two quantiser parameters exist:
- Q1 for MPEG1 compatible coding of low frequency components.
- Q2 for odd field refinement and high frequency components and for the even fields.

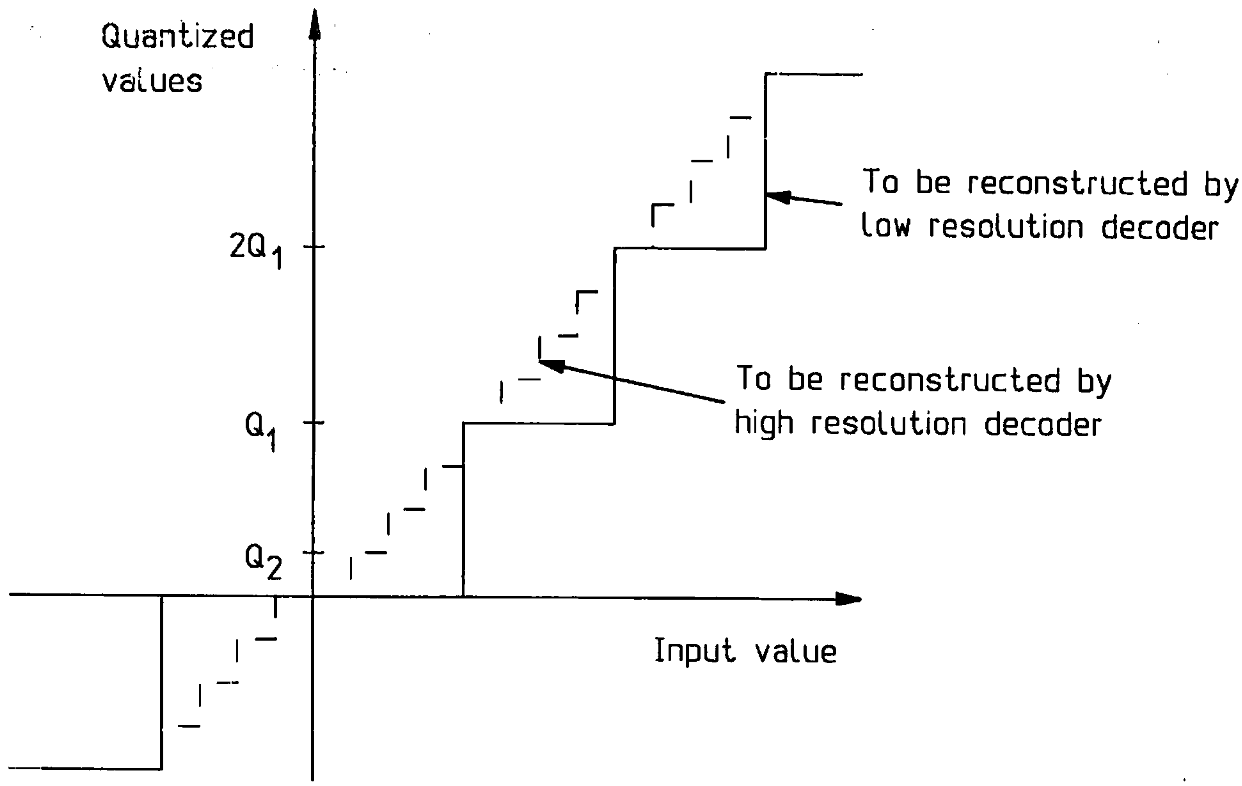

Figure 3.2 : Refinement quantisation curve

Figure 3.2 shows the refinement quantisation curve in combination with the quantisation curve of the "low resolution" (MPEG1) decoder, in this figure k=2, 2k = 4 additional refinement steps.

— Q1 step is used for the compatible part.
— Q2 can be used at the "high resolution" decoder side , thanks to refinement data transmitted in the additional channel.

3.5 Quantization of INTRA coded blocks

In case of Intra coded blocks, a refinement strategy is used for quantisation, which is described below.

3.5.1 Low Frequency coefficients of INTRA blocks

Since independent bit rate regulations have to be performed on both the MPEG1 compatible bit stream and the total bit stream, two regulation parameters are needed. Of course, these two regulation parameters affect the quantization process in order to insure the desired bit rates.

1. The first one is the quantiser scale for 4:2:0 encoding, let us call it Q2. From the occupancy of the 4:2:0 buffer (compatible buffer occupancy + surplus buffer occupancy),

Q2 is calculated in a similar way as for a stand-alone bit rate regulation. Q2 is sent for every slice and on a Macroblock basis if needed to the decoder in the additional channel.

2. A quantiser scale, Q1, for the MPEG1 encoder is used to achieve bit rate regulation of the compatible bit stream. For the "refinement" technique, Q1 is calculated as follows:
   - In the first step, quantization scale Q1 is derived from the occupancy of the compatible buffer only.
   - Q1/Q2 ratio is computed. It is rounded to a power of 2 (the nearest one for instance), let us say 2^k.
   - then Q1 is updated: $Q1 = Q2 \times 2^k$.

   Q1 is sent for every slice and on a macroblock if needed to the decoder in the MPEG1 bit stream.

The quantization works as follows: first the signal is quantised with stepsize Q1, which goes into the MPEG1 bit stream. Then, the 4:2:0 data is quantised with "Q2 accuracy". This is achieved by transmitting in the 4:2:0 channel additional data for each quantised MPEG1 coefficient. In principle, this can be done by transmitting k bits for each MPEG1 non zero coefficient, or k+1 bits for each MPEG1 zero coefficient (for a MPEG1 zero coefficient a sign bit is necessary). Transmission of this extra information is dealt with in section 3.6 (VLC techniques).

This refinement quantisation technique is illustrated on figure 3.2.

3.5.2 High Frequency coefficients of INTRA blocks

High Frequency coefficients are quantised using directly the Q2 quantiser scale (no refinement technique is used since these data are sent only in the additional channel).

3.6 VLC techniques for INTRA coded blocks

The coding of INTRA coded blocks is split into three stages: MPEG1 coding, refinement of MPEG1 and high resolution coding.

3.6.1 Low Frequency coefficients

The low frequency coefficients are VLC coded in accordance to MPEG1 (the inner loop is basically a MPEG1 encoder).

3.6.2 Refinement of Low Frequency coefficients

As said in section 3.5.1 "k" bits per MPEG1 quantised coefficient and "k+1" bits per MPEG1 zero-coefficient, could be used for the refinement data. In practice, we use the more efficient following procedure:

— first we transmit for each MPEG1 non zero coefficient k bits per coefficient to provide the refinement.

- the more efficient part is the following: we consider the succession of refinement values for positions corresponding to "0" quantised MPEG1 coefficients. This succession of values is coded using a bi-dimensional VLC. The VLC which is used is determined by the value of "k" which defines the refinement, see appendix B.

3.6.3 High Frequency coefficients

These high frequency data are part of the 4:2:0 enhancement bit stream. The data are coded using a specific bi-dimensional VLC. See appendix B.

3.7 VLC techniques for INTER coded blocks

The low frequency coefficients of the inner loop and high frequency coefficients use a fixed coding mode. Low frequency coefficients of the outside loop can use 2 modes depending on low resolution prediction mode selection of the prediction selection unit.

3.7.1 Low Frequency coefficients of the inner loop

They are VLC coded in accordance to MPEG1 (the inner loop is basically a MPEG1 encoder).

3.7.2 Outside loop, low frequency coefficients

1. Prediction of the prediction error mode.

When this mode is used a specific bi-dimensional VLC is used for the 8 x 8 Low Frequency coefficients.

2. Low Resolution Prediction

A specific bi-dimensional VLC for the 8 x 8 Low Frequency coefficients is used for the low resolution prediction, which VLC is used, depends on the low resolution prediction flag. See appendix B.

3. Low Resolution prediction flag

One bit per block is used to indicate whether the low resolution prediction is used for this block.

3.7.3 High Frequency coefficients

High Frequency coefficients are coded using a specific bi-dimensional VLC (same as for INTRA coded blocks).

Chapter 4

Principle of processing of 4:2:0 even fields

For the even fields no compatibility constraint is taken into account in this scheme. Due to implementation concerns we have chosen the even field coding to be as close as possible to MPEG1. The modes and motion vectors coding are described in this chapter.

4.1 Coding modes close to MPEG1

The coding modes used are very close to those used for MPEG1 B-Pictures. An extra coding mode, the "copy mode", is introduced that predicts the block from the previous even field. For even fields following an Intra coded odd field, intra-field mode is not forced, but the entry point constraint is respected by constraining the choice of prediction modes.

The coding modes are selected on a 16 x 16 Macroblock basis.

4.2 Coding modes for even fields

4.2.1 "Copy mode" from the previous even field

This mode is in addition with respect to MPEG1 B-Pictures like coding modes. The mode is an inter coding mode with prediction as follows. The mode is supposed to be the "normal" mode. It means that it is the first one to be tested and directly retained if the result is good enough.

For this mode, we use half pixel accuracy for both horizontal and vertical directions. The motion vector is computed between the current even field and the previous original even field.

This mode is not used if the previous odd field is intra coded, so that the entry point constraint is respected.

4.2.2 "Interpolation mode" from previous and next odd fields

The interpolation coding mode with prediction is as follows. The two odd fields adjacent to the considered even field are first vertically upsampled. Then, bidirectional prediction from these odd fields is performed to get the predicted even fields. This is sketched on the figure 4.1

Accuracies:

In the vertical direction half pixel accuracy is thus used, by the vertical up-sampling. In the horizontal direction, half pixel accuracy is also used.

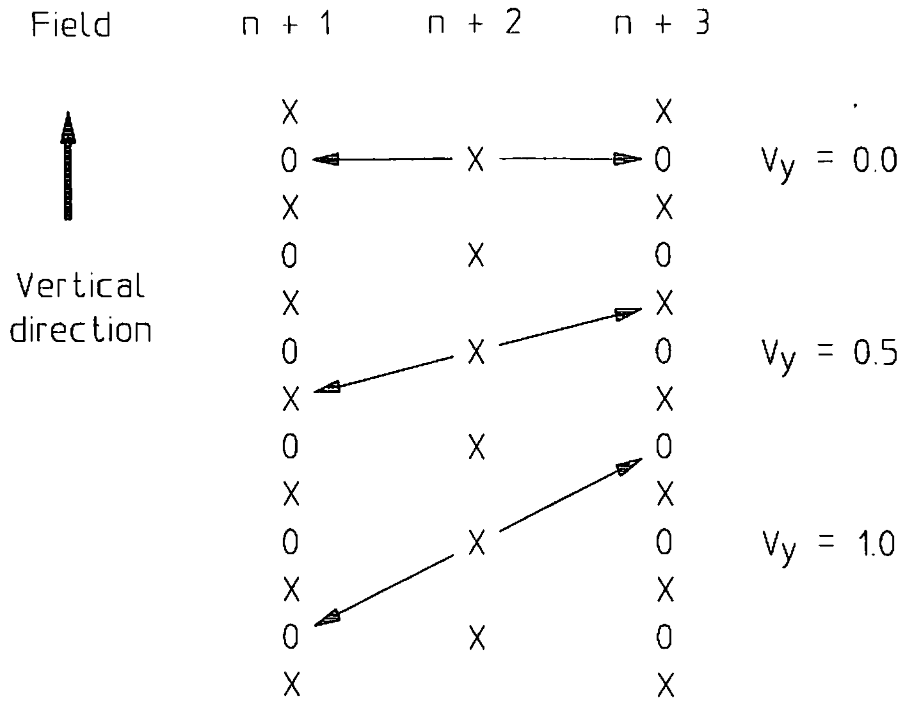

Figure 4.1 : Even field interpolation

Figure 4.1 shows three examples of even field interpolation. Three fields are shown in the figure. Field n+2 is an even field, and field n+1 and n+3 are both odd fields. The X's are the pixels coming from one line of each field. The O's are interpolated pixels, they are interpolated in the field, by using a 1/2, 1/2 filtering. In the figure three examples are shown of interpolation with three different vectors.

4.2.3 "Previous" mode from previous odd fields

The "Previous" coding mode is as follows. Prediction is obtained from the previous decoded odd field with the vertical upsampling and accuracies as for the "interpolated" mode.

4.2.4 "Next" mode from next odd fields

The "Next" coding mode is as follows. Prediction is obtained from the next decoded odd field with the vertical upsampling and accuracies as for the "interpolated" mode.

4.2.5 Intra coding mode

If the error energy based on a block basis provided by the preceding modes is too large then the intra mode can be used.

4.3 Motion Vectors for even fields reconstruction

The motion vectors are transmitted using the differential coding techniques described in MPEG1.

For each macroblock, the vector predictor is the one of the last Macroblock using the same mode. Resetting is done only when starting a new slice or after an intra Macroblock.

Chapter 5

Parameters of the proposed scheme

The most important parameters of the scheme are given in this section.

5.1 Odd Fields Processing

5.1.1 SIF loop (inner loop)

Exactly MPEG1 parameters and syntax, for instance: 8 x 8 DCT, 1 macroblock = 16 x 16 Y + 8 x 8 U + 8 x 8 V, 1/2 pixel accuracy in horizontal and vertical direction for Motion Compensation. MPEG1 VLC tables.

5.1.2 4:2:0 loop (Outside loop)

Exactly MPEG1 syntax and parameters for: GOP, picture. Slice layer syntax is only modified by the transmission of the value of Q2 at the beginning of each slice. Syntax and parameters very close to MPEG1 for macroblock, block layers.

1/ 16 x 8 DCT is used = blocks are 16 x 8

2/ Macroblock characteristics

- macroblocks are 32 x 16 Y + 16 x 8 U + 16 x 8 V: 6 blocks.
- Macroblock type: same as MPEG1. (previous, next, bidirectional prediction...)
- macroblock pattern: exactly as for MPEG1 coded/not coded blocks; not used for refinement and High Frequency components.
- low resolution prediction pattern codeword is transmitted in addition, which transmits the information: low resolution prediction mode of the prediction error mode 6 bits, 1 bit per DCT block.

3/ motion compensation for each macroblock: 4 vectors are transmitted for the 4 16 x 8 Y blocks, fully independently from MPEG1 vectors. These vectors are coded differentially with the same VLC as in MPEG1. In a macroblock, the vector for the top left block uses the prediction of the vector of the last Macroblock of the same mode at the bottom right position. The top right vector uses the top left vector as prediction. The bottom left vector use the top right vector, and the bottom right vector uses the bottom left vector. These 4 vectors are used to get predictions for the 4 luminance blocks. Each vector for luminance is used to get a prediction for each 8 x 4 pixels U and V subblock spatially, corresponding to the 16 x 8 luminance block.

4/ VLC tables for DCT coefficients

- MPEG1 coded data for Low Frequency: MPEG1 VLC is used of course.
- Intra coded blocks: refinement technique leads to a new coefficient VLC table

- prediction of the prediction error on Low Frequency: specific VLC leads to a new coefficient VLC table
- independent VLC for the low resolution prediction on Low Frequency coefficients leads to a new coefficient VLC table
- independent VLC on High Frequency coefficients leads to a new coefficient VLC table

5.2 Even Fields Processing

Exactly MPEG1 syntax and parameters for: GOP, picture, slice layers. Syntax and parameters very close to MPEG1 for macroblock, block layers.

— DCT is performed on 8 x 8 blocks.
— Macroblocks are 16 x 16 Y +8 x 8 U +8 x 8 V.
— 8 x 8 DCT is used = blocks are 8 x 8
— One macroblock is 16 x 16 Y (4 Y +2 U+2 V)
— Macroblock type: same as MPEG1 B-fields (type for prediction from odd fields) + one type added: predicted from previous even field.
— Macroblock pattern: coded/not coded, same VLC as for MPEG1
— For each macroblock:
  - 4 Y blocks with spatial positions: the first are the two upper blocks, the second are for the 2 lower blocks.
  - 2 motion vectors are transmitted.
  - The 2 vectors are coded with the MPEG1 technique (DPCM+VLC). First vector is coded differentially from the second of the previous macroblock, second vector is coded differentially from the first of the actual macroblock.

— Each vector for luminance is used to get a prediction for each 8 x 4 pixels U and V subblocks spatially corresponding to the 16 x 8 luminance area.

High and low resolution data streams

The full syntax of the MUPCOS is given in appendix A. The syntax for the low resolution data equals the MPEG1 syntax. The syntax for the high resolution data is close to the MPEG1 syntax. No concrete proposal is made for the multiplexing of the two data streams. One can think of different scenarios to handle this. The first one would be to forward both data streams to the MPEG1 systems multiplex, this could be done fully MPEG1 compatible. A second scenario would be the use of the extension data.

Chapter 6

Features of MUPCOS

The MUPCOS is a highly flexible system which can suit the needs for many different applications. Different applications have different requirements. The requirement claims met by MUPCOS are given in this chapter.

6.1 Requirements of different applications

In the MPEG Packet Proposal Description a number of requirements for different applications are listed, the requirements with the most important implications on the algorithms are: compatibility, low codec delay, cell loss resilience and scalability. Constraints concerning for instance bit error resilience can mostly be handled with a FEC.

6.1.1 Compatibility

A very obvious requirement is the **compatibility requirement**, this is a must for for instance:

The so called 'compact disk interactive' systems, to have a:
— Stable investment in equipment
— Stable investment in software (compact disks)
— A stable platform for the consumer market
— A compatible product range with increasing performance which can be offered to the customer

The conversational services:
— Future systems should be able to interwork with existing systems
— Stable investment in equipment
— A stable platform for the market

For those applications not needing this compatibility, it might be too a heavy burden in price or maybe in performance. Therefore the MUPCOS allows to switch off the compatible mode in the encoder and the decoder, so for those applications it is not necessary to implement this.

6.1.2 Low end to end delay

A second important requirement is the **low delay requirement**, this requirement is a must for for instance:

The conversational services:
— For proper videophone use or video conferencing low delay is required.

— The total end to end delay should be low, desirably less than about 150 ms. This means that the maximum delay should not too often exceed this value, and that is very desirable to offer the customer a delay which is much less than the above mentioned 150 ms.

For these applications there is always the trade off between picture quality and delay. The less delay, the less the image quality is. The reason for this as follows due to less delay the future and past time windows will be small, with a small time window low correlation in picture sequences will be found. The advantage of low delay systems is that when the time window gets smaller the memory to store the information also will reduce. The MUPCOS can be switched, in a similar way as MPEG1, to a mode which only uses P (forward predict only) fields. By using field coding it can be demonstrated that it can result in lower delays than by using frame coding.

A model to visualise the different components of the total end to end delay is given below:

Encoder	d_{fc}	Format conversion
	d_{lb}	Line to Block conversion
	d_{pe}	Initial processing delay
	d_{re}	Frame/Field reordering delay
	d_{be}	Buffer delay
Network	d_n	Network delay
Decoder	d_{bd}	Buffer delay
	d_{pd}	Initial processing delay
	d_{rd}	Frame/Field reordering delay
	d_{bl}	Block to Line conversion
	d_{fd}	Format conversion

Table : 6.1 : End to end delay

Examples for the items given in table 6.1 are for a 50Hz interlaced source and a 50Hz processing format:

— Format conversion: no format conversion is required; $d_{fe} = 0$ ms.
— Line to Block conversion: $d_{lb} = 1$ ms.
— Initial processing delay, this time is required to retrieve for instance some motion vectors or perform an image analysis: d_{pe} = about 5 ms to 25 ms.
— Frame/Field reordering delay:
  - For frame coding: $d_{re} = 20$ ms.
  - For field coding: $d_{re} = 0$ ms, if no interpolation is used.
— Buffer delay: this delay plus the buffer delay from the decoder are almost constant.

— Network delay: depending on the infrastructure in the range of about 1 ms to several 100s ms. If satellite links are used, network adaptation is included. In this example we will assume $d_n = 0$ ms.
— Buffer delay: the total encoder and decoder delay equals to the total number of bits in the encoder and decoder buffer over the average bitrate when a constant bitrate is assumed, so $d_b = d_{be} + d_{bd}$. The H.261 hypothetical reference decoder specifies a B value which is a measure for the buffer delay: $B = 4R_{max}/29.97$, where R_{max} is the maximum video bit rate to be used in the connection.
For this example the formula can be modified to: $B = F*R_{max}/50$, where F is a peak factor.
The buffer delay bd is then, combining the two formulas, in the worst case about $(F*R_{max}/50)/R_{max}$ seconds, for F=4, $d_b = 80$ ms.
— Frame/Field reordering delay:
  • For frame coding: 20 ms.
  • For field coding: 0 ms, if no interpolation is used.
— Initial processing delay: about 1 ms.
— Block to Line conversion: 1 ms.
— Format conversion: no format conversion is required; 0 ms.

The biggest delay in this example is the buffers delay, it is suggested to take this item into account in further studies.

The typical maximum total delay is, for a frame coding algorithm, in this example about 128 ms to 148 ms. The typical maximum total delay for a field coding algorithm is in this example about 88 ms to 108 ms.

Conclusion: for the end to end delay it is important to select the processing format close to the source input format.

6.1.3 Cell loss resilience

A third important requirement is the **cell loss resilience** requirement, this requirement is a must for applications in the ATM network.

The future communications network will be the Broadband Integrated Services Digital Network (B-ISDN). This network will be of the Asynchronous Transfer Mode (ATM) type. Some of the characteristics of such networks are: low delay and packet switched. These packets are called cells in the B-ISDN network, these cells have a netto size of 386 bits, and one of the consequences of the low delay is that cells can be lost in the network.

Video services which use the network should be able to cope with these cell losses and therefore should be able to handle the loss of non recoverable data chunks of at least 386 bits.

The MUPCOS uses a hierarchical coding structure. Utilising this in a layered coding system the visibility of errors can be effectively reduced and recovery from errors can be achieved.

6.1.4 Scalability

An other requirement is the **scalability** requirement, this requirement is of interest for window oriented applications.

MUPCOS is by nature a scalable system, which comes implicit from the forward and backward compatibility, which makes the MUPCOS also upward and downward compatible.

6.2 Forward, backward compatibility and scalability claim

The 14 sequences coded for the TEST are all coded compatible to the MPEG1 core. For the 4 Mbit/s coded sequences, 1 Mbit/s are used for the MPEG1 and 3 Mbit/s for the enhancement data. For the 9 Mbit/s coded sequences, 1 Mbit/s is used for the MPEG1 and 8 Mbit/s is used for the enhancement data.

These claims are demonstrated with the following processed sequences:
- Susie coded at 1.5Mbit/s in the MPEG1 channel, and with a total bit rate of 5Mbit/s.
- Table Tennis coded at 1.5Mbit/s in the MPEG1 channel, and with a total bitrate of 5Mbit/s.
- Flower Garden coded at 1.5Mbit/s in the MPEG1 channel, and with a total bitrate of 5Mbit/s.

In the demonstration the sequences are shown decoded with the MUPCOS decoder and with a MPEG1 decoder. The MPEG1 quality is of about the quality demonstrated of the so called 'SM3+' software simulations in previous MPEG meetings.

6.3 Low delay claim

This claim is demonstrated with the following processed sequences:
- Susie coded at 1Mbit/s in the MPEG1 channel, and with a total bitrate of 4Mbit/s.

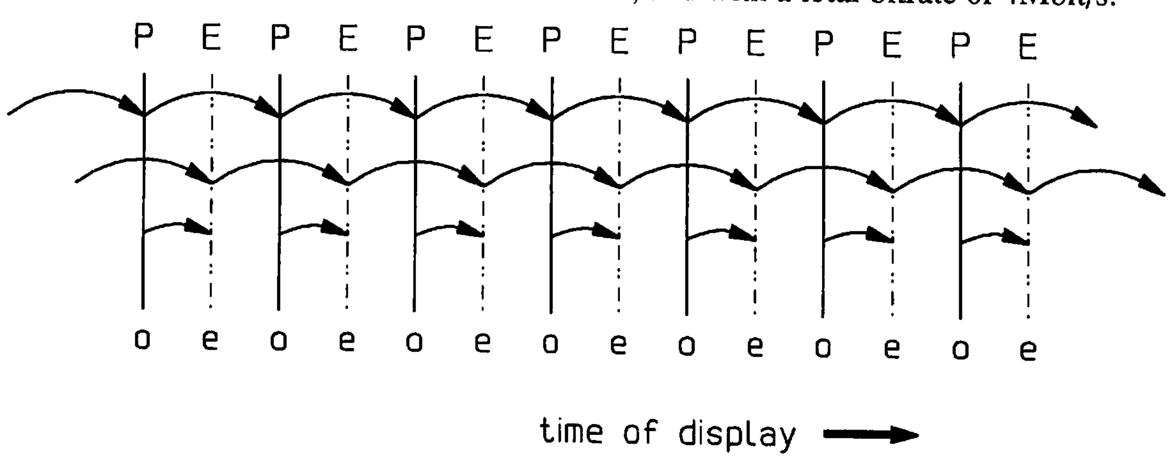

Figure 6.1 : Low end to end delay prediction flows

– Dawn coded at 1Mbit/s in the MPEG1 channel, and with a total bitrate of 4Mbit/s.
– Table Tennis coded at 1Mbit/s in the MPEG1 channel, and with a total bitrate of 4Mbit/s.

Note: Dawn is a sequence originated by PTT Research that has been used in COST 211 ter for ATM studies.

The forward prediction information flow compatible to MPEG1 is shown in figure 6.1.

The delay for the MUPCOS in the compatible low delay mode is given in table 6.

Format conversion	0 ms
Line to Block conversion	1 ms
Initial processing delay	5 ms
Frame/Field reordering delay	0 ms
Buffer delay	20 ms
Network delay	0 ms
Buffer delay	20 ms
Initial processing delay	1 ms
Frame/Field reordering delay	0 ms
Block - Line conversion	1 ms
Format conversion	0 ms
Total	48 ms

Table 6.2 : MUPCOS end to end delay

One of the advantages low delay codecs can have is that less memory is required for the implementation of these systems and also the computational performance requirements are less. The memory requirements for the MUPCOS in this low delay mode is 3 CCIR 601 field memories for the encoder and 3 CCIR 601 field memories for the decoder.

6.4 Cell loss resilience claim

To overcome the effect of cell loss in an ATM network the MUPCOS can be used in a two layer coding configuration.

The first layer contains a base picture which is transmitted over a guaranteed channel. The second layer contains enhancement data which are transmitted over a second channel.. This channel could undergo cell loss.

The target value for cell loss for B-ISDN as being standardised by CCITT SG XVIII is not yet clear. Cell loss probabilities could be in the order of 10^{-3} for low priority and 10^{-8} for high priority (utilising the priority bit, CLP, in the cell header). Recent developments indicate a move towards better quality with even lower cell loss probabilities.

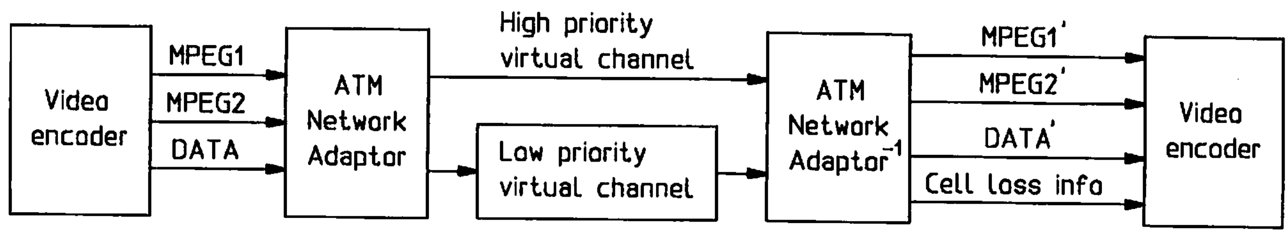

Figure 6.2 : Example of encoder,network,decoder diagram

The cell los resilience is demonstrated with the following processed sequences in the low end to end delay:

- Susie coded at 1Mbit/s in the MPEG1 channel and with a total bitrate of 4Mbit/s.
- Dawn coded at 1Mbit/s in the MPEG1 channel and with a total bitrate of 4Mbit/s.
- Table Tennis coded at 1Mbit/s in the MPEG1 channel, and with a total bitrate of 4Mbit/s.

Simulating a cell loss rate of 10^{-3} for the total cell stream, and the cell loss only occurs in the enhancement channel.

Demonstrated is the effect on the full resolution pictures. Cell loss gives disturbances in blocks, macro blocks or slices. The decoder however recovers from these losses within a few frames using the MPEG1 prediction. This simple method does however not fully utilize the potential in cell loss resilience. More advanced methods which will not increase the complexity are under study.

DECODER IMPLEMENTATION STUDY

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October 31, 1991

1 INTRODUCTION

This paper deals only with the implementation of the decoder. We give in this document a global architecture of an one chip decoder IC implementation.

- In the first part, we give the required number of field memory for real-time decoding and then the minimum memory size.
- Memory accesses are studied in detail in the second part and a memory organization is proposed.
- Part three gives for each module the characteristics required by the proposed algorithm.
- And finally, in the last part, a gate count is given for the presented chip.

The decoder receives two separate bitstreams:

- MPEG-I bitstream (compressed sub-window of the ODD field),
- MPEG-II bitstream (complement part of the ODD field plus the EVEN field).

According to the presented algorithm, we give functional block diagram description of the decoder for each field (figure 1 and 2).

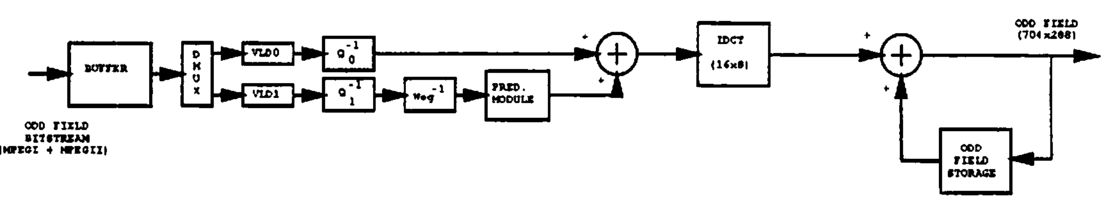

Figure 1: Block diagram of an odd field decoder

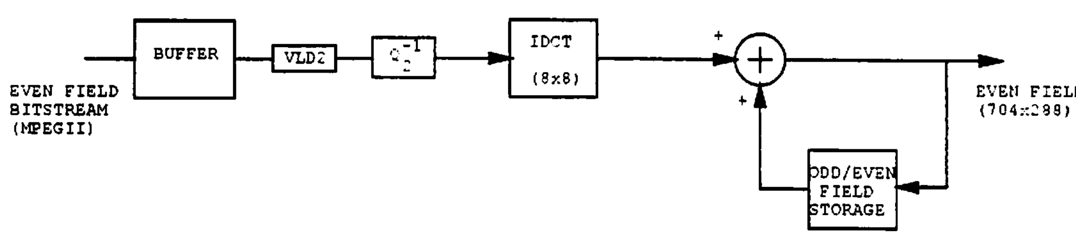

Figure 2: Block diagram of an even field decoder

One important factor for decoder architecture (memory organization, memory access, decoder organization...) is the reconstruction of interpolated fields according to motion compensation vectors.

1.1 Odd fields

Motion compensation on odd fields is done in a MPEG-I way. MPEG-I coded block and MPEG-II coded corresponding complement block have the same motion estimation type.
The different field types are:

- Intra field (I-field),
- Predicted field (P-field),
- Bidirectional Interpolated field (B-field).

Motion vectors are estimated for 16x8 luminance blocks (and 8x4 chrominance blocks using the corresponding luminance vectors). Note the relation between DCT blocks and motion blocks (figure 3). One macroblock may require four bidirectional vectors (one past and one future vector = one bidirectional vector).

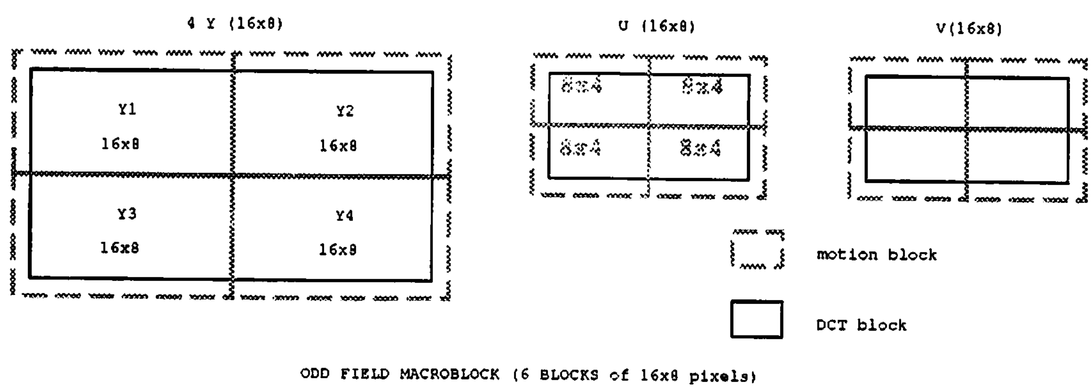

Figure 3: Odd field DCT macroblock and motion macroblock

1.2 Even fields

Motion compensation on even field can be done in four ways (figure 4):

- Copy mode: the field is interpolated from the past even field (C-field),
- Interpolated mode: the field is interpolated from the past and future odd field (T-field),
- Previous mode: the field is interpolated from the previous odd field (P-field),
- Next mode: the field is interpolated from the next odd field (N-field).

Motion vectors are estimated for 16x8 luminance blocks (one vector for 2 DCT blocks) (figure 5).
As in MPEG-I, motion vectors are half pixel vectors.

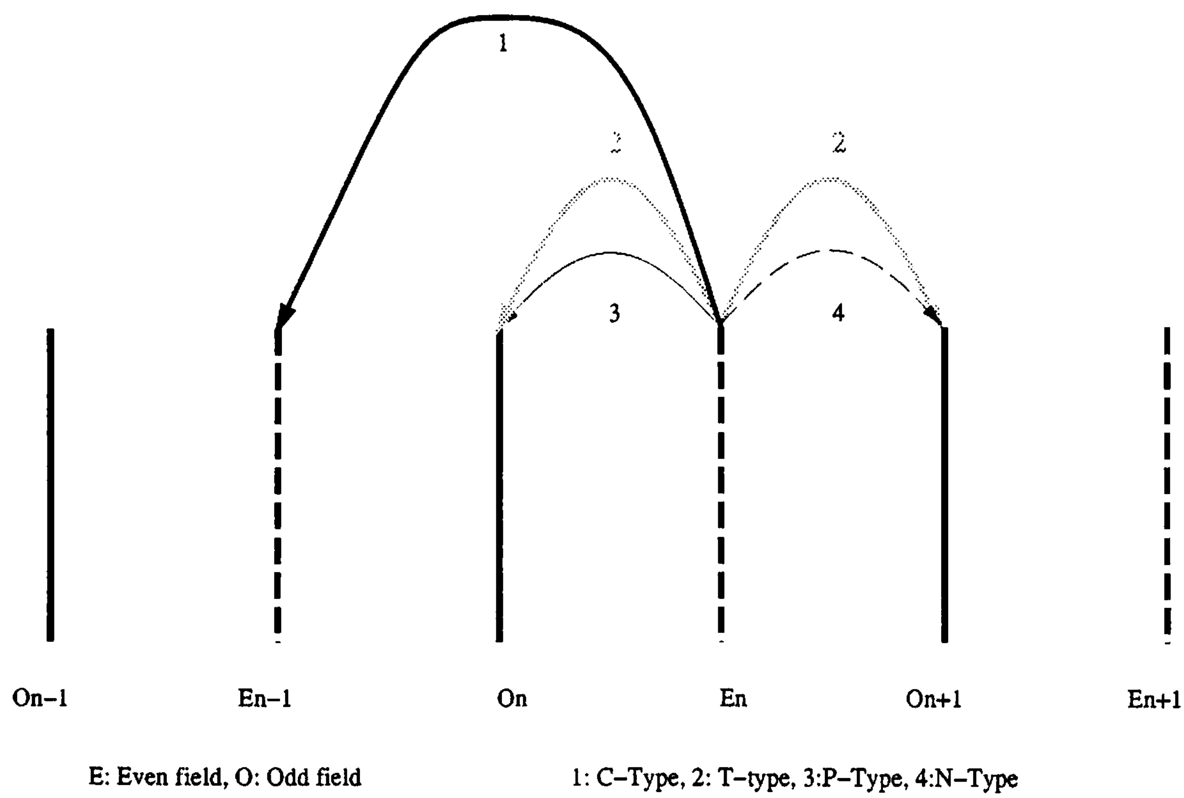

Figure 4: Even field Interpolation

2 ESTIMATION OF FIELD MEMORIES NUMBER

We only consider ($M \leq 3$) sequences case. A general diagram of fields in natural display order and corresponding coded order is given in figure 6.
It must be noted that odd fields have to be decoded before decoding even fields.
Figure 7 shows that **five field memories** are required for correct real time decoding.
Note that:

- Odd field = 396 macroblocks (1 MB = 6 blocks of 16x8 pixels, 1 pixel = 8 bits).
- Even field = 792 macroblocks (1 MB = 6 blocks of 8x8 pixels).

It is important to note that there is no storage of SIF MPEG-I decoded image.

FIELD MEMORY NUMBER	5
MINIMUM MEMORY SIZE	1.52 Mbytes

3 GENERAL MEMORY ACCESS AND BUS LOAD

Let us consider a single memory and bus system as represented in figure 8.
According to algorithm, memory has to be accessed for:

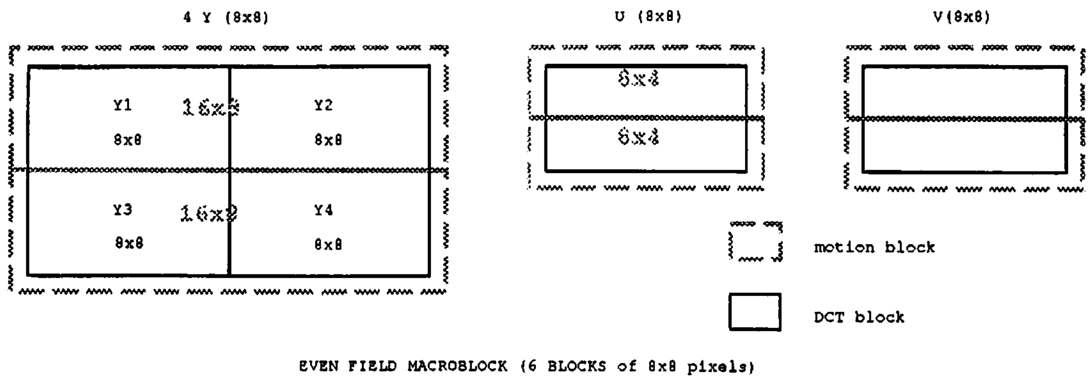

Figure 5: Even field DCT macroblock and motion macroblock

- fields interpolation,
- bitstreams buffering,
- decoded fields storage,
- decoded field display.

For these accesses, we must consider the worst case. All figures must be taken as a global estimation which doesn't take into account the way memory is really accessed.

3.1 INTERPOLATION (Read memory access)

3.1.1 Odd field

Interpolation is done on 16x8 Y blocks or 8x4 C blocks.
To reconstruct one past or future 16x8 Y block (8x4 C blocks) with half-pixel motion, 17x9 Y pixels (9x5 C pixels) must be read for each "motion block"(worst case).
Table 1 gives memory read number in pixels for odd field.

Field Type	Y read/ MB	C read/MB	total read/field
B type	1 224	720	769 824
P type	612	360	384 912

Table 1: Odd field Interpolation

3.1.2 Even field

Interpolation is also done on 16x8 Y blocks or 8x4 C blocks.
Table 2 gives memory read actions in pixels for even field.

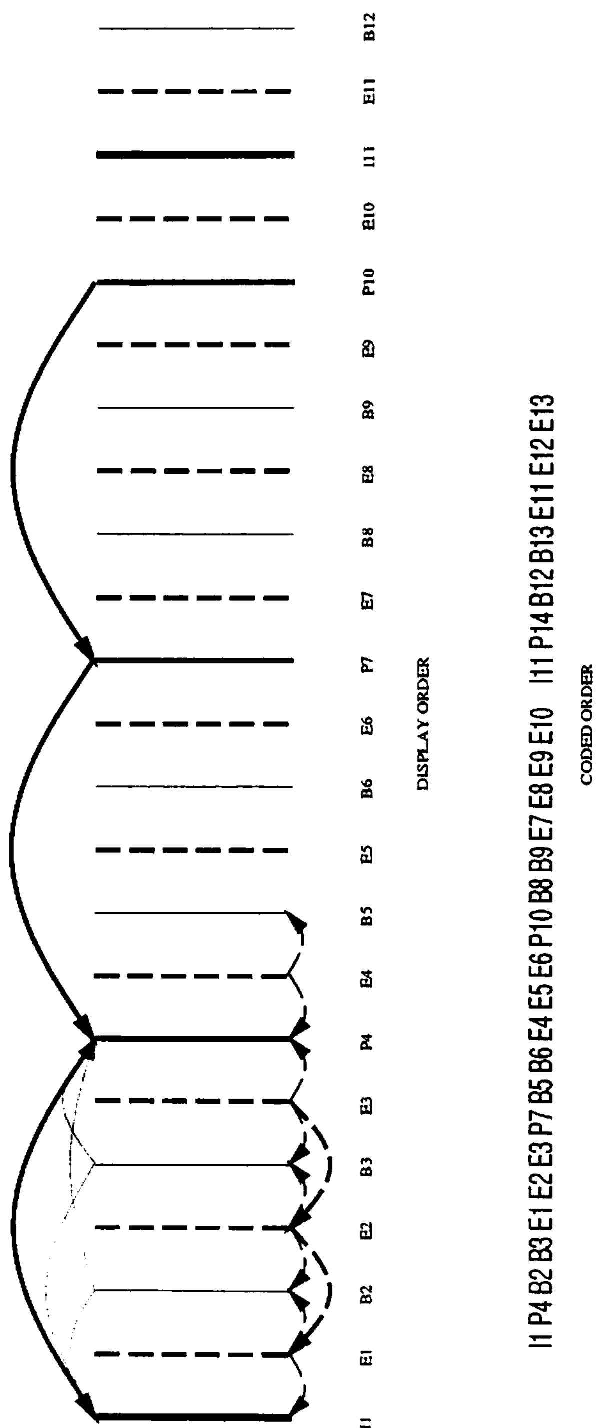

Figure 6: Coded and display field order

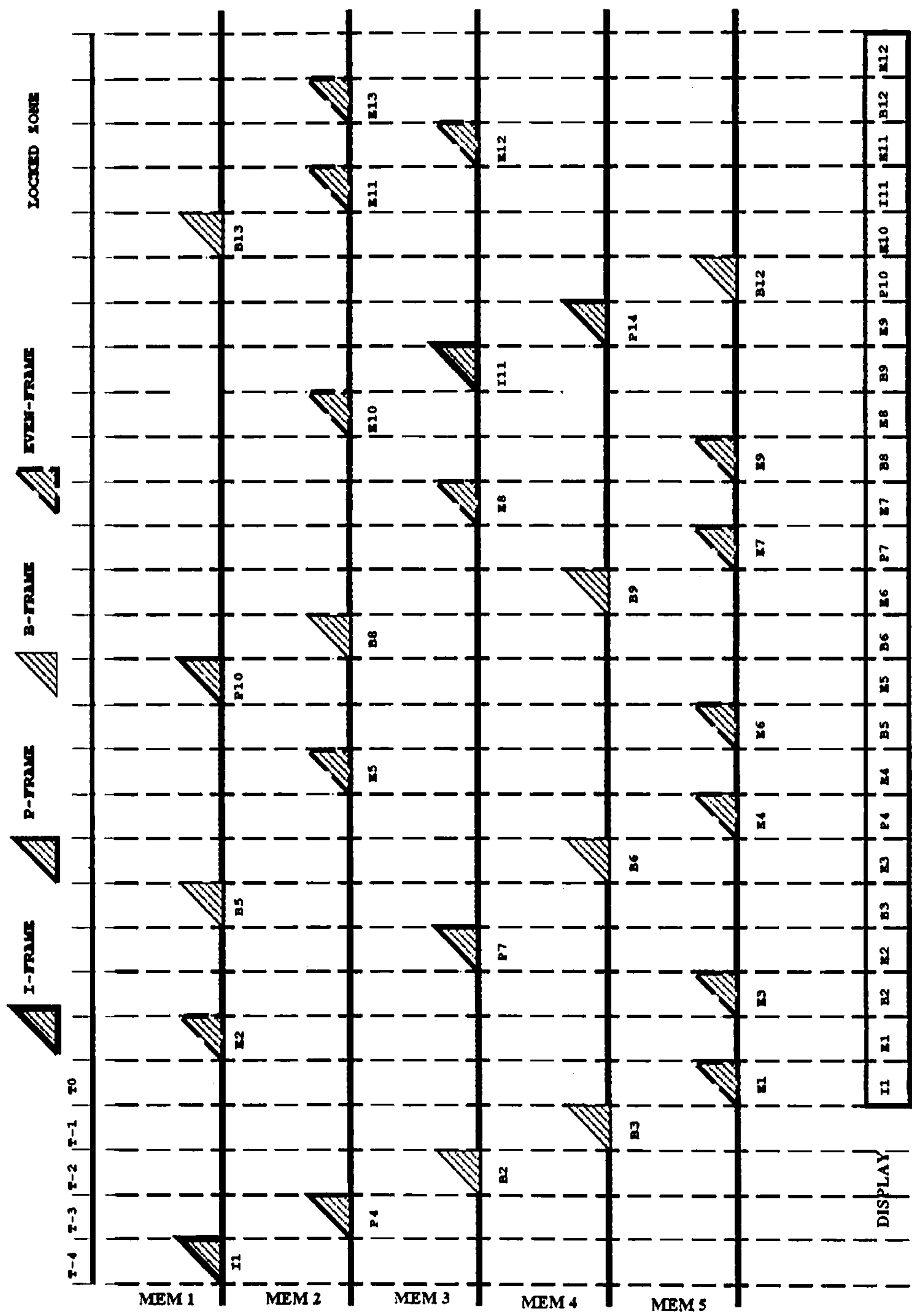

Figure 7: Field memory allocation

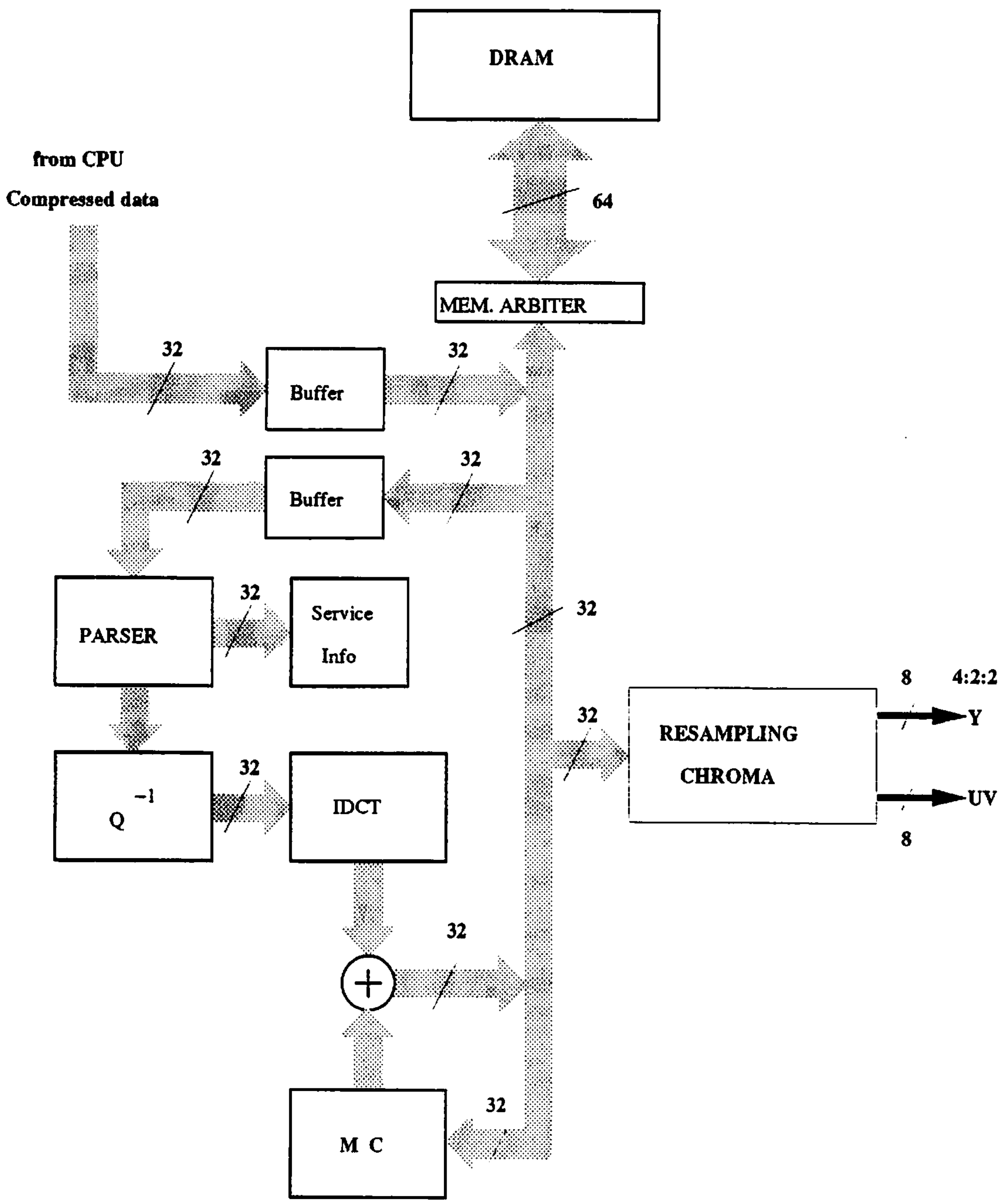

Figure 8: Memory, Bus and Modules organization

Field Type	Y read/ MB	C read/MB	total read/field
T type	612	360	769 824
P/N/C type	306	180	384 912

Table 2: Even field Interpolation

3.2 DECODED FIELD STORAGE (Write memory access)

Table 3 gives memory write number in pixels for odd/even fields.

Field Type	Y write/ MB	C write/MB	total write/field
Odd I/B/P type	512	256	304 128
Even T/P/N/C type	256	128	304 128

Table 3: Decoded field storage

3.3 FIELD DISPLAY (Read memory access)

Odd/Even field represents (704x288 Y , 352x144 U, 352x144 V). At least, 304 128 pixels/field have to read back from memory to display decoded field.

3.4 READ/WRITE REGULATION BUFFERS

The target bit rate is 10 Mbits/s. That represents 1.25 Mpels/s (read) and 1.25 Mpels/s (write). That is to say that 50 Kpels/s are exchanged on bus to read or write bitstreams data (FIFOs access).

3.5 CONCLUSION

Table 4 give the global R/W memory access figures.

Field Type	total read/field	total write/field	total/field	Frequency
I type	329 128	329 128	658 256	33 Mpels/s
T/B type	1 098 952	329 128	1 428 080	71.4 Mpels/s
P/N/C type	714 040	329 128	1 043 168	52.2 Mpels/s

Table 4: Average memory accesses

According to DRAM and VLSI technology (0.8 μm), we assume the following system configuration: DRAM is accessed at 20MHz, and chip is clocked at 40 MHz.
Moreover, bus load and page mode access considerations allow us to conclude that DRAM width must be 64 bits.

This leads to the following memory organization.

4 MEMORY ORGANIZATION

Requirements:

- 5 field memories,
- 2 FIFOs (one per bitstream),
- words of 64 bits.

A good memory organization is given on figure 9. The memory size is 16 Mbits (2 Mbytes). One field memory represents 297 Kbytes (198 Kbytes for Y and 99 for (U,V)). FIFOs' sizes are respectively (FIFO1=160 Kbytes) and (FIFO2=243 Kbytes). That quite fulfills algorithm buffer regulation requirements.
Fields are bitmap stored. Note that U and V pixels can be accessed in parallel in write and read mode. That allows to treat U and V in parallel on chip.

5 MODULES DESCRIPTION

The whole decoding chain is globally pipelined. Compressed data send by CPU are written in current FIFO according to bitstream type. Then, data are read back from FIFOs to be decoded. The PARSER is able to switch decoding between MPEG-I and MPEG-II bitstreams. Bitstream contexts are locally stored in each module when switching from one algorithm to another one. All modules above described are dynamically programmed and configurated to decode the three algorithms (MPEG-I, MPEG-II odd fields, and MPEG-II even fields).
As shown on figure 8, all modules access to DRAM in an asynchronous way. Bus access is centrally controlled by an arbiter module. Arbiter grants memory access to modules with a hierarchical priority. It is important to notice here that arbiter grants access both for data (compressed data or pixels) and for associated microcode.

5.1 HALF PIXEL MOTION FILTER AND INTERPOLATION

Half pixel interpolation is done in a linear way line by line and pixels by pixels. Figure 10 gives the organization of the half-pel motion filter and interpolation module.
For interpolated blocks (B or T-types), past and future blocks, read from DRAM, are interpolated, stored and finally added to idct blocks.
Table 5 gives the number of addition and right shifts (division by 2) per second and table 6 gives the required on chip memory.

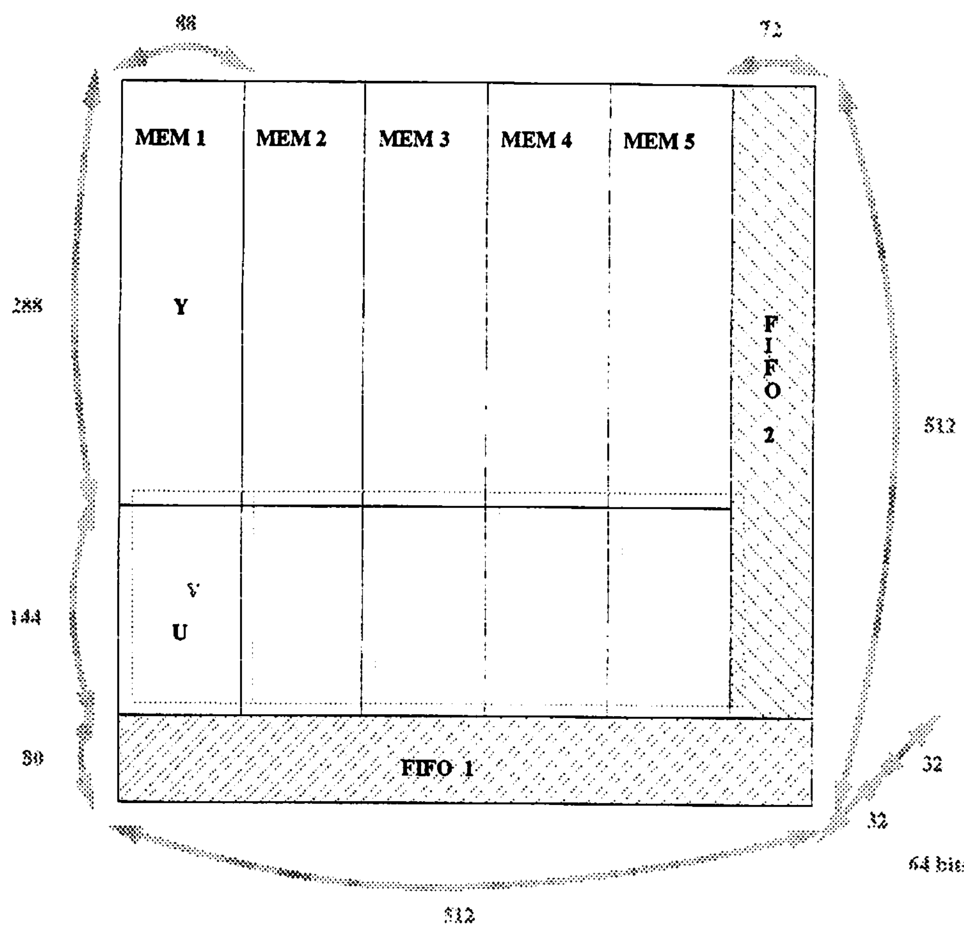

Figure 9: Memory organization

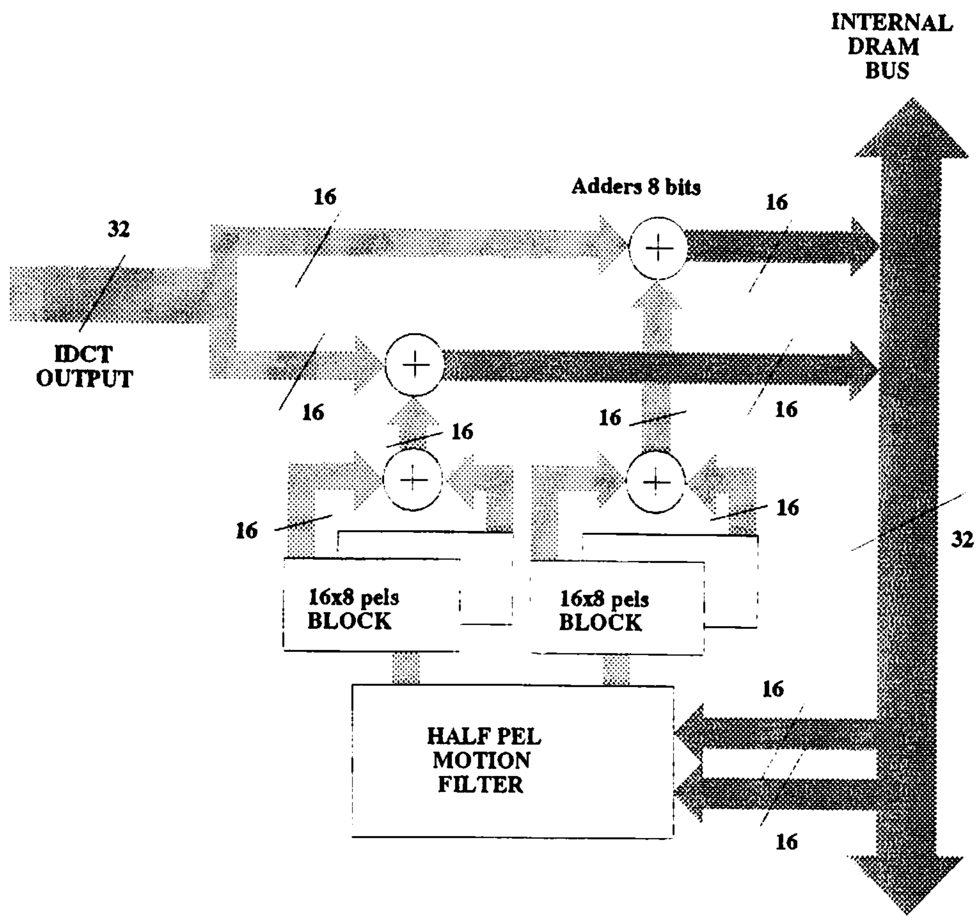

Figure 10: Half-pel motion filter and interpolation module

5.2 INVERSE DISCRETE COSINE TRANSFORM

There are two DCT block sizes: 8x8 DCT blocks for even fields or MPEG-I odd fields, and 16x8 DCT blocks for complement MPEG-II odd fields. When using one single IDCT computing module, it is able to deal with these two block formats. The proposed architecture is given figure 11. IDCT computing is splitted in two parts taking advantage of the permutation principle. First IDCT is a 1D-8-IDCT and second one is either a 1D-8-IDCT or a 1D-16-IDCT depending on the decoded block format. The 1D-8-IDCT with fixed butterfly is used for vertical pass; the 1D-16/8-IDCT with versatile butterfly is used for horizontal pass. The implemented IDCT architecture (for each butterfly) is a bit serial architecture. The average IDCT computation time is less than 8.4μs for a 16x8 block or 4.2μs for a 8x8 block.

Table 7 gives the required number of multiplications and additions per second and an estimation of on chip memory.

Half-pel motion filter		
OPERATION	Y half-pel motion filter	C half-pel motion filter
ADDs	147 Mop/s	136 Mop/s
SHIFTs	142 Mop/s	128 Mop/s
Block Interpolation		
ADDs	213 Mops/s	
SHIFTs	213 Mops/s	
TOTAL		
ADDs	360 Mop/s	
SHIFTs	355 Mop/s	

Table 5: Number of operations per second for half-pel motion filter and interpolation (peek figures)

BLOCK STORAGE	4x16x8 bytes
LINE STORAGE	21 bytes
TOTAL STORAGE	533 bytes

Table 6: On chip storage for half-pel interpolation module

5.3 INVERSE QUANTIZATION

Inverse quantization is done on a block base (figure 12). The same operative part is used for all algorithms. Operations on coefficients are: $coeff[n][m] * quant\_scale * quant\_matrix[n][m]$ (2 multiplications per coefficient, and one access to quantization tables), then correct rounding and thresholding have to be done on dct coefficients before performing the IDCT (this part includes additions and shifts). The number of quantization tables is 2 in RAM plus 1 in ROM per algorithm (algorithm1 is MPEG-I , algorithm2 is odd-MPEG-II, algorithm3 is even-MPEG-II). Tables in ROM are the default intra_quantizer_matrix tables, and tables in RAM are the loadable intra_quantizer_matrix and non_intra_quantizer_matrix. A

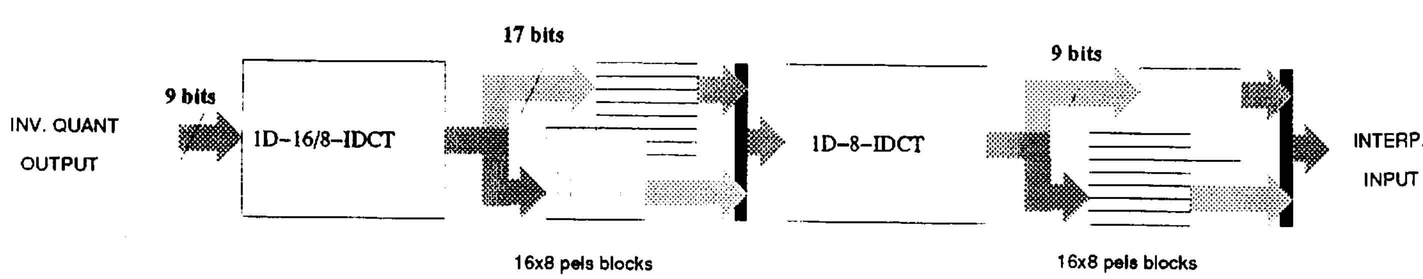

Figure 11: IDCT module

IDCT COMPUTATION LOAD	
x	69 Mop/s
+	166 Mop/s
ON CHIP STORAGE	
TOTAL STORAGE	6.5 Kbits

Table 7: IDCT characteristics

quantization table in RAM are rewritten every new sequence of the corresponding algorithm. Table 8 gives the required on chip RAM and ROM size.

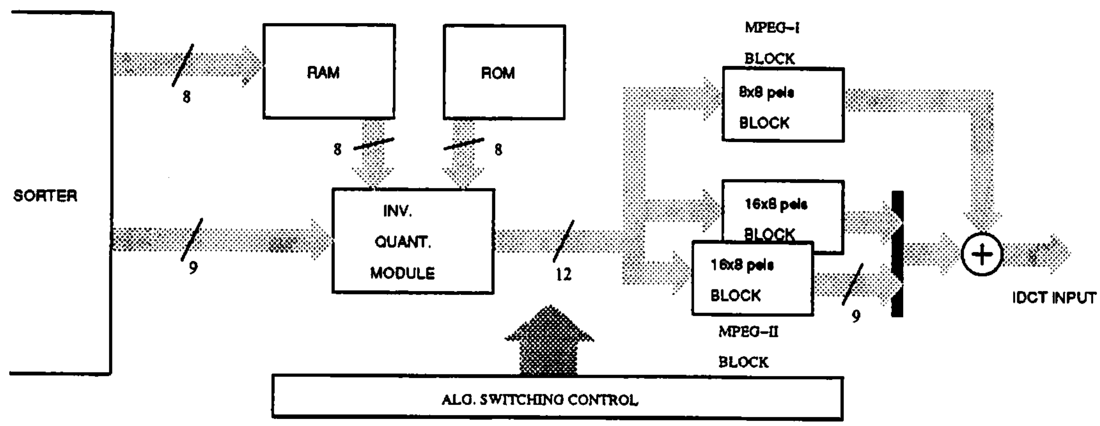

Figure 12: Inverse quantization module

MEMORY	SIZE
RAM TABLES	4 Kbits
ROM TABLES	2 Kbits
DATA	3.75 Kbits

Table 8: Inverse quantization on chip memory

Average number of table lookups is given in table 9.
Table 10 gives the average number of operations per second for each field type.

5.4 DISPLAY MODULE

Decoded fields has to be read back from DRAM to be displayed in a real-time order in respect to field and line frequency. As DRAM is accessed by multi asynchronous processes and assuming that bus can't be hold too longer by display module,

FIELD TYPE	TABLE LOOKUPS
ODD	23 M/s
EVEN / MPEGI-ODD	15 M/s
ODD + EVEN / MPEGI-ODD	19 M/s

Table 9: Inverse quantization number of read table lookups

OPERATION	ODD FIELD	EVEN FIELD	ODD+EVEN
x	46 Mop/s	31 Mop/s	38 Mop/s
+	23 Mop/s	15 Mop/s	19 Mop/s

Table 10: Inverse quantization number of operations per second

decoded (Y,U,V) field data have to be read in bursts. That includes on chip storage of (Y,U,V) lines (partly or wholly depending on the post-processing).
(U,V) have to be interpolated vertically to reach the required 4:2:2 normal TV output format. Without multi-access to same DRAM data, two on chip line memories (one for U and one for V) are required. Asynchronous DRAM access and strict synchronous pixel output require temporal local storage of read data. The figure 13 presents the general architecture of the module.
Table 11 gives the required on chip storage, and the average number of operations per second for chrominance interpolation (we only consider 1-2-1 interpolation).

CHROMA FILTER OPERATION	
+	13.5 Mop/s
shifts	27 Mop/s
ON CHIP MEMORY	
(U,V)	5.5 Kbits + cache size
Y	cache size

Table 11: Display (Resampling Chroma) Module

5.5 DATA SORTER (PARSER)

This block parses data coming from the two different flows (MPEG-I and MPEG-II). The main feature of this architecture is that this unit is fully programmable. The control part is a static RAM downloaded from the main memory (DRAM). Its content is partly updated when the input bitstream is switched from MPEG-I mode to MPEG-II mode and inversely. In addition, firmware means are provided to perform task call and return (stack management). On a system point of view, microcode of data sorter unit is a ressource stored in DRAM and is accessed by

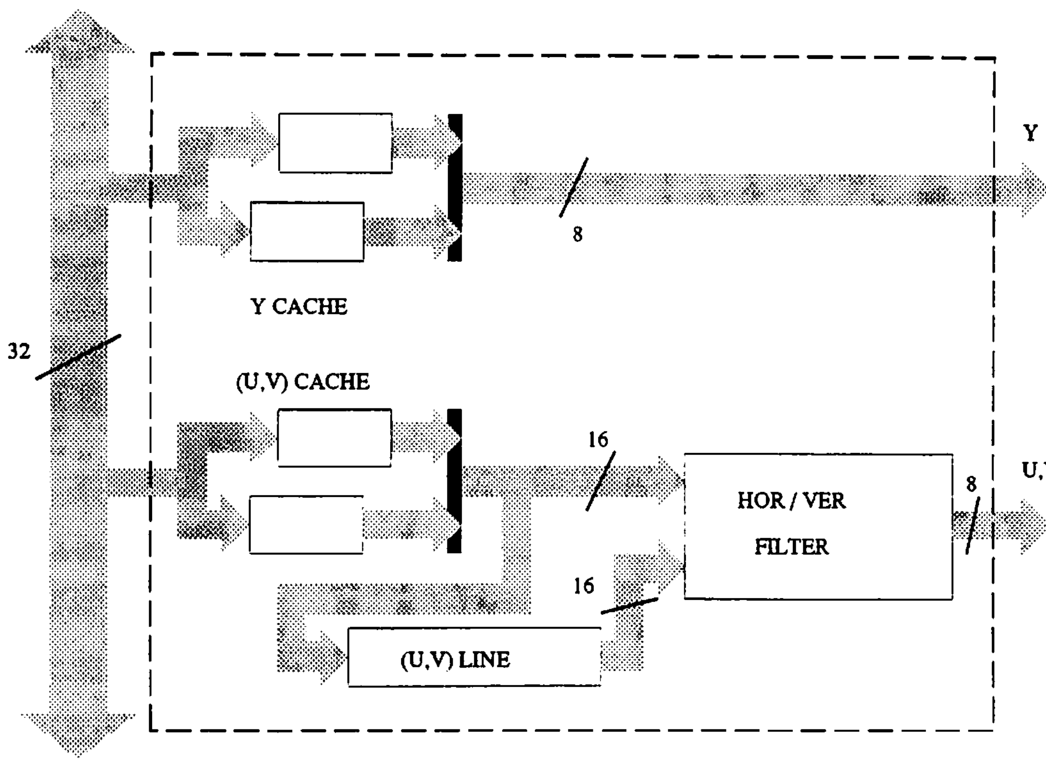

Figure 13: Display module

a on chip control automate after central arbiter has granted its access to DRAM (figure 14).

5.5.1 CORE

This module is made of a 32 bits pipeline of registers, and of a 32 barrel shifter. The command of the barrel shifter is provided by update module. The barrel shifter realizes the windowing function necessary for either variableor fixed length decoding. Start mode detection is realized in this module and consistst of a lookup table in parallel on the 32 bits data flow.

5.5.2 UPDATE

This module is aimed at updating the command of the barrel shifter. It simply consists of a five bits accumulator whose outputs can be forced by the shift value synthesized by the start code decoder in the following situation:

- error code detected,
- skip of stuffing bytes,
- unexpected start code.

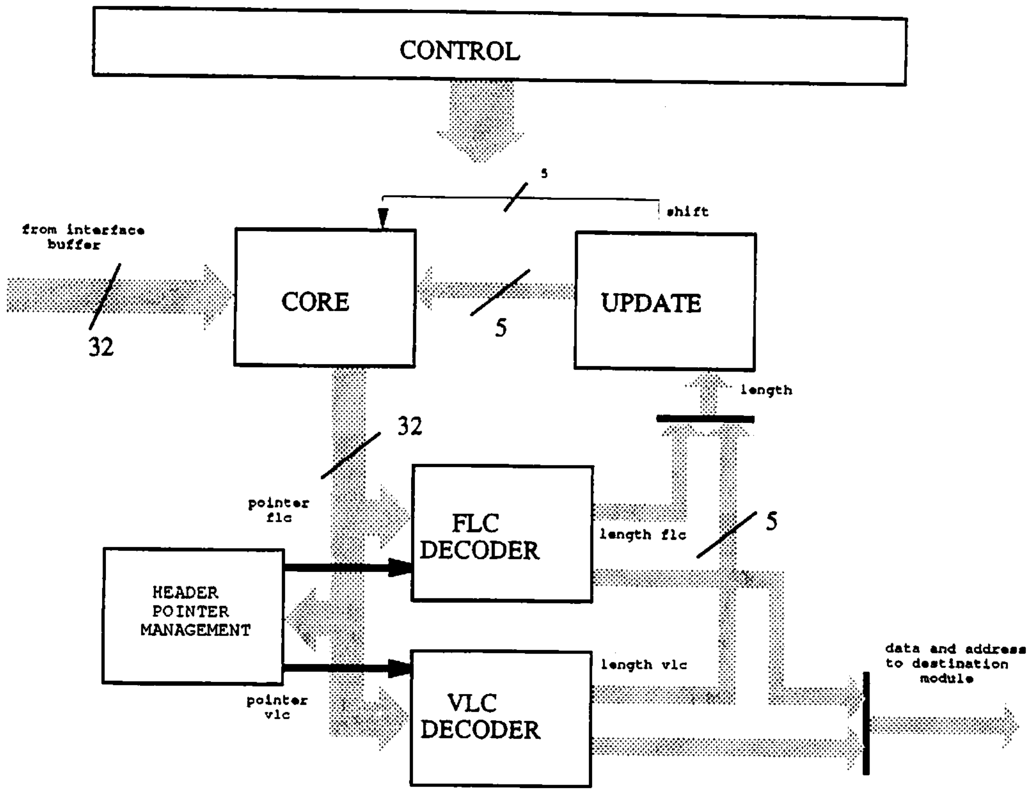

Figure 14: Parser Module

5.5.3 HEADER POINTER MANAGEMENT

This module is programmed to follow MPEG hierarchical syntax with possible jumps conditioned by the test bits field outputted by the barrel shifter. It synthesizes for *VLC and FLC decoder modules* the next value on their respective pointer on MPEG bitstream. Basically, the increment is 1 and it can be up to 8.

5.5.4 FLC DECODER

This module decodes fixed length data from video sequence to macroblock layer (excluded). It mainly consists of lookup tables that output the on chip address of the module to which the incoming data is destined, and the length of the decoded word to *update module*.

5.5.5 VLC DECODER

It mainly consists of lookup tables associated to each bitstream:

- data (AC and DC),
- motion vectors,
- macroblock type,

- macroblock address increment.

As for *flc module*, *vlc decoder* provides the length of the variable length decoded data to *update module* and the on chip address destination of the vlc word.

6 CONCLUSION

Table 12 summarizes the main characteristics of the presented one chip decoder.

DECODER OVERVIEW	
EXTERNAL MEMORY SIZE	2 Mbytes (see *remark1*)
MEMORY TYPE	DRAM , 20 MHz
MEMORY BUS WIDTH	64 bits
CHIP SIZE	150 mm^2 (technology 0.8 μm)
CHIP FREQUENCY	40 MHz
INTERNAL BUS WIDTH	32 bits
AVERAGE BUS LOAD	75%
ON CHIP MEMORY	30 Kbits
COMPUTATION POWER	1.17 Gop/s (see *remark2*)

Table 12: Decoder characteristics (overview)

Remark1: *The proposed algorithm can be constrained to parameters providing low decoding delays, e.g. for conversional services. In such cases, M is forced to 1. Then, only 3 fields memory are required, and smaller FIFOs can be used. Then, external memory size is estimated to 1 Mbytes for such applications.*
Remark2: *This figure includes addresses and sorter module calculation.*

ENCODER IMPLEMENTATION STUDY

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October 31, 1991

1 Introduction

In this section we describe the global architecture of the encoder associated to the proposed algorithm. It has to be noted that contrary to the decoder where the main goal is to achieve a one chip solution, the main property of the encoder is the ability to use off the shell IC's (DCT processor, motion estimator, variable length encoder) for the design of the encoder.
We will give the overall encoder architecture without implementation details concerning each module, assuming that the function can be realized by standard IC with some additional hardware..

2 Partitioning

As described in the algorithm part, the encoding algorithm can be splitted in two parts.: odd field encoder and even field encoder. Motion estimation is performed both on odd fields and on even fields. Moreover, even fields motion estimation (noted ME) computes vectors from both odd and even fields. This property leads to the architecture depicted in figure 1. Decisions and motion vectors relative to odd and even fields are stored in separate RAMs which are in parallel accessed respectively by odd and even field encoders.

Motion compensation will be studied in section 4 and spatial encoding will be studied in section 5.

3 Motion estimation

Motion estimation and compensation are the main bottleneck of the encoder regarding to memory bandwidth and computation load. We first describe the temporal sequencing of motion estimation. Then an estimation of the required memory bandwith is given. A memory organization is deduced from the resulting figures. From the estimated computation load of motion estimation, an architecture is given for the motion estimation part of the encoder.

3.1 Encoding sequencing

Figure 2 gives the temporal sequencing of motion estimation . In the upper part, the content of field stores (odd and even) used for motion estimation is represented along the time. 5 field stores are required to store odd fields and 6 for even fields. Moreover, the different operations performed (motion compensated read, read for spatial encoding, read for motion estimation and write from input source) are represented for each field store in a time slot of 20 ms. In the lower part of the figure, the different operations performed on each stored field is represented.

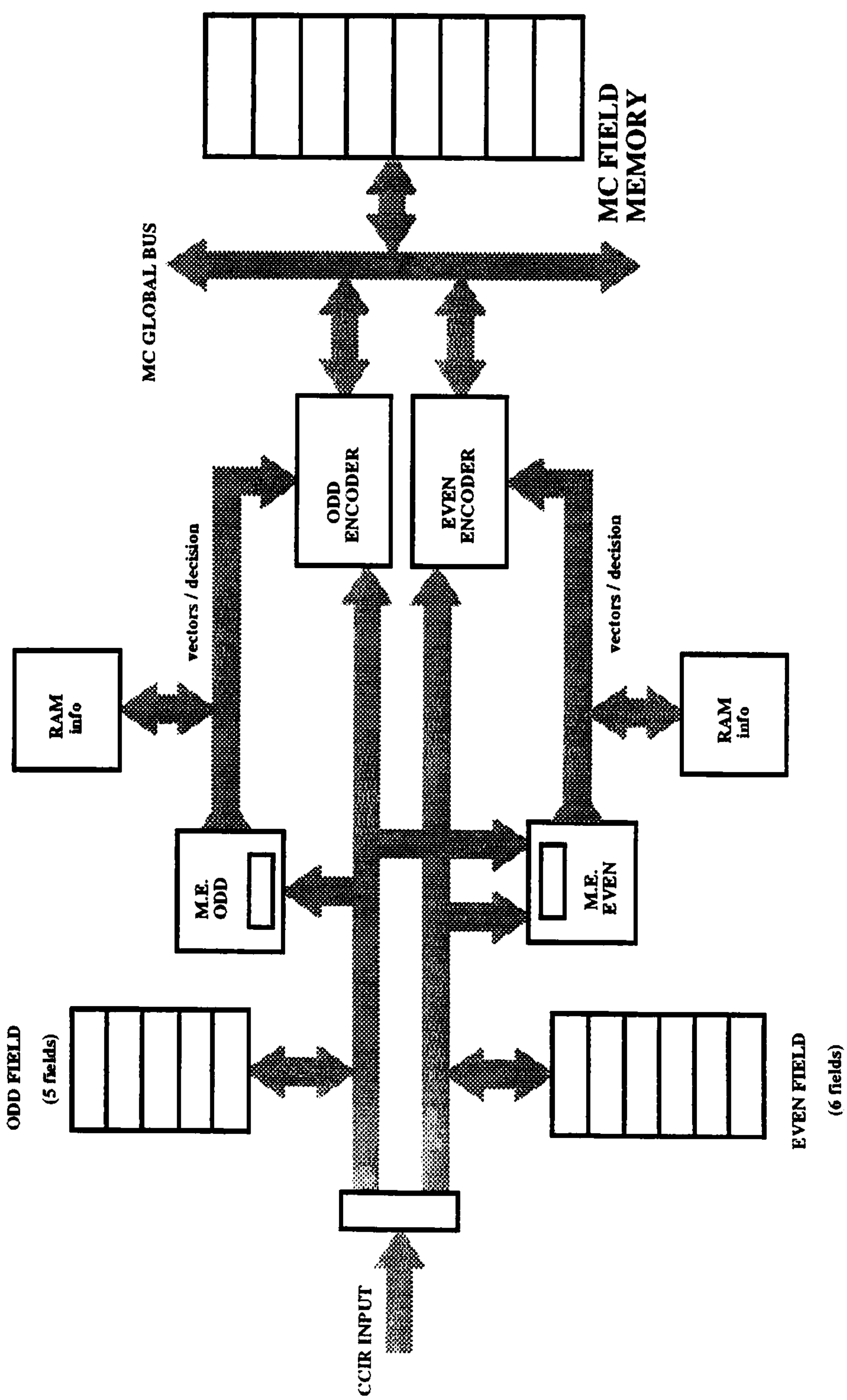

Figure 1: Encoder architecture

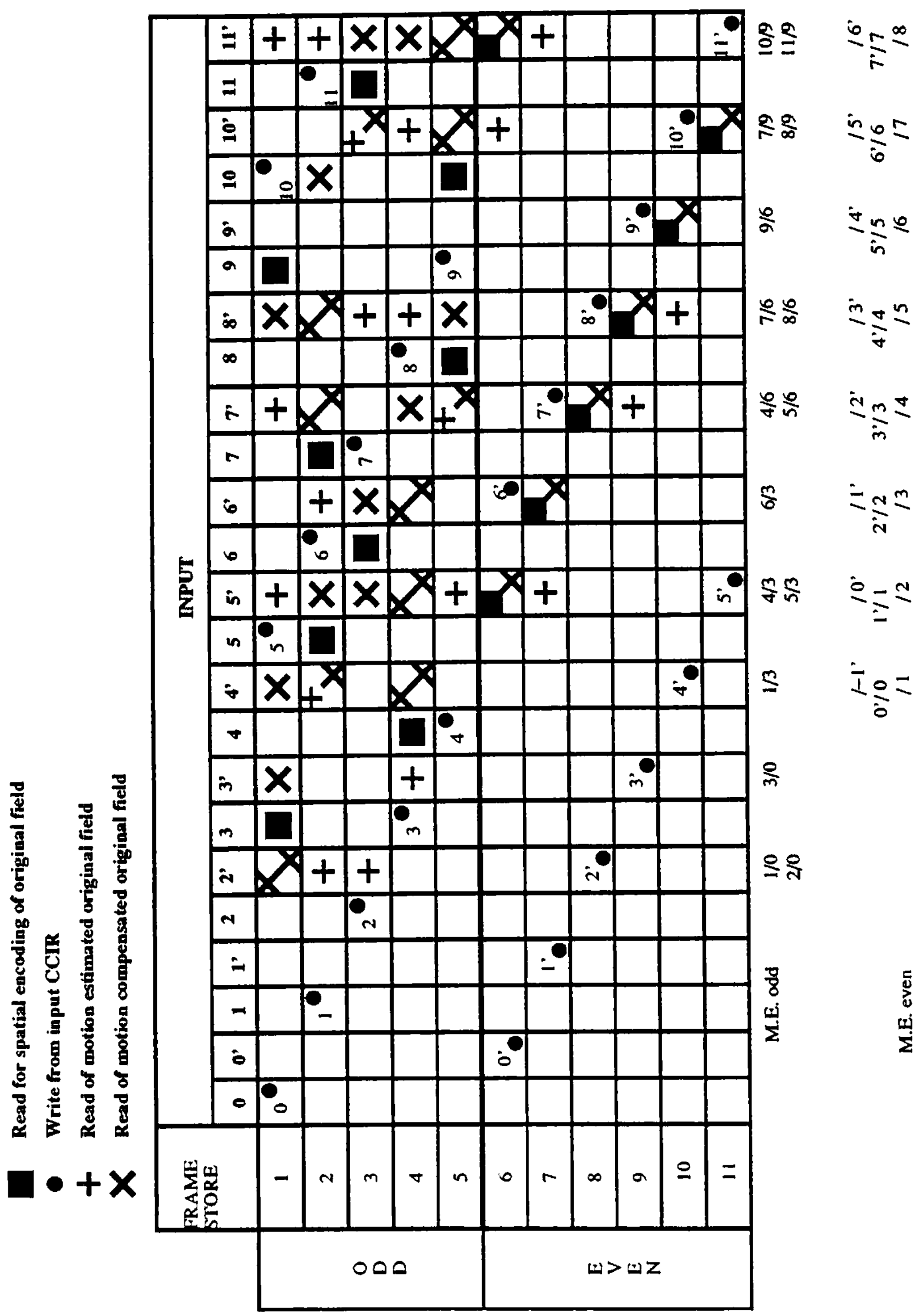

Figure 2: Motion Estimation sequencing

3.2 Memory bandwidth

To reduce the number of memory accesses in the full search algorithm, we will assume that the memory fields accessed for motion estimation are read in a raster scan macroblock order.This implies that a cache memory, whose size is 720 by 48 pels is present in the motion estimator. From figure 2, one can see that at maximum 3 different odd field stores and 1 even field store are simultaneously read by the full search algorithm. This implies 3 separated caches for MEodd and 1 cache for MEeven.
Read and write actions will be counted as the same basic action, since it is transparent to the memory.
The worst case corresponds to the reading of 10 fields in a period of 20 ms. The total number of accessed bytes per second is therefore :

$$50 \times 10 \times (720 \times 288) = 103.7 \text{ Mbytes per second.}$$

The calculation can be splitted for even and field stores :

- Maximum odd memory bandwidth = 50 x 6 x (720 x 288) = 62.2 Mbytes per second
- Maximum odd memory bandwidth = 50 x 4 x (720 x 288) = 41.5 Mbytes per second

3.3 Memory organization

If we take into account the overhead in the communication with the memory due to DRAM address generation and due to the fact that we access it in bursts, and if we consider the maximum achievable speed of commercial DRAMs in page mode, a single memory bank organization would lead to a 128 bits DRAM organization clocked at 20 MHz. To balance processing power of motion estimation and memory bandwidth between odd and even fields, we chose the architecture depicted in figure 1, with two memory banks organized in 64 bits.
Odd bank contains 5 fields , ie 5 x 720 x 288 = 0.98 Mbytes
Even field contains 6 fields, i.e. 6 x 720 x 288 = 1.18 Mbytes
Since memory must be organized in 64 bits, the cheapest implementation consists in organizing each bank in 16 x(256Kx4).
The table summarizes the main figures concerning motion estimation :

Memory bandwith	Memory bandwidth (Mbytes/s)		Memory	
	required	maximum	size (Mbytes)	package(1Mbit)
Odd bank	62..2	160	2	16
Even bank	41.5	160	2	16
Total	103.7	320	4	32

3.4 Computation load

We give in this part the detailed count of the different operations performed by motion estimator during the motion estimation phase. For each field type (P, B, R, N), we give the corresponding peak rate operation per second. The matching criterion used for motion estimation is the sum of the absolute values of differences.

G op/s	P	B	R	N
abs(diff)	186	104	5	15
sum	187	105	5.5	16.5
shift	0.1	0.2	0.2	0.3
compare	0.9	0.5	0.1	0.3
total	374	209	10.8	32.1

3.5 Architecture

The maximum number of operations per second to achieve is 374 Goperations per second. This implies to build a motion estimator with a a high level of parallelism. As 3 fields are at most estimated in the same period of 20 ms, the motion estimator will have at least to be made of 3 motion estimators working in parallel.

4 Motion compensation

In the encoder, motion compensation of odd fields is performed on odd fields and motion compensation of even fields is performed on odd and even fields. Figure 3 depicts the architecture of the odd and even encoder parts after the motion estimation phase.

4.1 Encoding sequencing

The encoding algorithm requires to store :

- for odd fields encoding : 2 SIF pictures + 4 field stores,
- for even fields encoding : 2 field stores.

Figure 4 depicts the sequencing of motion compensation during encoding phase.

4.2 Memory bandwidth

In motion compensation, a block is read once from past or future field, so there is no need here for a cache memory. The maximum number of fields to be accessed. The total bandwidth of accesses to memory is :

$$50 \times 4 \times 720 \times 288 = 41.5 \text{ Mbytes per second}$$

4.3 Memory organization

From the architecture evaluation of the motion estimation, we deduce that a 64 bit memory organization is able to support the worst case. The total amount of required memory is :

$$2 \times (360 \times 288) + 6 \times (720 \times 288) = 1.38 \text{ Mbytes}$$

We will use 2 Mbytes of memory organized in 16 x (256Kx4).

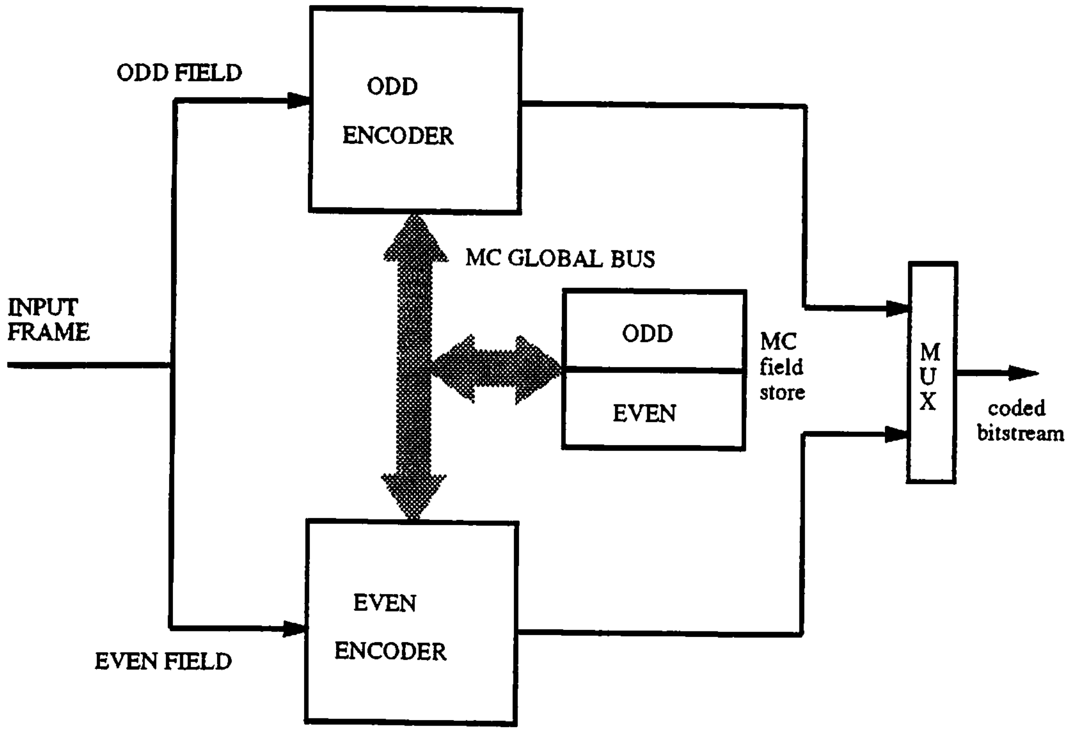

Figure 3: Even and Odd Encoder Architecture

4.4 Computation load

The computation load consists on one hand in an address generation for the field memory which is linked to the chosen memory organization and the other hand on the decision taking and on the half pixel filtering . We give here the computation load for the decision taking and for the computation of the filter. Once again, we give the peak rate operation per second for each field type.

4.4.1 Decision taking

Mop/s	P	B	R	N
abs(diff)	20	91	61	71
sum	30	121	76	86
shift	0.02	1.9	1.9	1.9
compare	0.02	5.8	3	3
mult	0	1.9	0.95	0.95
total	50.02	221.6	142.8	162.8

	Frame store	0	0'	1	1'	2	2'	3	3'	4	4'	5	5'	6	6'	7	7'	8	8'	9	9'	10	10'	11	11'
		ENCODED FIELDS																							
ODD	12							● 0		R		R	R	R		● 6		R		R		R	R	R	R
ODD	13									● 3		R		R		R	R	R	R	R		● 9		R	
ODD	14											● 1	R		R			● 4	R		R			● 7	R
EVEN	15													● 2	R		R			● 5	R		R		
EVEN	16												● 0'		R		● 2'		R		● 4'		R		● 6'
EVEN	17														● 1'		R		● 3'		R		● 5'		R

● Write encoded field

R Motion compensated read of encoded field

Figure 4: Motion compensation sequencing

4.4.2 Filtering

Mop/s	P	B	R	N
add	68	147	101	147
shift	23	55.7	40	55.7
total	91	202.7	141	202.7

4.5 Architecture

Decision taking takes at maximum 221 Moperations per second for B fields . As it is based on a different set of operation the best way to implement it is to use one DSP in each encoder for that task. Concerning the filtering, as it is a repetitive task a dedicated circuit can realize this function.

5 Spatial encoding

Spatial encoding includes all the processing which that do not concern motion estimation or compensation. Figures 5 and 6 describe the architecture of both odd encoder and even encoder.
It consists in the following operations :

- DCT (Forward and Inverse)
- Quantization (Forward and Inverse)
- Variable length coding
- Bit stream formatting
- Miscellaneous (rate control, time code generation, ...)

5.1 Hardware mapping

All those functions can be realized by standard or dedicated ICs . We give above a flexible mapping of different functions on target ICs, which to our mind fit the best with a criterion of flexibility of an encoder.

- DCT: DCT (forward and inverse) is realized with a dedicated DCT processor.
- VLC: Variable length encoder is also realized with a dedicated variable length encoder at MPEG format.
- Quantization:Quantization (forward and inverse) is realized with general purpose DSPs.
- Filtering:This function is mapped on a dedicated fast circuit (gate array)
- Formatting: Bit stream formatting is realized with a 32 bit RISC processor (having a barrelshifter).
- Control: Central control is performed by a powerful microprocessor able to handle multi processes.

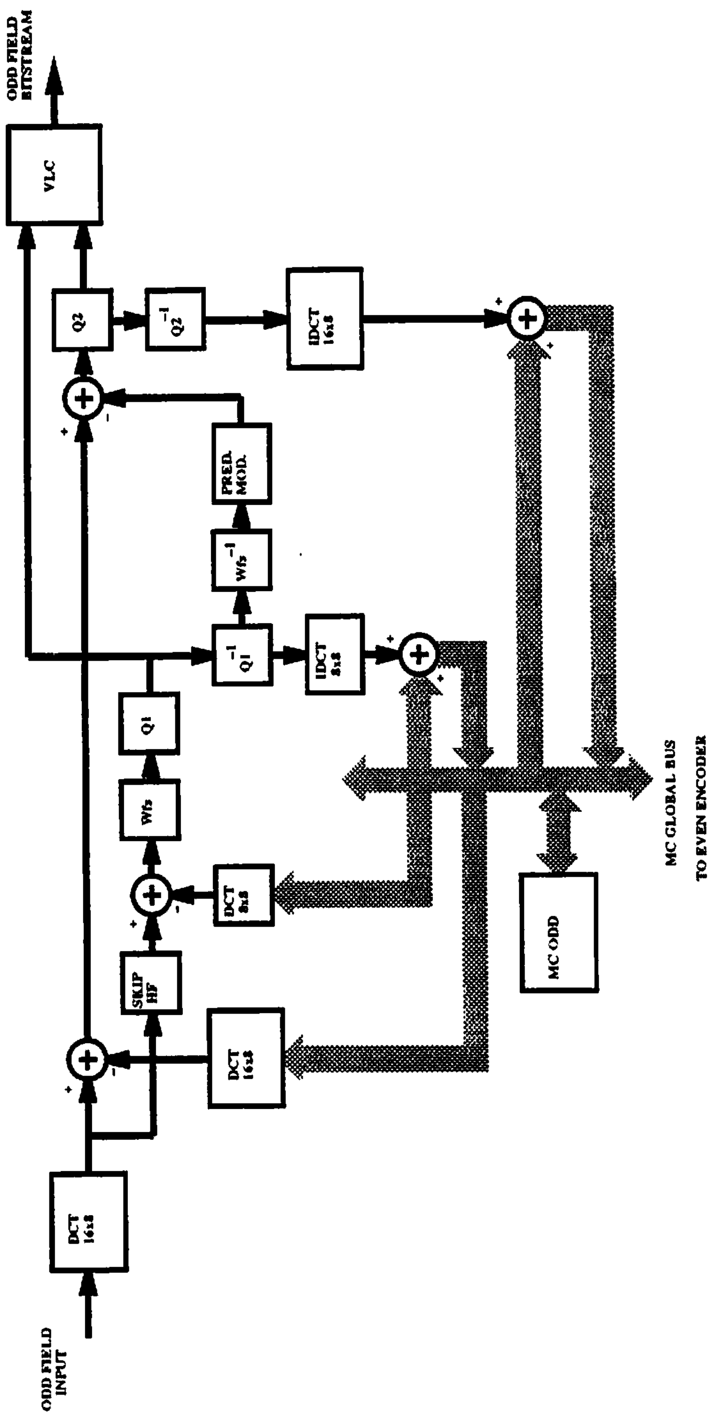

Figure 5: Odd encoder architecture

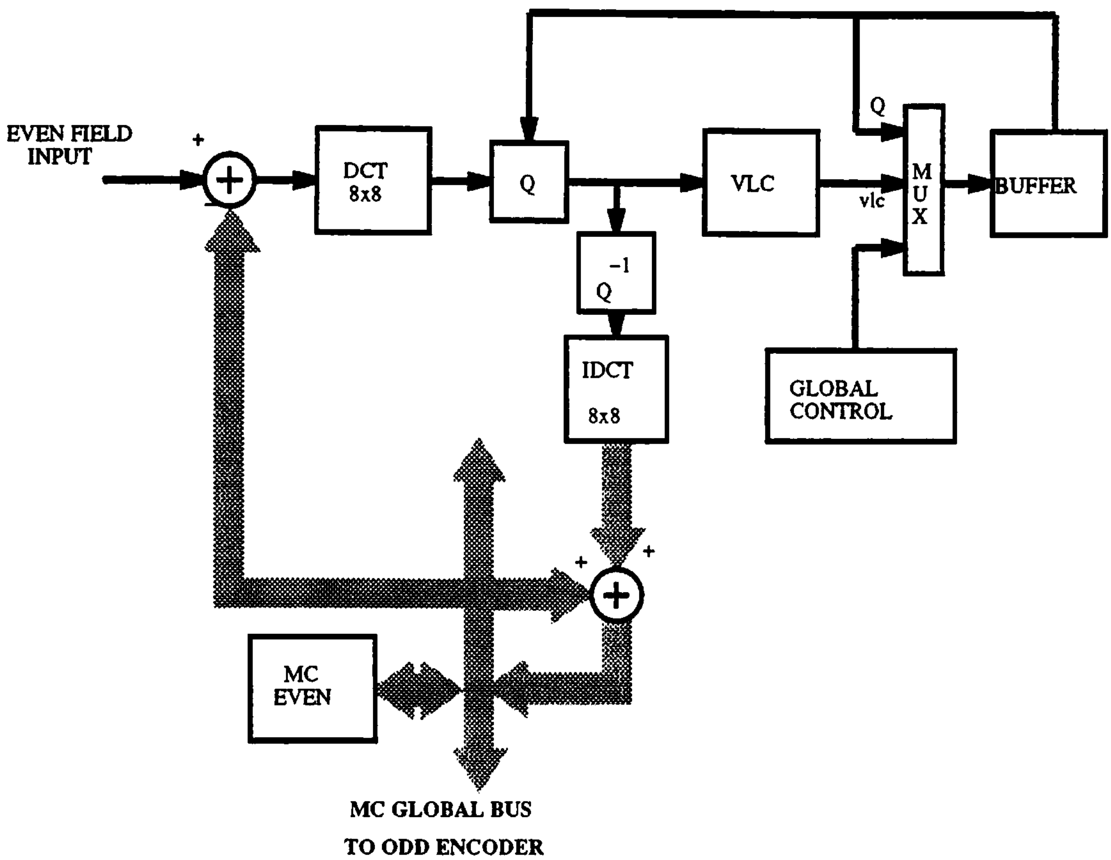

Figure 6: Even encoder architecture

5.2 Cost estimation

Figures 7 and 8 give a mapping of all the function to be realized by the spatial encoder. The table summarizes the different circuits used in the encoder.

Encoder	DCT processor	DSP	VLC processor	RISC	Microprocessor for control
even	2	1	1	1	1
odd	5	2	1	1	1
Total	7	3	2	2	2

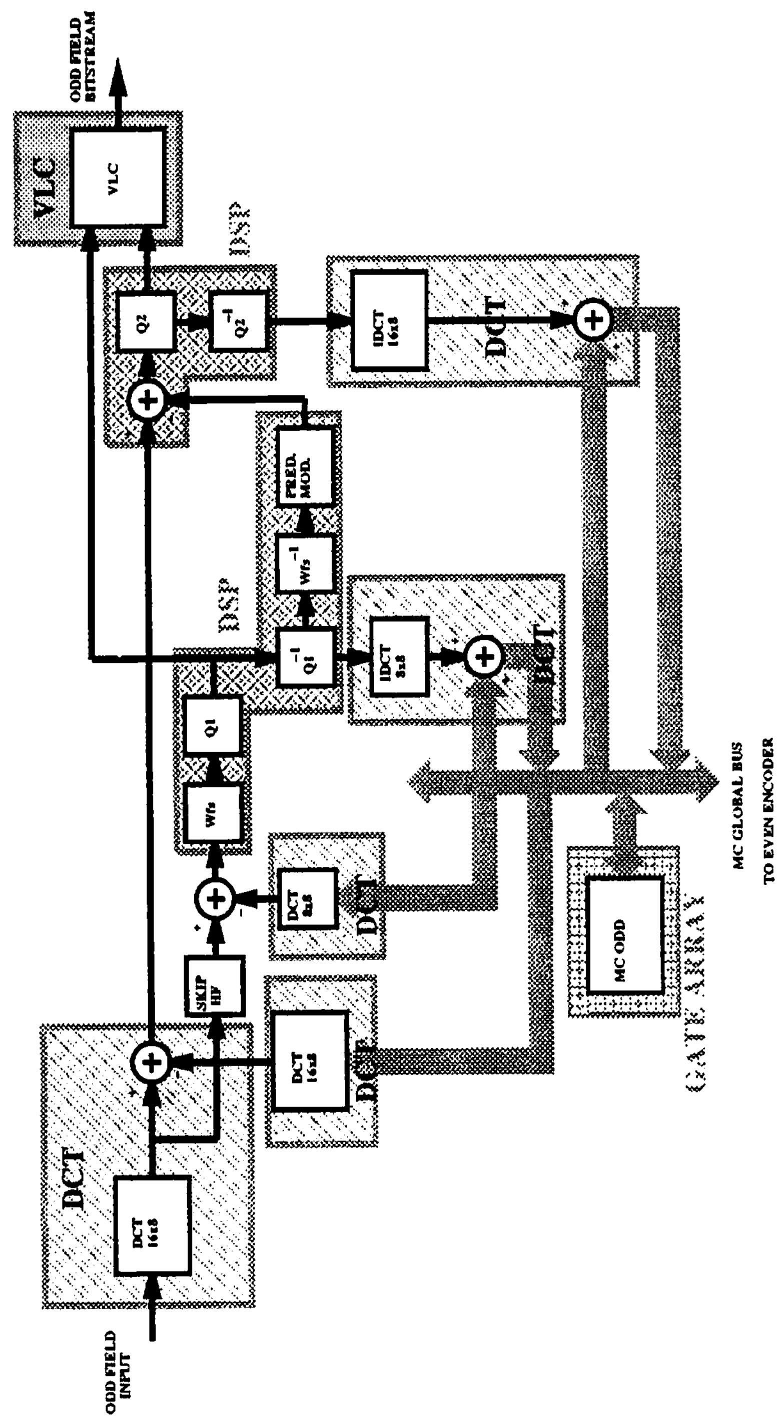

Figure 7: Mapping of an odd field encoder

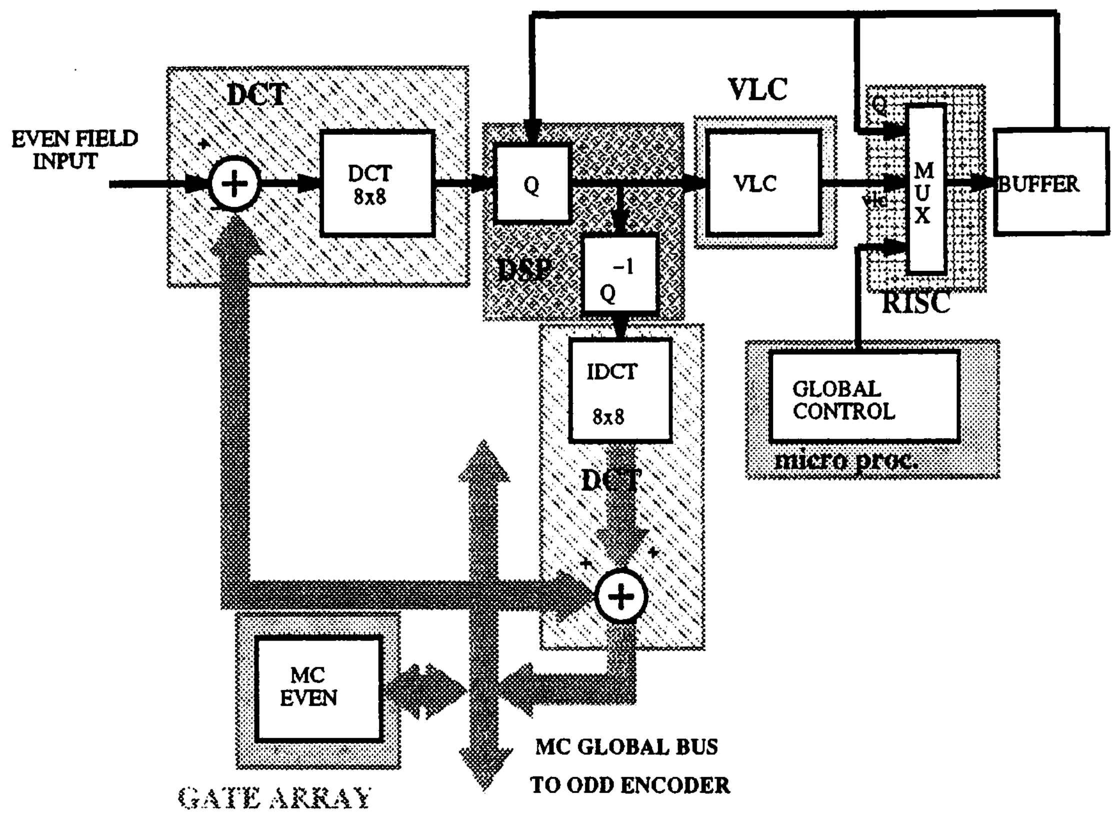

Figure 8: Mapping of an even field encoder

6 Encoder cost estimation

We sum up here the different hardware resources required to build a real time encoder that executes the proposed algorithm :

- Memory : 6 Mbytes of DRAM
- Motion estimation :
  - 1 motion estimator (with 1 cache of 720 x 48)
  - 2 odd motion estimators (with 3 caches of 720 x 48)
- Motion compensation : 2 gate arrays
- Decision taking : 2 DSPs (one for each field encoder)

- Spatial encoding :
  - 7 DCT processors
  - 3 DSPs
  - 2 VLC processors
  - 2 RISC microprocessors (with barrelshifter)
  - 2 general purpose microprocessors

Appendix A

Syntax

The appendix syntax describes the entier syntax of the MUCPOS video scheme. For the MPEG2 compatible Scheme, the Video Sequence Layer, the Sequence Header, and GOP Layer are the same as in the MPEG1 scheme.

One should note that:
— channel 1 is the MPEG1 compatible channel.
— channel 2 is the MPEG2 extension channel.
— "next_bits1 ()" is the MPEG1 function "next_bits ()" applied on channel 1.
— "next_bits2 ()" is the MPEG1 function "next_bits ()" applied on channel 2.

```
----------------------------------------------------------------------------
                         MPEG2 Picture Layer
                                                            bits  channel
picture ()
    picture_start_code                                       32      1
    termporal_reference                                      10      1
    picture_coding_type                                      3       1
    buffer_fullness                                          16      1
    if (picture_coding_type == 2 || picture_coding_type == 3) {
        full_pel_forward_vector                              1       1
        forward_f                                            3       1
        forward_f_mp2_x                                      3       2
        forward_f_mp2_y                                      3       2
    }
    if (picture_coding_type == 3) {
        full_pel_backward_vector                             1       1
        backward_f                                           3       1
        backward_f_mp2_x                                     3       2
        backward_f_mp2_y                                     3       2
    }
    if (picture_coding_type == 2) {
        do {
            even_field()
        } while (next_bits2 () != end_of_extension_code)
        end_of_extension_code                                32      2
    }
    while (nextbits() == '1') {
        extra_bit_picture                                    1       1
        extra_information_picture                            8       1
    }
    extra_bit_picture                                        1       1
    next_start_code()
    if (nextbits() == extension_start_code) {
        extension_start_code                                 32      1
        while (nextbits() != '0000 0000 0000 0000 0000 0001') {
            picture_extension_data                           8       1
```

```
        }
        next_start_code()
    }
    if (next_bits() == user_start_code) {
        user_data_start_code                                            32      1
        while (nextbits() != '0000 0000 0000 0000 0000 0001') {
            user_data                                                    8      1
        }
        next_start_code()
    }
    do {
        slice ()
    } while (next_bits1 () == slice_start_code)
}
```

MPEG2 Slice Layer

```
                                                                bits  channel
slice ()
    slice_start_code                                             32      1
    quantizer_scale                                              5       1
    quantizer_scale_mp2                                          5       2
    while (nextbits() == '1') {
        extra_bit_slice                                          1       1
        extra_information_slice                                  8       1
    }
    extra_bit_slice                                              1       1
    do {
        macroblock ()
    } while (next_bits1() != '000 0000 0000 0000 0000 0000')
    next_start_code1()
}
```

MPEG2 Macroblock Layer

```
                                                                bits  channel
macroblock () {
    while (next_bits1 () == '0000 0001 111')
        macroblock_stuffing                                      11      1
    while (next_bits1 () == '0000 0001 000') {
        macroblock_escape                                        11      1
    }
    macroblock_adress_increment                                  1-11    1
    macroblock_type                                              1-6     1
    if (macroblock_quant) {
        quantizer_scale                                          5       1
    }
    mb_quant_mp2_flag                                            1       2
    if (mb_quant_mp2_flag) {
        mb_quantizer_scale_mp2                                   5       2
    }
    if (macroblock_motion_forward) {
        motion_horizontal_forward                                1-14    1
```

```
        motion_vertical_forward                                     1-14    1
        for (i = 0; i < 4; i++) {
            motion_horizontal_forward_mp2[i]                        1-14    2
            motion_vertical_forward_mp2[i]                          1-14    2
        }
    }
    if (macroblock_motion_backward) {
        motion_horizontal_backward                                  1-14    1
        motion_vertical_backward                                    1-14    1
        for (i = 0; i < 4; i++) {
            motion_horizontal_backward_mp2[i]                       1-14    2
            motion_vertical_backward_mp2[i]                         1-14    2
        }
    }
    if (macroblock_pattern)
        coded_block_pattern                                         3-9     1
    for (i = 0; i < 6; i++) {
        block(i)
        block_extension(i)
    }
    if (picture_coding_type == 4) {
        end_of_macroblock                                           1       1
    }
}
```

MPEG2 Block Layer

block () - identical to the MPEG1 function: block ()

MPEG2 Block Extension Layer

```
                                                                    bits  channel
block_extension(i) {
    if (macroblock_type == 1) {
        non_zero_coeff_refinements_intra                            FLC     2
        while (next_bits2() != end_of_block_ref_intra) {
            zero_coeff_refinements_intra                            VLC     2
        }
        end_of_block_ref_intra                                      3-4     2
    }
    else {
        simulcast_flag                                              1       2
        if (!simulcast) {
            while (next_bits2() != end_of_block_nosimulcast) {
                dct_coeff_inter_lf                                  VLC     2
            }
            end_of_block_nosimulcast                                3       2
        }
        else {
            while (next_bits2() != end_of_block_simulcast) {
                dct_coeff_inter_lf                                  VLC     2
```

```
            }
            end_of_block_simulcast                                3       2
        }
    }
    while (next_bits2() != end_of_block_hf) {
        dct_coeff_hf                                              2-28    2
    }
    end_of_block_hf                                               2       2
}
```

NB: - HF and refinement are not sent for SKIPPED macroblocks.
- In Intra mode, there is no DC refinement.
- If simulcast_flag is FALSE, the reconstructed value of the MPEG1 coefficient is used as a prediction for the reconstruction of the MPEG2 coefficient.

Even Field Layer

```
                                                                  bits  channel
even_field () {
    even_field_start_code                                         32      2
    temporal_reference                                            10      2
    even_field_coding_type                                        1       2
    buffer_fullness                                               16      2
    full_pel_forw                                                 1       2
    forw_f_x                                                      3       2
    forw_f_y                                                      3       2
    full_pel_backw                                                1       2
    backw_f_x                                                     3       2
    backw_f_y                                                     3       2
    if (even_field_coding_type != 0) {
        full_pel_copy                                             1       2
        copy_f_x                                                  3       2
        copy_f_y                                                  3       2
    }
    while (nextbits() == '1') {
        extra_bit_picture                                         1       2
        extra_information_picture                                 8       2
    }
 extra_bit_picture                                                1       2
    do {
        even_slice ()
    } while (next_bits2 () == even_slice_start_code)
```

Even Slice Layer

```
even_slice ()
    slice_start_code_even                                         32      2
    quantizer_scale_even                                          5       2
    while (nextbits() == '1') {
        extra_bit_slice                                           1       2
        extra_information_slice                                   8       2
```

```
    }
    extra_bit_slice                                                  1       2
    do {
        macroblock ()
    } while (next_bits1() != '000 0000 0000 0000 0000 0000') {
    next_start_code1()
}
```

MPEG2 EVEN Macroblock Layer

```
                                                                bits   channel
even_macroblock () {
    while (next_bits1 () == '0000 0001 000')
        macroblock_escape                                        11       2
        macroblock_adress_increment                              1-11     2
        macroblock_type                                          1-6      2
        if (macroblock_quant) {
            quantizer_scale                                       5       2
        }
        if (macroblock_motion_forward) {
            motion_horizontal_forward                            1-14     2
            motion_vertical_forward                              1-14     2
            for (i = 0; i < 4; i++) {
                motion_horizontal_forward_mp2[i]                 1-14     2
                motion_vertical_forward_mp2[i]                   1-14     2
            }
        }
        if (macroblock_motion_backward) {
            motion_horizontal_backward                           1-14     2
            motion_vertical_backward                             1-14     2
            for (i = 0; i < 4; i++) {
                motion_horizontal_backward_mp2[i]                1-14     2
                motion_vertical_backward_mp2[i]                  1-14     2
            }
        }
        if (picture_coding_type != 0) {
            if (macroblock_motion_copy) {
                motion_horizontal_copy                           1-14     2
                motion_vertical_copy                             1-14     2
                for (i = 0; i < 4; i++) {
                    motion_horizontal_copy_mp2[i]                1-14     2
                    motion_vertical_copy_mp2[i]                  1-14     2
                }
            }
        }
        if (macroblock_pattern)
            coded_block_pattern                                  3-9      2
        for (i = 0; i < 6; i++) {
            even_block(i)
        }
    }
}
```

MPEG2 EVEN Block Layer

even_block () - very similar to the MPEG1 function: block ()

Appendix B

VLC Tabels

In this appendix the following VLC tables are listed:
— High Frequency VLC table
— Intra Refinment VLC table for k_ref equals 4
— Intra Refinment VLC table for k_ref equals 8
— Even fields coeficients VLC table
— Inter Refinement VLC table
— Inter Refinement VLC table for no low resolution prediction

High Frequency VLC TABLE

CODE	RUN	LEVEL
11	eob	
101s	0	1
0110s	0	2
001011s	0	3
0001011s	0	4
00001110s	0	5
000010000s	0	6
0000010010s	0	7
0000001100s	0	8
00000010000s	0	9
000000010000s	0	10
0000000010100s	0	11
0000000010101s	0	12
00000000001001s	0	13
00000000000110s	0	14
100s	1	1
001101s	1	2
00010100s	1	3
000001111s	1	4
00000011100s	1	5
000000010010s	1	6
0000000001111s	1	7
00000000010000s	1	8
0111s	2	1
0001001s	2	2
000001101s	2	3
00000010010s	2	4
000000000110s	2	5
0101s	3	1
00001111s	3	2
0000001111s	3	3
000000001110s	3	4
0000000000010s	3	5
01001s	4	1
000011000s	4	2
00000001010s	4	3
0000000000110s	4	4
01000s	5	1
000010011s	5	2
000000010001s	5	3
00000000000010s	5	4
00111s	6	1
000001100s	6	2
000000001100s	6	3
001100s	7	1
0000010110s	7	2
000000001101s	7	3
001001s	8	1
0000001101s	8	2
0000000000101s	8	3
001000s	9	1
00000010111s	9	2
000110s	10	1
00000001100s	10	2
0001110s	11	1
000000010111s	11	2
0001111s	12	1
000000010011s	12	2
0001000s	13	1
000000001001s	13	2
00010101s	14	1
0000000001001s	14	2
00001101s	15	1
00000000010001s	15	2
00001011s	16	1
00000000000111s	16	2
000010001s	17	1
000010010s	18	1
000010100s	19	1
000011001s	20	1
000010101s	21	1

000001110s	22	1
000001010s	23	1
0000010111s	24	1
0000010011s	25	1
0000010001s	26	1
00000010101s	27	1
00000001110s	28	1
00000001101s	29	1
00000001111s	30	1
00000010100s	31	1
00000010001s	32	1
00000010110s	33	1
00000011101s	34	1
0000010000s	35	1
00000010011s	36	1
000000010110s	37	1
000000001000s	38	1
000000001011s	39	1
0000000001110s	40	1
0000000001010s	41	1
00000000000011s	42	1
00000000000001s	43	1
000000000000001s	46	1
0000000001011s	47	1
000000001111s	48	1
0000000000111s	49	1
00000000001000s	50	1
001010	escape	

Refinement INTRA VLC TABLE (K_REF = 4)

CODE	RUN	LEVEL
010	eob	
11s	0	1
10s	1	1
011s	2	1
0011s	3	1
0010s	4	1
00011s	5	1
000101s	6	1
000100s	7	1
000010s	8	1
0000011s	9	1
0000010s	10	1
00000011s	11	1
000000101s	12	1
000000100s	13	1
000000011s	14	1
00000000111s	15	1
0000000100s	16	1
00000000011s	17	1
00000000101s	18	1
00000000100s	19	1
00000000110s	20	1
00000000010s	21	1
000000000011s	22	1
000000000010s	23	1
000000000001s	24	1
00000000000001s	26	1
0000000000001s	27	1
000011	escape	

Refinement INTRA VLC TABLE (K_REF = 8)

CODE	RUN	LEVEL
0011	eob	
11s	0	1
101s	0	2
011s	0	3
100s	1	1
0101s	1	2
00101s	1	3
0100s	2	1
000111s	2	2
000100s	2	3
00100s	3	1
0000110s	3	2
00000110s	3	3
000110s	4	1
00000111s	4	2
000000100s	4	3
0000111s	5	1
000001001s	5	2
0000000111s	5	3
0000101s	6	1
0000001101s	6	2
00000000111s	6	3
0000100s	7	1
0000000110s	7	2
000000001001s	7	3
00000101s	8	1
0000001001s	8	2
0000000000100s	8	3
000001000s	9	1
00000000101s	9	2
000000000111s	9	3
000000101s	10	1
000000001000s	10	2
00000000001011s	10	3
0000001100s	11	1
000000000110s	11	2
00000000000100s	11	3
0000000101s	12	1
00000000000010s	12	2
00000001000s	13	1

0000000000011s	13	2
000000000000011s	13	3
00000000110s	14	1
000000000000010s	14	2
000000000100s	15	1
0000000001010s	16	1
0000000001011s	17	1
0000000000111s	18	1
0000000000110s	19	1
00000000001010s	20	1
00000000000101s	21	1
00000000000011s	22	1
000000000000001s	23	1
000101	escape	

Even Field VLC TABLE

CODE	RUN	LEVEL
111	eob	
110s	0	1
01110s	0	2
0010101s	0	3
000101000s	0	4
0000010100s	0	5
00000001000s	0	6
1001s	1	1
001111s	1	2
00010000s	1	3
0000001111s	1	4
000000011000s	1	5
1000s	2	1
0010011s	2	2
0000010111s	2	3
000000000111s	2	4
01111s	3	1
0010000s	3	2
0000010000s	3	3
01011s	4	1
00011101s	4	2
00000010111s	4	3
011001s	5	1
00010111s	5	2
00000010000s	5	3
01010s	6	1
00011100s	6	2
00000010110s	6	3
011000s	7	1
00001101s	7	2
00000010001s	7	3
010011s	8	1
000101001s	8	2
00000001110s	8	3
01000s	9	1
00001110s	9	2
00000001111s	9	3
010010s	10	1
00010010s	10	2
00000000010s	10	3
001110s	11	1
000010111s	11	2
00000000110s	11	3
0011000s	12	1
000001110s	12	2
0011001s	13	1
000010011s	13	2
000000001011s	13	3
001101s	14	1
000011111s	14	2
000000000110s	14	3
0010100s	15	1
0000010110s	15	2
0010010s	16	1
00000011010s	16	2
0001100s	17	1
00000001010s	17	2
00011010s	18	1
00000001011s	18	2
00011011s	19	1
000000001010s	19	2
0010001s	20	1
00000010100s	20	2
0001111s	21	1
00000001101s	21	2
00010110s	22	1
000000011001s	22	2
00010001s	23	1
00010101s	24	1
000000001111s	24	2
00010011s	25	1
0000000000001s	25	2
000011110s	26	1
000011001s	27	1
0000010101s	28	1
0000100001s	29	1
000001100s	30	1
000001101s	31	1
000010110s	32	1
000010010s	33	1
000011000s	34	1
00001010s	35	1
000000000011s	35	2
000010001s	36	1
000001111s	37	1
0000100000s	38	1
0000010001s	39	1
00000011011s	40	1
000000001110s	41	1
00000000100s	44	1
0000001001s	45	1
0000001100s	46	1

0000010010s	47	1
0000010011s	48	1
0000001110s	49	1
00000010101s	50	1
000000000010s	51	1
000000000001s	56	1
00000001001s	57	1
001011	escape	

Refinement Inter VLC TABLE

CODE	RUN	LEVEL
111	eob	
110s	0	1
01010s	0	2
0001101s	0	3
00010000s	0	4
000001011s	0	5
00000010110s	0	6
000000001000s	0	7
100s	1	1
001111s	1	2
000011110s	1	3
00000011010s	1	4
000000001001s	1	5
0111s	2	1
0001110s	2	2
000001110s	2	3
00000001101s	2	4
0000000000001s	2	5
0110s	3	1
00010101s	3	2
0000010001s	3	3
000000000110s	3	4
01011s	4	1
00010010s	4	2
00000010001s	4	3
0000000000110s	4	4
01001s	5	1
000011111s	5	2
00000001111s	5	3
01000s	6	1
000010010s	6	2
000000001100s	6	3
00110s	7	1
000010000s	7	2
0000000001111s	7	3
001110s	8	1
0000011010s	8	2
000000000010s	8	3
001011s	9	1
0000011001s	9	2
001001s	10	1
0000011000s	10	2
0010101s	11	1
0000010101s	11	2
0010100s	12	1
00000100100s	12	2
0001111s	13	1
00000010000s	13	2
0000000000010s	13	3
0001100s	14	1
000000001110s	14	2
0001011s	15	1
000000001111s	15	2
00010100s	16	1
00010011s	17	1
000011011s	18	1
00001110s	19	1
00010001s	20	1
00001100s	21	1
000010101s	22	1
000010110s	23	1
000010001s	24	1
00000000000001s	24	2
000010011s	25	1
000010100s	26	1
000010111s	27	1
0000000000011s	27	2
000011010s	28	1
000000010111s	28	2
000001111s	29	1
0000001010s	30	1
0000001100s	31	1
0000010011s	32	1
00000011011s	33	1
0000011011s	34	1
0000010100s	35	1
0000001111s	36	1
00000010010s	37	1
00000010111s	38	1
00000000101s	39	1
00000010011s	40	1
0000001110s	41	1
0000010000s	42	1
00000100101s	43	1
00000001001s	44	1
000000001101s	45	1
000000010001s	46	1
0000000001110s	47	1
0000000000111s	48	1
000000010101s	49	1
000000010100s	50	1
00000001100s	51	1
000000010110s	52	1
000000010000s	53	1
000000011100s	54	1
000000011101s	55	1
000000000101s	58	1
000000000100s	60	1

001000	escape

Refinement Inter VLC TABLE for low relution prediction

CODE	RUN	LEVEL
110	eob	
111s	0	1
0111s	0	2
010001s	0	3
0001110s	0	4
000011100s	0	5
0000011111s	0	6
00000000111s	0	7
000000000110s	0	8
101s	1	1
00111s	1	2
00010110s	1	3
000010110s	1	4
00000001111s	1	5
000000000010s	1	6
100s	2	1
0010101s	2	2
000011000s	2	3
00000010000s	2	4
0110s	3	1
0001101s	3	2
0000011110s	3	3
000000010011s	3	4
0101s	4	1
00010101s	4	2
00000101011s	4	3
01001s	5	1
00010001s	5	2
00000110101s	5	3
010000s	6	1
000010101s	6	2
000000000001s	6	3
001101s	7	1
0000100000s	7	2
000000000011s	7	3
001100s	8	1
0000101000s	8	2
001011s	9	1
0000001010s	9	2
0010100s	10	1
0000010011s	10	2
0010001s	11	1
00000011011s	11	2
0010000s	12	1
000000001010s	12	2
0001111s	13	1
000000010010s	13	2
00010111s	14	1
0000000000001s	14	2
0001100s	15	1
00010100s	16	1
000011101s	17	1
00001101s	18	1
000100000s	19	1
00001111s	20	1
000100001s	21	1
000010001s	22	1
000010011s	23	1
000001110s	24	1
000010111s	25	1
000011001s	26	1
00010011s	27	1
00010010s	28	1
000010010s	29	1
0000101001s	30	1
0000011011s	31	1
0000010111s	32	1
0000011000s	33	1
0000010001s	34	1
00000011111s	35	1
0000010110s	36	1
00000010001s	37	1
00000010010s	38	1
0000001110s	39	1
00000010110s	40	1
0000000110s	41	1
0000100001s	42	1
0000011001s	43	1
0000010000s	44	1
00000000100s	45	1
000000000111s	46	1
00000010011s	47	1
00000000010s	48	1
00000001010s	49	1
00000001000s	50	1
000000001011s	51	1
00000000110s	52	1
00000110100s	53	1
00000100100s	54	1
00000001011s	55	1
00000011010s	56	1
0000001100s	57	1
00000010111s	58	1
00000011110s	59	1
00000001110s	60	1
00000100101s	61	1
00000101010s	62	1
0000010100s	63	1
001001	escape	

Appendix C

Simulation Results for the 50Hz sequences

Simulation results for the 7 processed sequences are depicted in this appendix. All sequences are processed in MPEG1 compatible mode, with about 1 Mbit/s in the MPEG1 channel. The sequences are:
- Flower Garden coded at 4Mbit/s
- Flower Garden coded at 9Mbit/s
- Popple coded at 9Mbit/s
- Table Tennis coded at 4Mbit/s
- Table Tennis coded at 9Mbit/s
- Mobile and Calendar coded at 4Mbit/s
- Mobile and Calendar coded at 9Mbit/s

Per coded sequences the following results are given:
- SM3/RM8 like statistics
- Accumulated bitcount
- SNR for Y, U, V for each frame
- Bitcount for each frame

Code files with size in 512 byte blocks, VMS dir/size command.

OUT_MPEG2_FLO91.CODE	1498
OUT_MPEG2_FLO91.CODE2	9437
OUT_MPEG2_MOB91.CODE	1497
OUT_MPEG2_MOB91.CODE2	9383
OUT_MPEG2_POP91.CODE	1542
OUT_MPEG2_POP91.CODE2	9417
OUT_MPEG2_TAB91.CODE	1529
OUT_MPEG2_TAB91.CODE2	9334
OUT_MPEG2_FLO41.CODE	1502
OUT_MPEG2_FLO41.CODE2	3308
OUT_MPEG2_MOB41.CODE	1497
OUT_MPEG2_MOB41.CODE2	3296
OUT_MPEG2_TAB41.CODE	1526
OUT_MPEG2_TAB41.CODE2	3224

Flower Garden 4Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			10.21	8.30	10.84	10.342
SNR for luminance			27.94	29.75	27.43	27.84
SNR for chrominance			31.46	32.15	30.97	31.52
SNR for chrominance			34.22	34.65	33.99	34.22
Mean value of QP1			38.07	12.07	38.43	42.39
Mean value of QP2			24.11	9.40	24.69	26.42
Non-zero coeffs/cod blck			9.28	17.26	5.20	4.05
Non-zero coeffs_ref/cod blck			4.06	0.00	7.67	5.70
Non-zero coeffs_hf/cod blck			0.24	0.14	0.37	0.25
Zero coeffs/coded block			21.57	14.37	26.38	25.55
Zero coeffs_ref/coded block			26.75	0.00	38.87	45.39
Zero coeffs_hf/coded block			0.91	0.20	1.51	1.22
Intra	Pred	Interp				
C	Fixed	Fixed		396	0	6
C	MC+C	Int NC			286	180
	noMC+C	Int C				0
	MC noC	Bak NC				11
	Intra	Bak C				0
		For NC				10
		For C				25
		Intra				0
No. of coded MB			392	396	396	390
No. of coded blocks			717	2376	799	405
Diff DC			1760	15592	0	0
MBTYPE			1225	586	1488	1243
Quantiser			777	949	1089	641
MB address			399	396	396	400
Vector data			3324	0	2800	4071
Vector mp2 data			17002	0	14350	20810
CBP			855	0	1276	857
EOB			1433	4752	1598	810
Coeffs Y			37129	206704	27160	11582
Coeffs U			2251	17237	573	265
Coeffs V			1375	11663	138	41
Extra data			759	746	753	763
Seq. Extra data			8			
Total			49528	243032	37270	20663
Coeffs VLC REF			18023	0	36887	14660
Coeffs FLC REF			1647	14587	0	0
Coeffs EOB REF			6240	0	7112	7007
Total ref			27993	14587	46374	24005
bits EOB HF			2351	2376	2376	2338
Coeffs Y HF			2476	3116	3184	2125
Coeffs U HF			393	401	397	391
Coeffs V HF			402	411	422	394
Total hf			24059	7625	22352	27448

Item		All	Refresh	Normal
RMS for luminance		9.90	8.55	10.07
SNR for luminance		28.22	29.50	28.07
SNR for chrominance		30.97	31.66	30.89
SNR for chrominance		34.20	34.58	34.15
Mean value of QP		30.72	24.27	31.55
Non-zero coeffs/cod blck		2.93	4.73	2.62
Zero coeffs/coded block		20.68	24.38	20.04
Code	Intra		0	0
N Code	Intra		0	0
Code	Interp		439	207
N Code	Interp		204	49
Code	Next		22	22
N Code	Next		1	2
Code	Previous		99	14
N Code	Previous		2	1
Code	Copy		0	289
N Code	Copy		0	180
No. of coded MB		764	765	764
No. of coded blocks		1757	2248	1693
Diff DC		1	3	1
MBTYPE		2272	2107	2293
Quantiser		854	899	848
MB address		807	803	807
No. Vector data		12483	16567	11959
of CBP		2361	2522	2340
bits EOB		5270	6745	5080
Coeffs Y		32639	66545	28284
Coeffs U		91	69	94
Coeffs V		68	121	61
Extra data		748	742	749
Seq. Extra data		0		
Total		**56908**	**96434**	**51831**

Frame	Accum. Bitcount
10	1760123
20	3219717
30	4751564
40	6324950
50	7938218
60	9503723
70	11013563
80	12613489
90	14213942
100	16034048
110	17580158
120	19067737

SNR Y,U,V per frame

0	29.86	33.22	35.27	50	28.03	30.65	33.88	100	27.53	31.41	34.35
1	28.30	32.30	34.95	51	27.89	30.46	33.90	101	27.34	31.11	34.18
2	27.59	31.92	34.73	52	28.13	31.40	34.44	102	26.93	30.97	34.03
3	27.39	31.39	34.46	53	28.31	31.52	34.48	103	26.85	30.89	33.82
4	27.21	30.73	34.06	54	29.64	31.75	34.71	104	26.70	30.56	33.68
5	27.04	30.47	33.91	55	28.12	31.44	34.54	105	26.90	30.73	33.74
6	27.18	30.56	33.93	56	27.70	31.18	34.40	106	27.63	31.14	33.92
7	27.48	31.25	34.28	57	27.36	31.01	34.25	107	27.24	31.51	34.11
8	27.56	31.65	34.39	58	27.28	30.76	33.95	108	28.98	31.51	34.17
9	29.23	31.81	34.49	59	27.23	30.37	33.77	109	27.40	31.17	33.98
10	27.68	31.40	34.25	60	27.39	30.30	33.81	110	27.45	31.08	33.94
11	27.51	31.03	34.07	61	28.64	31.29	34.28	111	27.27	30.97	33.88
12	27.55	30.83	33.99	62	29.15	31.42	34.39	112	26.84	30.76	33.67
13	27.86	30.74	33.90	63	30.20	31.98	34.72	113	27.04	30.64	33.63
14	27.87	30.55	33.83	64	29.28	31.98	34.69	114	26.96	30.58	33.66
15	27.88	30.41	33.83	65	29.37	31.78	34.65	115	28.16	31.36	34.10
16	28.95	31.37	34.26	66	29.09	31.61	34.58	116	28.34	31.37	34.19
17	29.12	31.46	34.33	67	29.15	31.41	34.41	117	29.59	31.74	34.40
18	29.99	32.12	34.69	68	28.89	31.21	34.30	118	28.57	31.58	34.26
19	29.01	31.73	34.51	69	28.51	30.94	34.16	119	28.51	31.47	34.23
20	28.68	31.43	34.37	70	28.95	31.49	34.42	120	28.11	31.17	34.06
21	28.32	31.08	34.21	71	28.94	31.42	34.48	121	27.86	31.31	33.87
22	28.36	30.89	34.01	72	30.48	32.17	34.84	122	27.67	30.96	33.69
23	28.53	30.77	34.07	73	29.83	32.07	34.72				
24	28.00	30.47	33.99	74	29.32	31.81	34.62				
25	28.59	31.34	34.32	75	28.81	31.40	34.44				
26	28.48	31.42	34.40	76	27.87	31.21	34.14				
27	30.21	32.05	34.74	77	27.64	30.73	33.93				
28	28.79	31.59	34.51	78	27.72	30.78	34.03				
29	28.66	31.41	34.37	79	27.71	31.59	34.35				
30	28.38	31.13	34.22	80	27.97	31.58	34.42				
31	27.81	30.97	34.05	81	29.29	31.67	34.49				
32	27.72	30.99	34.04	82	28.38	31.40	34.32				
33	27.93	30.79	34.08	83	27.74	31.48	34.34				
34	28.49	31.46	34.43	84	27.36	31.30	34.19				
35	28.77	31.63	34.51	85	27.19	30.78	33.82				
36	29.95	31.92	34.79	86	27.17	30.46	33.69				
37	29.17	31.56	34.63	87	27.00	30.42	33.73				
38	28.58	31.16	34.40	88	27.53	31.26	34.11				
39	28.34	30.94	34.31	89	27.30	31.30	34.13				
40	28.09	30.72	34.12	90	29.12	31.61	34.38				
41	27.91	30.51	33.95	91	27.23	31.29	34.19				
42	27.96	30.72	34.11	92	27.17	31.22	34.14				
43	27.95	31.40	34.39	93	27.53	31.23	34.08				
44	28.09	31.72	34.54	94	26.85	30.64	33.69				
45	29.49	31.58	34.50	95	26.68	30.54	33.62				
46	28.32	31.39	34.31	96	27.03	30.53	33.66				
47	27.37	30.99	34.10	97	27.22	31.02	33.95				
48	27.47	30.89	34.02	98	27.21	31.63	34.31				
49	28.06	30.79	33.91	99	28.81	31.53	34.40				

Bitcount per frame

0	327833	50	114133	100	114106
1	108972	51	147597	101	126322
2	138814	52	148157	102	148103
3	149729	53	117098	103	143758
4	143652	54	384272	104	145088
5	133582	55	111377	105	157384
6	165550	56	135605	106	107411
7	135809	57	159372	107	116059
8	131475	58	132064	108	330996
9	324707	59	115830	109	156883
10	119538	60	157865	110	144831
11	127919	61	107603	111	142434
12	140937	62	94549	112	129574
13	109914	63	394252	113	125375
14	115085	64	114018	114	155490
15	156490	65	113521	115	099455
16	109876	66	156321	116	102228
17	110431	67	103763	117	366067
18	358757	68	107095	118	112253
19	110647	69	160853	119	109872
20	118159	70	120581	120	146577
21	165318	71	117287	121	141342
22	118400	72	407636	122	112372
23	128163	73	100160		
24	174735	74	114942		
25	109349	75	133099		
26	111905	76	147595		
27	365560	77	129661		
28	120717	78	193335		
29	119541	79	135630		
30	152199	80	115516		
31	147221	81	372201		
32	146166	82	100312		
33	172656	83	148448		
34	103193	84	168736		
35	108164	85	136978		
36	358983	86	115839		
37	110599	87	171279		
38	123312	88	131045		
39	150893	89	140099		
40	142423	90	359229		
41	134730	91	150601		
42	182434	92	148526		
43	124463	93	126112		
44	127900	94	143015		
45	357838	95	139670		
46	116508	96	137007		
47	161376	97	121934		
48	162219	98	138817		
49	103377	99	355195		

Flower Garden 9Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance	+, 5.50		4.47	5.35	5.732	
SNR for luminance			33.32	35.13	33.57	32.96
SNR for chrominance			32.92	34.02	32.61	32.85
SNR for chrominance			36.49	37.56	36.44	36.34
Mean value of QP1			39.98	12.27	40.96	44.37
Mean value of QP2			9.36	3.25	9.60	10.32
Non-zero coeffs/cod blck			9.94	18.40	4.96	4.00
Non-zero coeffs_ref/cod blck			22.87	6.38	36.00	32.14
Non-zero coeffs_hf/cod blck			3.41	1.81	5.44	3.79
Zero coeffs/coded block			20.89	14.33	25.50	25.01
Zero coeffs_ref/coded block			50.86	9.52	64.94	86.76
Zero coeffs_hf/coded block			12.59	3.47	19.88	17.71
Intra	Pred	Interp				
C	Fixed	Fixed		396	0	5
C	MC+C	Int NC			273	186
	noMC+C	Int C				0
	MC noC	Bak NC				12
	Intra	Bak C				0
		For NC				17
		For C				32
		Intra				0
No. of coded MB			393	396	396	391
No. of coded blocks			677	2376	728	370
Diff DC			1760	15592	0	0
MBTYPE			1183	515	1432	1212
Quantiser			643	595	988	533
MB address			398	396	396	399
Vector data			3266	0	2800	3982
Vector mp2 data			16634	0	14350	20254
CBP			798	0	1228	787
EOB			1354	4752	1456	739
Coeffs Y			37044	219871	23680	10392
Coeffs U			2443	19224	504	240
Coeffs V			1519	13030	109	35
Extra data			759	746	753	763
Seq. Extra data			8			
Total			49408	259129	33344	19074
Coeffs VLC REF			84629	59	15059	66409
Coeffs FLC REF			8963	79382	0	0
Coeffs EOB REF			6621	47	6763	6885
Total ref			10230	14357	15973	75640
bits EOB HF			2356	2376	2376	2346
Coeffs Y HF			1413	2435	2262	9498
Coeffs U HF			472	479	536	449
Coeffs V HF			813	1246	1492	506
Total hf			35656	29331	42739	34317

Item		All	Refresh	Normal
RMS for luminance		4.81	3.81	4.94
SNR for luminance		34.49	36.51	34.26
SNR for chrominance		32.92	33.73	32.82
SNR for chrominance		36.88	37.55	36.80
Mean value of QP		11.61	8.50	12.01
Non-zero coeffs/cod blck		9.23	15.34	8.40
Zero coeffs/coded block		27.90	27.92	27.89
Code	Intra		0	0
N Code	Intra		0	0
Code	Interp		511	225
N Code	Interp		171	84
Code	Next		24	12
N Code	Next		0	0
Code	Previous		66	9
N Code	Previous		1	1
Code	Copy		0	357
N Code	Copy		0	88
No. of coded MB		776	773	777
No. of coded blocks		2561	2713	2541
Diff DC		0	0	0
MBTYPE		2165	2022	2183
Quantiser		1046	1171	1030
MB address		798	800	798
No. Vector data		12984	16785	12496
of CBP		2781	2987	2755
bits EOB		7682	8139	7623
Coeffs Y		142313	265691	126466
Coeffs U		1481	3403	1234
Coeffs V		3073	6627	2616

Frame	Accum. Bitcount
10	4121357
20	7535340
30	10988961
40	14633465
50	18295201
60	21765372
70	25306856
80	28858507
90	32424148
100	36543606
110	40033111
120	43475924

SNR Y,U,V per frame

0	36.91	35.03	38.58	50	34.59	32.86	36.70	100	32.85	33.09	36.55
1	34.19	34.09	37.62	51	33.95	32.63	36.68	101	32.89	32.57	36.18
2	33.86	33.24	36.90	52	33.25	32.51	36.41	102	31.96	32.33	35.99
3	34.49	33.13	36.94	53	33.28	32.66	36.63	103	32.12	31.91	35.48
4	33.44	32.33	36.08	54	35.39	33.26	37.33	104	32.01	31.74	35.36
5	33.21	32.17	36.01	55	33.17	32.83	36.83	105	32.78	31.94	35.68
6	33.90	32.38	36.24	56	32.89	32.29	36.35	106	33.09	32.34	35.75
7	33.51	32.58	36.17	57	33.26	32.25	36.36	107	33.04	32.46	35.84
8	33.33	32.90	36.41	58	32.77	31.90	35.93	108	34.95	33.22	36.68
9	35.75	33.95	37.51	59	32.90	31.74	35.76	109	33.07	32.27	35.90
10	33.44	33.17	36.63	60	33.93	32.08	36.30	110	32.71	32.15	35.87
11	33.46	32.58	36.21	61	34.53	33.16	37.02	111	33.50	32.27	36.11
12	33.97	32.84	36.59	62	35.26	33.70	37.43	112	32.45	31.92	35.66
13	34.32	32.90	36.58	63	36.23	34.09	37.93	113	32.80	31.87	35.64
14	34.44	32.95	36.63	64	34.60	33.97	37.62	114	33.11	32.10	36.04
15	34.56	32.92	36.80	65	34.80	33.91	37.58	115	33.86	33.05	36.59
16	35.14	33.83	37.38	66	35.88	33.91	37.84	116	34.63	33.28	36.90
17	35.26	33.93	37.48	67	35.36	33.86	37.59	117	35.37	33.50	37.09
18	36.09	34.16	37.80	68	35.24	33.75	37.52	118	33.86	33.31	36.80
19	34.13	33.71	37.30	69	35.60	33.57	37.57	119	34.13	33.32	36.85
20	34.32	33.55	37.15	70	34.63	33.73	37.37	120	34.49	33.16	36.94
21	34.42	33.35	37.09	71	34.35	33.56	37.33	121	33.32	32.58	36.20
22	33.99	33.14	36.82	72	36.87	34.45	38.20	122	33.14	32.30	36.06
23	34.28	33.18	36.93	73	35.41	34.35	37.93				
24	34.79	32.87	36.92	74	35.21	34.16	37.81				
25	34.45	33.17	36.96	75	34.67	33.76	37.56				
26	34.34	33.33	37.19	76	32.77	32.75	36.54				
27	35.95	34.09	37.74	77	32.56	32.17	36.10				
28	34.34	33.62	37.25	78	33.54	32.24	36.42				
29	34.36	33.56	37.20	79	32.96	32.68	36.43				
30	34.70	33.41	37.24	80	32.87	33.03	36.69				
31	33.41	32.79	36.61	81	36.02	34.06	37.67				
32	33.07	32.57	36.49	82	34.01	33.59	37.14				
33	34.91	32.80	36.99	83	33.31	32.82	36.45				
34	34.16	33.18	37.07	84	33.40	32.72	36.42				
35	34.49	33.38	37.23	85	32.56	32.07	35.78				
36	35.49	33.63	37.45	86	32.74	31.85	35.71				
37	34.44	33.44	37.23	87	32.29	31.76	35.77				
38	34.41	33.14	37.07	88	32.86	32.36	36.05				
39	34.83	33.07	37.16	89	32.42	32.58	36.24				
40	33.70	32.57	36.72	90	36.28	34.23	37.82				
41	33.29	32.34	36.48	91	33.07	32.83	36.45				
42	34.62	32.64	36.90	92	32.50	32.66	36.30				
43	33.09	32.63	36.56	93	33.13	32.82	36.37				
44	33.20	32.70	36.65	94	32.26	31.85	35.44				
45	35.02	33.18	37.01	95	31.98	31.77	35.41				
46	33.72	32.58	36.37	96	32.35	31.92	35.72				
47	32.73	32.01	35.97	97	32.97	31.95	35.70				
48	34.00	32.30	36.38	98	32.87	32.58	36.10				
49	34.38	32.68	36.54	99	35.02	33.52	37.11				

Bitcount per frame

0	719534	50	292298	100	279296
1	270612	51	333111	101	286000
2	330586	52	337571	102	312828
3	430471	53	273520	103	310128
4	334789	54	733312	104	310678
5	300995	55	265282	105	379823
6	390777	56	296875	106	264952
7	329145	57	400688	107	303452
8	310615	58	292274	108	672337
9	703833	59	245240	109	370011
10	293658	60	409519	110	317492
11	295408	61	252550	111	397756
12	366391	62	236499	112	282036
13	267617	63	780224	113	287657
14	281429	64	261467	114	380030
15	377422	65	258224	115	254663
16	274006	66	460787	116	282318
17	276886	67	223505	117	735154
18	726536	68	252748	118	251587
19	254630	69	405961	119	254120
20	263627	70	279678	120	390945
21	401308	71	275600	121	307403
22	266920	72	835378	122	223409
23	283427	73	235203		
24	429150	74	282583		
25	268275	75	346839		
26	283466	76	303577		
27	714851	77	251304		
28	270926	78	443946		
29	271671	79	297543		
30	406519	80	254407		
31	321512	81	809628		
32	298503	82	259537		
33	464547	83	342928		
34	254477	84	408082		
35	268055	85	289920		
36	706423	86	243775		
37	259511	87	352651		
38	261089	88	297538		
39	403868	89	307175		
40	324730	90	796079		
41	282773	91	373851		
42	438032	92	323877		
43	273545	93	306043		
44	285300	94	316425		
45	688496	95	304753		
46	284983	96	306005		
47	360158	97	312775		
48	471950	98	345352		
49	251769	99	734298		

Popple 9Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			4.61	4.21	4.46	4.73
SNR for luminance			34.85	35.64	35.15	34.63
SNR for chrominance			35.06	38.29	34.45	34.81
SNR for chrominance			38.70	40.97	38.47	38.45
Mean value of QP1			29.14	6.91	30.61	32.43
Mean value of QP2			7.76	2.66	8.12	8.51
Non-zero coeffs/cod blck			6.53	11.91	4.94	3.84
Non-zero coeffs_ref/cod blck			13.66	1.96	21.18	17.67
Non-zero coeffs_hf/cod blck			6.23	3.00	9.77	6.66
Zero coeffs/coded block			15.68	12.21	17.03	17.27
Zero coeffs_ref/coded block			27.47	4.67	38.76	36.80
Zero coeffs_hf/coded block			18.77	4.26	44.10	16.47
Intra	Pred	Interp				
C	Fixed	Fixed		396	0	12
C	MC+C	Int NC			198	209
	noMC+C	Int C				4
	MC noC	Bak NC				19
	Intra	Bak C				0
		For NC				1
		For C				19
		Intra				0
No. of coded MB			388	396	396	384
No. of coded blocks			884	2376	851	640
Diff DC			1469	12894	0	20
MBTYPE			1184	439	1411	1234
Quantiser			656	213	783	689
MB address			394	396	396	394
Vector data			7352	0	5861	9117
Vector mp2 data			19687	0	15279	24553
CBP			988	0	1277	1058
EOB			1768	4752	1702	1281
Coeffs Y			28488	142296	19497	12127
Coeffs U			4768	24673	316	1916
Coeffs V			4492	22550	308	1889
Extra data			759	746	753	763
Seq. Extra data			8			
Total			50850	196063	37930	30457
Coeffs VLC REF			71310	19	10998	66939
Coeffs FLC REF			4006	35425	0	9
Coeffs EOB REF			6302	23	6881	6781
Total ref			83674	57324	11924	76028
bits EOB HF			2327	2376	2376	2302
Coeffs Y HF			3217	4377	4994	24120
Coeffs U HF			924	1232	1180	784
Coeffs V HF			2162	2289	3050	1838
Total hf			58261	50335	72972	54591

Item		All	Refresh	Normal
RMS for luminance		4.15	3.30	4.26
SNR for luminance		35.78	37.75	35.55
SNR for chrominance		35.84	38.02	35.60
SNR for chrominance		39.41	40.84	39.24
Mean value of QP		9.71	6.28	10.15
Non-zero coeffs/cod blck		7.13	16.17	5.99
Zero coeffs/coded block		27.66	30.01	27.37
Code	Intra		4	4
N Code	Intra		0	0
Code	Interp		662	445
N Code	Interp		29	28
Code	Next		42	29
N Code	Next		0	0
Code	Previous		48	33
N Code	Previous		0	0
Code	Copy		0	233
N Code	Copy		0	13
No. of coded MB		785	785	785
No. of coded blocks		2896	2856	2902
Diff DC		18	718	3187
MBTYPE		2085	1795	2123
Quantiser		1106	1069	1111
MB address		798	798	798
No. Vector data		15779	16266	15716
of CBP		3832	3893	3824
bits EOB		8689	8568	8705
Coeffs Y		120014	282715	99116
Coeffs U		5398	10807	4704
Coeffs V		11971	19719	10976
Extra da.ta		748	742	749
Seq. Extra data		0		

Frame	Accum. Bitcount
10	4036526
20	7531764
30	11054941
40	14658739
50	18214533
60	21770842
70	25405718
80	29021600
90	32584153
100	36324441
110	39935945
120	43500264

SNR Y,U,V per frame

0	36.82	38.59	41.62	50	33.32	34.76	38.34	100	34.03	32.86	36.63
1	34.93	36.65	40.07	51	34.39	35.25	39.13	101	33.87	32.64	36.46
2	35.28	36.95	40.42	52	34.33	35.69	39.08	102	33.99	32.48	36.41
3	36.28	37.35	40.81	53	34.41	35.66	38.95	103	33.86	32.20	36.26
4	35.57	36.79	40.30	54	36.67	38.53	41.16	104	33.67	32.01	36.03
5	35.57	36.77	40.47	55	34.90	36.25	39.48	105	34.17	31.92	36.16
6	36.24	36.68	40.63	56	34.48	35.55	38.78	106	34.09	32.62	36.56
7	35.54	36.84	40.43	57	35.38	35.81	39.14	107	34.16	32.78	36.57
8	35.62	36.93	40.53	58	35.33	35.53	38.86	108	35.24	35.15	38.36
9	36.92	39.21	41.99	59	35.57	35.46	38.78	109	34.00	32.71	36.54
10	35.40	37.13	40.45	60	36.12	35.70	39.20	110	34.19	32.79	36.57
11	35.51	37.05	40.57	61	36.60	37.05	40.14	111	34.20	32.52	36.46
12	36.14	36.97	40.55	62	36.56	36.91	40.11	112	34.05	32.31	36.24
13	35.54	36.40	40.12	63	38.21	40.37	42.50	113	33.99	32.26	36.21
14	35.61	36.41	40.08	64	36.75	37.28	40.42	114	33.80	31.92	35.93
15	35.89	36.25	40.27	65	36.72	37.00	40.37	115	33.74	32.27	36.14
16	35.50	36.63	40.20	66	36.75	36.43	40.15	116	33.76	32.55	36.21
17	35.52	36.76	40.29	67	36.61	36.41	40.00	117	35.02	34.95	37.98
18	36.80	39.16	41.84	68	36.81	36.63	40.27	118	33.95	32.54	36.37
19	35.23	36.82	40.23	69	36.88	36.17	40.14	119	33.78	32.39	36.26
20	35.19	36.74	40.17	70	36.94	37.26	40.70	120	34.03	32.37	36.28
21	35.73	36.56	40.18	71	36.87	37.18	40.72	121	33.90	32.21	36.22
22	35.21	36.26	39.84	72	38.24	40.99	43.08	122	33.80	32.09	36.06
23	35.12	36.11	39.80	73	37.04	37.44	40.69				
24	35.60	36.08	40.08	74	36.82	37.19	40.42				
25	35.29	36.32	39.97	75	36.81	36.53	40.29				
26	35.31	36.53	40.09	76	36.51	36.34	40.05				
27	36.79	39.18	41.81	77	36.61	36.50	40.23				
28	35.28	36.73	40.07	78	36.70	35.95	40.01				
29	35.29	36.72	40.05	79	36.61	36.73	40.34				
30	35.90	36.73	40.32	80	36.52	36.59	40.32				
31	35.28	36.40	39.92	81	37.82	40.03	42.28				
32	35.32	36.36	39.83	82	36.57	36.51	40.14				
33	35.79	36.36	40.16	83	36.33	36.22	39.92				
34	35.37	36.64	40.04	84	36.17	35.45	39.37				
35	35.37	36.55	39.94	85	35.69	34.93	38.75				
36	37.01	39.37	41.86	86	35.83	34.85	38.79				
37	35.19	36.86	40.05	87	35.65	34.24	38.41				
38	35.18	36.72	40.04	88	35.38	34.36	38.15				
39	35.44	36.63	40.21	89	35.22	34.42	38.18				
40	34.86	35.96	39.54	90	36.36	37.31	40.17				
41	34.80	35.92	39.59	91	35.39	34.45	38.28				
42	34.92	35.97	39.87	92	34.80	34.10	37.76				
43	34.30	36.02	39.57	93	35.19	33.84	37.89				
44	33.94	36.17	39.64	94	34.71	33.51	37.34				
45	36.40	38.79	41.48	95	34.56	33.33	37.13				
46	34.06	36.26	39.39	96	34.69	32.97	37.14				
47	33.81	35.95	39.29	97	34.18	33.06	36.90				
48	33.93	35.32	39.24	98	34.27	33.11	36.93				
49	33.34	34.91	38.73	99	35.22	35.40	38.57				

Bitcount per frame

0	734060	50	279979	100	346043
1	236463	51	368413	101	341199
2	272141	52	302560	102	382852
3	462765	53	293365	103	342312
4	284211	54	699895	104	340271
5	281548	55	369428	105	382270
6	420606	56	288498	106	347095
7	272374	57	368144	107	336245
8	280743	58	291873	108	450571
9	791615	59	294154	109	342646
10	253766	60	361583	110	340387
11	282875	61	333302	111	372804
12	397280	62	319763	112	334223
13	272639	63	630041	113	341323
14	277295	64	342329	114	377707
15	377003	65	321855	115	330863
16	272254	66	358437	116	332127
17	275383	67	294716	117	444092
18	830630	68	311444	118	350103
19	256113	69	361406	119	340690
20	278986	70	333771	120	378609
21	378514	71	327542	121	342398
22	276455	72	567385	122	336257
23	281302	73	357214		
24	377224	74	326461		
25	273822	75	362918		
26	273013	76	317301		
27	846829	77	319483		
28	259852	78	367008		
29	277180	79	336799		
30	366155	80	331391		
31	277852	81	507788		
32	275719	82	358112		
33	367614	83	330546		
34	278958	84	362488		
35	274942	85	323915		
36	857783	86	322186		
37	262681	87	379991		
38	272822	88	321015		
39	369272	89	325121		
40	262836	90	472900		
41	271084	91	348508		
42	390151	92	347546		
43	290784	93	376639		
44	278805	94	347496		
45	798676	95	334809		
46	268712	96	383167		
47	304883	97	343505		
48	381437	98	326246		
49	308426	99	459472		

Table Tennis 4Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			6.77	7.05	6.86	6.69
SNR for luminance			31.52	31.17	31.40	31.63
SNR for chrominance			37.35	38.75	36.70	37.36
SNR for chrominance			38.69	40.08	38.29	38.61
Mean value of QP1			17.35	8.91	17.34	18.79
Mean value of QP2			13.80	5.93	14.69	14.83
Non-zero coeffs/cod blck			8.71	13.02	6.56	6.44
Non-zero coeffs_ref/cod blck			3.62	0.26	5.17	5.50
Non-zero coeffs_hf/cod blck			1.97	1.10	2.61	2.23
Zero coeffs/coded block			21.75	15.36	24.87	25.15
Zero coeffs_ref/coded block			15.60	0.66	20.44	26.13
Zero coeffs_hf/coded block			8.58	2.34	11.42	12.13
Intra	Pred	Interp				
C	Fixed	Fixed		396	2	86
C	MC+C	Int NC			240	141
	noMC+C	Int C				8
	MC noC	Bak NC				74
	Intra	Bak C				0
		For NC				10
		For C				21
		Intra				1
No. of coded MB			339	396	394	310
No. of coded blocks			793	2376	1177	391
Diff DC			1436	12388	8	53
MBTYPE			966	524	1220	955
Quantiser			557	640	792	463
MB address			394	396	397	393
Vector data			2775	0	2615	3303
Vector mp2 data			10590	0	9444	12789
CBP			814	0	1540	705
EOB			1586	4752	2354	783
Coeffs Y			38980	165107	45866	15095
Coeffs U			1382	8493	116	241
Coeffs V			2120	10901	220	591
Extra data			759	746	753	763
Seq. Extra data			8			
Total			50334	191558	58910	23281
Coeffs VLC REF			17049	26	37098	12658
Coeffs FLC REF			2166	19166	1	3
Coeffs EOB REF			5260	26	6988	5523
Total ref			26232	22095	46447	20035
bits EOB HF			2031	2376	2361	1859
Coeffs Y HF			1044	1643	1932	6396
Coeffs U HF			358	431	445	316
Coeffs V HF			455	492	641	385
Total hf			24856	20676	33452	22634

Item		All	Refresh	Normal
RMS for luminance		6.29	6.21	6.31
SNR for luminance		32.15	32.27	32.14
SNR for chrominance		37.29	38.04	37.20
SNR for chrominance		38.92	39.44	38.85
Mean value of QP		17.05	15.00	17.32
Non-zero coeffs/cod blck		4.62	9.10	3.87
Zero coeffs/coded block		27.15	30.63	26.57
Code	Intra		2	2
N Code	Intra		0	0
Code	Interp		432	160
N Code	Interp		155	142
Code	Next		41	17
N Code	Next		1	3
Code	Previous		85	7
N Code	Previous		4	2
Code	Copy		0	296
N Code	Copy		0	58
No. of coded MB		689	720	686
No. of coded blocks		1238	1555	1198
Diff DC		64	96	60
MBTYPE		1966	1945	1968
Quantiser		469	597	453
MB address		826	814	828
No. Vector data		8874	11595	8525
of CBP		2219	2452	2189
bits EOB		3715	4666	3593
Coeffs Y		36109	89849	29207
Coeffs U		154	305	135
Coeffs V		687	743	680
Extra data		748	742	749
Seq. Extra data		0		
Total		**55084**	**13023**	**47642**

Frame	Accum. Bitcount
10	1532834
20	2961510
30	4498526
40	6150932
50	7722898
60	9199216
70	10746043
80	12225249
90	13876920
100	15723602
110	17340687
120	18794262

SNR Y,U,V per frame

0	25.64	38.16	38.83	50	33.00	36.35	37.28	100	31.03	37.21	39.22
1	26.37	37.72	38.05	51	33.00	35.75	37.14	101	31.07	37.08	39.26
2	26.42	37.56	37.95	52	32.55	35.11	36.43	102	30.68	36.83	39.10
3	26.43	37.18	37.85	53	31.22	37.31	39.41	103	30.51	36.62	38.83
4	26.64	36.92	37.52	54	31.42	37.45	39.81	104	30.37	36.35	38.50
5	26.55	36.97	37.54	55	31.53	37.23	39.17	105	30.57	36.00	38.57
6	26.82	36.51	37.34	56	31.76	37.06	39.15	106	30.33	36.51	38.97
7	30.26	38.40	38.08	57	31.99	37.01	39.10	107	30.41	36.43	38.98
8	30.61	39.00	38.53	58	32.31	36.97	39.26	108	30.59	37.45	39.76
9	32.62	40.26	39.78	59	32.28	36.85	39.12	109	30.57	37.02	39.01
10	32.16	39.61	39.13	60	32.48	36.90	39.21	110	30.86	36.83	38.83
11	32.16	39.12	38.91	61	32.65	37.35	39.57	111	31.00	36.56	38.47
12	31.70	38.39	38.31	62	32.68	37.43	39.58	112	31.03	36.27	38.26
13	32.49	38.39	38.64	63	32.25	37.71	39.80	113	30.66	36.17	38.10
14	32.62	38.06	38.39	64	32.63	37.61	39.61	114	31.16	35.92	38.16
15	32.85	38.04	38.55	65	32.70	37.57	39.50	115	31.48	36.73	38.58
16	33.51	39.42	39.38	66	33.01	37.52	39.49	116	31.73	37.16	38.96
17	33.93	39.80	39.79	67	32.95	37.42	39.38	117	31.53	37.61	39.65
18	34.59	40.71	40.56	68	32.95	37.42	39.39	118	31.77	37.20	39.31
19	34.22	39.94	39.73	69	33.08	37.39	39.47	119	31.73	36.93	39.19
20	34.19	39.50	39.65	70	33.18	37.62	39.78	120	31.71	36.48	38.84
21	34.18	39.10	39.41	71	33.21	37.73	39.97	121	31.55	36.26	38.54
22	34.08	38.92	39.14	72	32.71	37.83	40.14	122	31.46	36.22	38.45
23	34.13	38.52	39.10	73	33.12	37.72	40.01				
24	34.06	38.37	38.94	74	33.16	37.63	39.95				
25	34.13	39.21	39.16	75	33.36	37.65	39.94				
26	34.23	39.69	39.35	76	33.34	37.58	39.80				
27	34.83	40.14	39.86	77	33.36	37.57	39.64				
28	34.10	39.37	38.74	78	33.47	37.51	39.80				
29	34.01	38.97	38.64	79	33.47	37.82	39.97				
30	33.92	38.52	38.59	80	33.50	37.84	40.06				
31	33.59	38.20	38.06	81	31.60	37.58	39.98				
32	33.51	37.99	38.19	82	28.96	32.68	36.03				
33	33.59	37.78	38.32	83	29.11	32.80	36.20				
34	33.57	38.52	38.39	84	30.09	33.08	36.75				
35	33.68	38.78	38.72	85	30.78	33.97	37.58				
36	34.28	39.55	39.54	86	30.80	34.07	37.64				
37	33.53	38.46	38.24	87	31.21	34.28	37.88				
38	33.38	38.21	38.25	88	31.67	35.83	38.98				
39	33.36	37.56	38.05	89	31.84	35.95	39.09				
40	33.09	37.16	37.62	90	31.31	37.58	39.98				
41	32.97	36.74	37.58	91	32.02	37.49	39.61				
42	33.06	36.73	37.54	92	32.11	37.46	39.57				
43	33.13	37.62	37.80	93	32.41	37.44	39.73				
44	33.35	38.10	38.16	94	32.28	37.37	39.51				
45	33.93	38.81	38.90	95	32.09	37.33	39.51				
46	33.33	37.85	37.95	96	31.82	37.28	39.47				
47	33.31	37.68	37.92	97	31.64	37.54	39.56				
48	33.20	36.98	37.73	98	31.22	37.54	39.69				
49	33.11	36.69	37.32	99	30.99	37.58	40.02				

Bitcount per frame

0	349108	50	134834	100	102335
1	72198	51	187591	101	105012
2	83368	52	154874	102	183911
3	158298	53	138094	103	138988
4	93040	54	341162	104	118556
5	133651	55	66213	105	198410
6	199491	56	87968	106	114996
7	147828	57	160592	107	113256
8	99080	58	104303	108	407107
9	196772	59	100687	109	134514
10	139455	60	180431	110	84095
11	126319	61	97566	111	148409
12	145823	62	102634	112	105493
13	126739	63	423089	113	114343
14	125670	64	86250	114	167030
15	174991	65	93669	115	95078
16	118260	66	185736	116	99145
17	118822	67	105279	117	398377
18	220175	68	99070	118	109117
19	132422	69	173103	119	132488
20	131915	70	92176	120	182711
21	185938	71	95245	121	138942
22	135364	72	458097	122	130360
23	133844	73	99216		
24	196032	74	94628		
25	118273	75	181817		
26	119355	76	99029		
27	255350	77	95833		
28	130955	78	166767		
29	129990	79	96398		
30	200365	80	98732		
31	132555	81	380822		
32	127873	82	132679		
33	203538	83	62563		
34	123189	84	416476		
35	130006	85	91804		
36	265252	86	80330		
37	137231	87	223164		
38	135443	88	83194		
39	196954	89	81907		
40	138396	90	474553		
41	134551	91	76036		
42	192720	92	79759		
43	128433	93	200400		
44	126101	94	93609		
45	262394	95	90342		
46	138743	96	175632		
47	136587	97	112009		
48	179881	98	113645		
49	134160	99	430697		

Table Tennis 9Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			4.65	4.93	4.17	4.77
SNR for luminance			34.78	34.27	35.72	34.56
SNR for chrominance			38.39	39.31	38.14	38.33
SNR for chrominance			40.63	41.79	40.90	40.36
Mean value of QP1			17.15	8.31	17.87	18.42
Mean value of QP2			6.28	2.94	6.76	6.69
Non-zero coeffs/cod blck			9.41	14.23	6.36	7.11
Non-zero coeffs_ref/cod blck			14.40	4.90	19.15	20.30
Non-zero coeffs_hf/cod blck			8.47	3.18	12.00	10.76
Zero coeffs/coded block			21.83	16.31	24.56	25.29
Zero coeffs_ref/coded block			36.04	10.37	55.16	44.97
Zero coeffs_hf/coded block			26.35	5.55	41.53	33.94
Intra	Pred	Interp				
C	Fixed	Fixed		396	0	93
C	MC+C	Int NC			237	147
	noMC+C	Int C				7
	MC noC	Bak NC				81
	Intra	Bak C				0
		For NC				9
		For C				20
		Intra				0
No. of coded MB			334	396	396	303
No. of coded blocks			749	2376	1126	343
Diff DC			1414	12388	1	23
MBTYPE			945	476	1241	924
Quantiser			511	400	799	431
MB address			391	396	396	389
Vector data			2737	0	2627	3242
Vector mp2 data			10456	0	9478	12575
CBP			769	0	1515	645
EOB			1498	4752	2251	686
Coeffs Y			39133	177974	42684	14216
Coeffs U			1457	9502	106	218
Coeffs V			2220	12327	194	588
Extra data			759	746	753	763
Seq. Extra data			8			
Total			50421	206573	55272	22093
Coeffs VLC REF			60332	47	12753	39626
Coeffs FLC REF			5883	51989	0	20
Coeffs EOB REF			5372	36	6501	5280
Total ref			73323	10284	13640	46740
bits EOB HF			2006	2376	2376	1817
Coeffs Y HF			3752	4696	7815	22038
Coeffs U HF			473	511	784	360
Coeffs V HF			835	838	1492	610
Total hf			52070	51501	93310	38085

Item		All	Refresh	Normal
RMS for luminance		3.83	3.67	3.85
SNR for luminance		36.47	36.84	36.42
SNR for chrominance		38.73	39.04	38.69
SNR for chrominance		41.12	41.22	41.11
Mean value of QP		8.14	7.08	8.28
Non-zero coeffs/cod blck		8.92	17.67	7.80
Zero coeffs/coded block		38.06	34.85	38.47
Code	Intra		2	2
N Code	Intra		0	0
Code	Interp		618	255
N Code	Interp		27	28
Code	Next		36	21
N Code	Next		0	0
Code	Previous		100	8
N Code	Previous		0	0
Code	Copy		0	468
N Code	Copy		0	1
No. of coded MB		784	783	784
No. of coded blocks		2833	2811	2836
Diff DC		64	99	60
MBTYPE		1927	1822	1941
Quantiser		1017	925	1029
MB address		797	796	797
No. Vector data		9033	12043	8646
of CBP		3015	2996	3018
bits EOB		8500	8432	8509
Coeffs Y		155307	313073	135043
Coeffs U		786	1478	1697
Coeffs V		3189	4142	3067
Extra data		748	742	749
Seq. Extra data		0		
Total		183635	345766	162811

Frme	Accum. Bitcount
10	3904411
20	7435042
30	10898097
40	14571881
50	18111493
60	21608707
70	25220676
80	28683248
90	32070184
100	36098375
110	39739281
120	43170397

SNR Y,U,V per frame

0	31.72	38.53	40.43	50	35.99	38.23	40.20	100	34.65	38.22	40.95
1	32.23	38.06	39.87	51	36.81	38.17	40.49	101	34.81	38.24	41.14
2	32.77	37.96	39.99	52	35.34	37.15	39.27	102	35.28	38.05	41.20
3	33.39	37.88	40.02	53	33.87	37.89	40.93	103	34.38	37.78	40.66
4	32.78	37.49	39.46	54	35.07	38.39	41.45	104	34.16	37.42	40.39
5	31.97	37.51	39.40	55	35.52	38.44	41.46	105	35.08	37.46	40.78
6	31.83	37.40	39.20	56	35.84	38.42	41.52	106	34.05	37.60	40.59
7	34.30	39.13	40.03	57	36.16	38.36	41.48	107	34.29	37.48	40.28
8	34.46	39.54	40.35	58	36.13	38.34	41.40	108	34.65	38.18	41.15
9	36.43	41.20	41.71	59	36.12	38.28	41.39	109	34.33	37.83	40.51
10	35.87	40.17	40.62	60	36.66	38.33	41.61	110	34.79	38.06	40.67
11	35.67	39.81	40.77	61	36.29	38.54	41.60	111	35.56	37.91	40.61
12	36.50	39.79	41.22	62	36.25	38.58	41.60	112	34.86	37.82	40.40
13	35.96	39.38	40.66	63	35.33	38.38	41.43	113	34.41	37.70	40.20
14	36.13	39.22	40.51	64	35.80	38.57	41.35	114	35.77	37.73	40.64
15	36.81	39.60	41.31	65	36.08	38.59	41.42	115	35.38	38.03	40.73
16	36.10	40.16	40.75	66	36.91	38.61	41.62	116	35.47	38.41	40.91
17	36.52	40.68	41.37	67	36.40	38.50	41.39	117	35.58	38.62	41.42
18	37.76	41.56	42.37	68	36.38	38.55	41.55	118	35.25	38.38	40.72
19	36.89	40.66	41.18	69	37.26	38.59	41.88	119	35.41	38.28	40.87
20	36.68	40.33	41.38	70	36.56	38.78	41.82	120	35.78	38.10	40.96
21	37.51	40.29	41.86	71	36.54	38.86	41.84	121	35.19	38.00	40.35
22	36.68	39.86	41.09	72	35.56	38.56	41.64	122	35.10	37.86	40.34
23	36.71	39.62	41.26	73	36.02	38.75	41.71				
24	37.40	39.61	41.46	74	36.30	38.77	41.81				
25	36.52	39.93	40.90	75	37.35	38.82	42.08				
26	36.54	40.44	41.18	76	36.65	38.79	41.77				
27	37.92	40.89	41.99	77	36.74	38.84	41.82				
28	36.62	40.15	40.64	78	37.62	38.90	42.24				
29	36.46	39.88	40.65	79	36.67	39.01	41.87				
30	37.33	39.87	41.21	80	36.66	39.04	41.86				
31	36.23	39.40	40.06	81	34.57	38.24	41.36				
32	36.21	39.37	40.18	82	31.74	33.89	37.33				
33	37.02	39.42	41.01	83	32.26	34.40	38.00				
34	36.06	39.46	40.08	84	32.99	34.69	38.53				
35	36.08	39.69	40.50	85	34.86	36.52	40.04				
36	37.57	40.53	41.72	86	35.10	36.82	40.32				
37	36.29	39.48	40.26	87	36.74	37.22	41.00				
38	36.01	39.40	40.37	88	35.76	37.72	41.04				
39	36.92	39.28	41.09	89	35.94	37.83	41.14				
40	36.00	38.81	40.12	90	34.37	38.06	41.39				
41	35.98	38.40	40.18	91	35.37	38.40	41.18				
42	36.70	38.73	40.79	92	35.83	38.46	41.30				
43	35.95	39.03	40.12	93	37.84	38.67	42.08				
44	36.08	39.31	40.52	94	36.30	38.65	41.61				
45	37.42	40.09	41.62	95	36.22	38.63	41.71				
46	36.26	39.21	40.32	96	37.18	38.71	42.09				
47	36.08	39.05	40.36	97	35.02	38.59	41.50				
48	36.85	38.85	40.82	98	34.49	38.56	41.42				
49	36.05	38.42	40.00	99	34.68	38.32	41.38				

Bitcount per frame

0	854574	50	292770	100	254730
1	188762	51	462034	101	252194
2	256587	52	300715	102	474700
3	382991	53	276972	103	287605
4	210119	54	688178	104	275766
5	320863	55	253809	105	463620
6	496425	56	279856	106	262808
7	296314	57	386570	107	273880
8	269941	58	276975	108	787485
9	627835	59	279335	109	308118
10	348915	60	409588	110	230443
11	274310	61	270701	111	399842
12	426901	62	275114	112	249609
13	285275	63	725868	113	270734
14	281368	64	249355	114	430068
15	417661	65	272251	115	241974
16	271273	66	428263	116	260217
17	272067	67	269878	117	774655
18	628343	68	270268	118	272446
19	324518	69	440683	119	301128
20	279515	70	261787	120	414084
21	426478	71	267039	121	298271
22	289157	72	749631	122	279938
23	278778	73	246656		
24	434455	74	261397		
25	269795	75	452116		
26	266045	76	262726		
27	640945	77	260159		
28	302861	78	439953		
29	275026	79	261108		
30	449597	80	262387		
31	283325	81	640127		
32	273457	82	292310		
33	442430	83	181424		
34	277711	84	589081		
35	274815	85	221962		
36	623549	86	207037		
37	316204	87	570810		
38	281991	88	210267		
39	450705	89	211531		
40	290871	90	757034		
41	289119	91	199841		
42	440908	92	222243		
43	289181	93	589326		
44	278282	94	237411		
45	613392	95	234027		
46	320088	96	528740		
47	287609	97	237158		
48	436549	98	240381		
49	293613	99	782030		

Calendar 4Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			11.59	10.31	12.20	11.60
SNR for luminance			26.85	27.87	26.40	26.84
SNR for chrominance			31.90	32.84	31.07	32.04
SNR for chrominance			33.50	34.76	32.78	33.56
Mean value of QP1			42.78	14.27	44.55	47.04
Mean value of QP2			26.73	7.35	28.06	29.58
Non-zero coeffs/cod blck			9.99	19.34	5.02	3.50
Non-zero coeffs_ref/cod blck			3.08	0.20	6.45	3.90
Non-zero coeffs_hf/cod blck			2.05	1.79	2.46	2.06
Zero coeffs/coded block			26.20	16.75	30.82	33.03
Zero coeffs_ref/coded block			21.99	0.35	38.50	33.86
Zero coeffs_hf/coded block			10.42	3.53	15.10	14.56
Intra	Pred	Interp				
C	Fixed	Fixed		396	0	41
C	MC+C	Int NC			285	144
	noMC+C	Int C				0
	MC noC	Bak NC				11
	Intra	Bak C				0
		For NC				9
		For C				23
		Intra				0
No. of coded MB			369	396	396	355
No. of coded blocks			693	2376	731	393
Diff DC			1929	17078	0	2
MBTYPE			1168	580	1429	1180
Quantiser			776	920	1013	670
MB address			400	396	396	402
Vector data			1747	0	1694	2063
Vector mp2 data			9947	0	9281	11873
CBP			904	0	1379	896
EOB			1386	4752	1461	786
Coeffs Y			36825	212037	24408	11151
Coeffs U			2813	23931	389	35
Coeffs V			2595	21687	492	53
Extra data			759	746	753	763
Seq. Extra data			8			
Total			49375	265048	33413	17991
Coeffs VLC REF			13101	18	28182	9874
Coeffs FLC REF			4720	41805	0	0
Coeffs EOB REF			5791	16	6995	6341
Total ref			25557	43808	37553	18345
bits EOB HF			2213	2376	2376	2130
Coeffs Y HF			9931	2447	1256	6548
Coeffs U HF			371	409	396	355
Coeffs V HF			384	461	421	358
Total hf			24199	29022	26657	22536

Item		All	Refresh	Normal
RMS for luminance		11.45	10.33	11.60
SNR for luminance		26.95	27.85	26.84
SNR for chrominance		30.75	31.94	30.61
SNR for chrominance		32.73	33.75	32.61
Mean value of QP		34.19	28.01	34.98
Non-zero coeffs/cod blck		3.18	4.68	2.87
Zero coeffs/coded block		21.56	21.73	21.52
Code	Intra		1	0
N Code	Intra		0	0
Code	Interp		575	197
N Code	Interp		44	14
Code	Next		30	34
N Code	Next		0	0
Code	Previous		127	15
N Code	Previous		0	0
Code	Copy		0	366
N Code	Copy		0	96
No. of coded MB		728	776	722
No. of coded blocks		1885	2868	1758
Diff DC		14	24	12
MBTYPE		2041	1873	2063
Quantiser		1155	1303	1136
MB address		812	797	814
No. Vector data		8172	12931	7560
of CBP		3118	3867	3021
bits EOB		5654	8605	5275
Coeffs Y		37034	80357	31469
Coeffs U		126	103	129
Coeffs V		656	1088	601
Extra data		748	742	749
Seq. Extra data		0		
Total		**58831**	**10980**	**52133**

Frame	Accum. Bitcount
10	1840764
20	3277795
30	4774322
40	6314949
50	7903277
60	9542002
70	11130699
80	12670958
90	14133982
100	15948009
110	17532861
120	19042556

SNR Y,U,V per frame

0	27.31	32.65	34.28	50	26.53	31.04	32.93	100	27.21	31.86	33.64
1	26.48	32.34	33.77	51	26.40	30.63	32.48	101	26.72	31.36	33.17
2	26.32	31.99	33.42	52	26.27	31.36	32.79	102	26.28	30.91	32.76
3	25.82	31.53	33.00	53	26.42	32.04	33.50	103	26.18	30.71	32.59
4	25.75	31.42	32.81	54	27.48	32.33	34.04	104	26.00	30.37	32.28
5	25.69	31.14	32.61	55	26.28	31.47	33.06	105	26.09	30.11	32.06
6	25.64	31.02	32.44	56	26.02	30.87	32.45	106	26.61	31.09	32.78
7	26.14	32.13	33.44	57	25.95	30.24	32.08	107	26.71	31.15	32.99
8	26.29	32.23	33.66	58	25.88	29.90	31.86	108	27.65	31.92	33.78
9	27.39	32.69	34.42	59	25.92	29.79	31.78	109	27.06	31.34	33.07
10	26.64	32.50	33.98	60	25.76	29.51	31.57	110	26.79	30.91	32.66
11	26.68	32.17	33.63	61	26.32	30.61	32.41	111	26.42	30.37	32.24
12	26.77	31.73	33.31	62	26.39	30.85	32.64	112	26.37	29.99	31.95
13	26.69	31.45	33.01	63	27.43	32.18	33.86	113	26.22	29.75	31.84
14	26.73	31.24	32.95	64	26.52	31.66	33.05	114	26.30	29.78	31.95
15	26.82	31.03	32.79	65	26.42	31.12	32.59	115	26.65	30.91	32.93
16	27.47	31.87	33.47	66	26.06	30.63	32.17	116	26.71	31.11	33.12
17	27.54	31.97	33.78	67	26.02	30.39	31.94	117	27.53	31.75	33.66
18	28.30	32.88	34.72	68	25.81	30.10	31.72	118	27.03	31.49	33.24
19	27.46	32.49	34.15	69	25.57	29.88	31.60	119	27.01	31.32	33.09
20	27.52	32.19	33.86	70	26.25	30.76	32.49	120	26.71	30.88	32.68
21	27.29	31.84	33.63	71	26.30	30.85	32.66	121	26.59	30.85	32.65
22	27.24	31.68	33.38	72	27.41	31.92	33.78	122	26.24	30.31	32.12
23	27.25	31.36	33.24	73	26.64	31.38	33.05				
24	27.28	31.19	33.18	74	26.50	30.98	32.66				
25	27.73	31.86	33.72	75	26.36	30.53	32.31				
26	28.16	31.97	33.91	76	26.18	30.28	32.08				
27	28.81	32.93	34.88	77	26.10	30.17	31.97				
28	28.29	32.47	34.35	78	25.94	29.98	31.85				
29	28.20	32.20	34.18	79	26.36	30.93	32.56				
30	28.40	31.98	33.97	80	26.46	31.14	32.84				
31	28.29	31.72	33.76	81	27.40	32.00	33.74				
32	28.13	31.38	33.55	82	26.75	31.58	33.09				
33	28.17	31.16	33.44	83	26.54	31.14	32.66				
34	28.03	31.65	33.75	84	26.22	30.68	32.35				
35	28.19	32.07	34.23	85	26.17	30.60	32.33				
36	28.82	32.80	35.05	86	25.96	30.21	32.02				
37	28.21	32.44	34.51	87	25.86	30.02	31.86				
38	28.04	32.14	34.30	88	26.61	31.33	32.91				
39	27.94	31.82	34.08	89	26.81	31.51	33.15				
40	28.22	31.70	33.93	90	27.70	32.06	33.87				
41	28.08	31.49	33.80	91	27.42	31.75	33.39				
42	27.71	31.38	33.61	92	27.16	31.37	33.11				
43	28.24	32.21	34.25	93	26.84	31.04	32.83				
44	28.14	32.37	34.40	94	27.13	30.91	32.78				
45	28.83	32.85	35.05	95	26.98	30.71	32.63				
46	27.94	32.41	34.48	96	26.71	30.47	32.44				
47	27.66	31.93	34.00	97	27.34	31.38	33.19				
48	27.24	31.51	33.58	98	27.32	31.76	33.59				
49	26.81	31.38	33.27	99	28.12	32.38	34.35				

Bitcount per frame

0	419043	50	124697	100	105308
1	101498	51	179987	101	121736
2	116829	52	137706	102	165879
3	137603	53	131919	103	124583
4	122196	54	424187	104	122020
5	121132	55	122679	105	167756
6	171135	56	135330	106	118892
7	118719	57	160765	107	111512
8	111315	58	111288	108	443242
9	421294	59	110167	109	103924
10	114694	60	160342	110	117283
11	113929	61	120108	111	137689
12	117226	62	118614	112	128210
13	101564	63	432212	113	129895
14	101834	64	110922	114	144781
15	143863	65	118124	115	101245
16	97866	66	134495	116	99240
17	95568	67	113624	117	466290
18	439197	68	112464	118	85668
19	111290	69	167792	119	99394
20	111474	70	118967	120	142614
21	137628	71	112885	121	121493
22	109545	72	430019	122	121285
23	116469	73	117149		
24	149347	74	123211		
25	105205	75	127118		
26	94303	76	124593		
27	455639	77	126120		
28	104423	78	142028		
29	112494	79	118169		
30	133537	80	112530		
31	106515	81	429175		
32	118251	82	91855		
33	142141	83	110996		
34	120933	84	134952		
35	107985	85	112906		
36	496096	86	111389		
37	81196	87	174600		
38	90805	88	93216		
39	143168	89	91405		
40	83586	90	447720		
41	95415	91	83038		
42	166087	92	93449		
43	106840	93	147361		
44	108223	94	86345		
45	506807	95	88766		
46	109763	96	173369		
47	127204	97	111726		
48	155359	98	109149		
49	129044	99	473104		

Calendar 9Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			6.65	5.87	6.72	6.76
SNR for luminance			31.67	32.76	31.59	31.53
SNR for chrominance			33.23	34.37	32.63	33.26
SNR for chrominance			36.45	38.16	35.96	36.35
Mean value of QP1			42.40	14.43	44.13	46.59
Mean value of QP2			11.08	3.23	11.77	12.19
Non-zero coeffs/cod blck			9.95	19.21	5.10	3.54
Non-zero coeffs_ref/cod blck			17.64	10.74	25.29	19.84
Non-zero coeffs_hf/cod blck			10.40	6.02	12.56	13.51
Zero coeffs/coded block			26.27	16.63	30.96	33.18
Zero coeffs_ref/coded block			51.43	13.73	69.92	78.35
Zero coeffs_hf/coded block			30.69	8.29	39.59	48.04
Intra	Pred	Interp				
C	Fixed	Fixed		396	0	34
C	MC+C	Int NC			286	152
	noMC+C	Int C				0
	MC noC	Bak NC				11
	Intra	Bak C				0
		For NC				8
		For C				25
		Intra				0
No. of coded MB			374	396	396	362
No. of coded blocks			696	2376	742	394
Diff DC			1929	17078	0	1
MBTYPE			1174	503	1438	1199
Quantiser			737	534	1028	673
MB address			397	396	396	398
Vector data			1752	0	1694	2071
Vector mp2 data			9923	0	9281	11837
CBP			908	0	1389	898
EOB			1393	4752	1483	788
Coeffs Y			36943	211106	25035	11274
Coeffs U			2744	23263	406	39
Coeffs V			2557	21308	510	55
Extra data			759	746	753	763
Seq. Extra data			8			
Total			49365	262607	34129	18148
Coeffs VLC REF			65480	10	10663	44944
Coeffs FLC REF			1132	10033	0	1
Coeffs EOB REF			6302	61	6527	6249
Total ref			85084	20994	11553	53368
bits EOB HF			2242	2376	2376	2174
Coeffs Y HF			4222	8593	5278	31159
Coeffs U HF			456	835	490	380
Coeffs V HF			719	1613	988	474
Total hf			56871	91834	67405	47305

Item		All	Refresh	Normal
RMS for luminance		6.14	5.43	6.23
SNR for luminance		32.37	33.44	32.25
SNR for chrominance		32.34	33.26	32.22
SNR for chrominance		36.00	36.66	35.92
Mean value of QP		14.23	12.09	14.51
Non-zero coeffs/cod blck		8.92	14.74	8.12
Zero coeffs/coded block			29.48	28.69
Code	Intra		0	0
N Code	Intra		0	0
Code	Interp		622	184
N Code	Interp		44	33
Code	Next		35	17
N Code	Next		0	0
Code	Previous		74	9
N Code	Previous		0	0
Code	Copy		0	512
N Code	Copy		0	18
No. of coded MB		773	775	773
No. of coded blocks		2692	2855	2671
Diff DC		1	5	0
MBTYPE		1995	1808	2020
Quantiser		1431	1534	1418
MB address		797	797	797
No. Vector data		8318	13183	7693
of CBP		3744	3859	3730
bits EOB		8077	8565	8014
Coeffs Y		137629	252161	122918
Coeffs U		1641	2619	1515
Coeffs V		4887	7390	4565
Extra data		748	742	749
Seq. Extra data		0		
Total		**168583**	**291973**	**152735**

Frame	Accum. Bitcount
10	4095801
20	7517353
30	10996375
40	14574302
50	18087253
60	21687952
70	25260871
80	28807201
90	32195874
100	36225975
110	39824015
120	43321555

SNR Y,U,V per frame

0	32.94	34.12	37.65	50	30.92	32.41	35.71	100	31.89	33.26	36.53
1	31.46	33.63	36.78	51	31.14	32.00	35.35	101	31.43	32.79	36.06
2	31.51	33.28	36.44	52	30.71	32.08	35.12	102	31.36	32.38	35.80
3	30.89	32.84	36.05	53	30.55	32.48	35.63	103	31.17	32.14	35.54
4	30.46	32.54	35.73	54	32.59	33.53	37.00	104	30.87	31.91	35.33
5	30.45	32.33	35.53	55	30.79	32.48	35.60	105	31.49	31.81	35.37
6	30.52	32.11	35.35	56	30.43	31.86	35.03	106	31.55	32.27	35.67
7	30.88	32.81	35.99	57	30.72	31.44	34.88	107	31.41	32.33	35.76
8	30.85	32.85	36.11	58	30.75	31.28	34.69	108	32.87	33.39	37.11
9	32.67	33.91	37.44	59	30.93	31.27	34.82	109	32.17	32.80	36.32
10	31.93	33.62	36.84	60	30.63	30.93	34.50	110	31.97	32.47	35.98
11	31.83	33.40	36.67	61	31.21	31.73	35.20	111	31.48	31.97	35.52
12	32.23	33.27	36.71	62	31.08	31.92	35.37	112	31.35	31.59	35.18
13	31.96	32.94	36.18	63	32.60	33.49	37.03	113	31.07	31.35	34.99
14	32.22	33.03	36.43	64	31.24	32.76	35.94	114	31.77	31.61	35.47
15	32.13	32.79	36.22	65	31.31	32.38	35.67	115	31.76	32.35	35.99
16	32.58	33.47	36.80	66	31.05	31.99	35.37	116	31.88	32.53	36.16
17	32.66	33.65	37.10	67	31.01	31.71	35.02	117	32.49	32.96	36.73
18	33.71	34.51	37.95	68	30.89	31.45	34.88	118	32.24	32.62	36.41
19	32.18	33.98	37.17	69	30.71	31.21	34.66	119	32.47	32.55	36.34
20	32.27	33.81	37.00	70	31.17	31.83	35.22	120	32.08	32.18	35.94
21	32.68	33.54	36.88	71	31.06	31.98	35.44	121	31.78	32.25	35.95
22	32.53	33.31	36.58	72	32.63	33.34	36.95	122	31.40	31.77	35.40
23	32.40	33.08	36.49	73	31.71	32.71	36.05				
24	33.19	33.22	36.81	74	31.45	32.38	35.74				
25	32.97	33.60	36.93	75	31.86	32.17	35.73				
26	33.47	33.71	37.19	76	31.26	31.87	35.27				
27	34.17	34.63	38.13	77	31.18	31.68	35.09				
28	33.44	34.19	37.47	78	31.23	31.54	35.07				
29	33.30	34.07	37.45	79	31.19	32.04	35.44				
30	34.04	34.02	37.56	80	31.25	32.21	35.65				
31	33.56	33.68	37.01	81	32.55	33.22	36.77				
32	33.36	33.49	36.87	82	31.90	32.81	36.18				
33	33.75	33.35	36.98	83	31.96	32.51	35.86				
34	32.69	33.38	36.77	84	31.22	32.15	35.59				
35	32.85	33.79	37.24	85	31.19	31.99	35.52				
36	33.98	34.43	37.98	86	31.06	31.68	35.18				
37	33.30	34.02	37.42	87	31.29	31.55	35.12				
38	33.39	33.84	37.34	88	32.18	32.64	36.16				
39	33.23	33.67	37.21	89	32.38	32.85	36.39				
40	33.78	33.64	37.16	90	33.07	33.47	37.18				
41	33.80	33.58	37.10	91	33.11	33.21	36.81				
42	33.13	33.34	36.83	92	33.13	33.06	36.72				
43	33.36	33.89	37.26	93	33.18	32.93	36.61				
44	33.14	33.98	37.35	94	33.64	32.95	36.62				
45	33.92	34.40	37.95	95	33.58	32.90	36.66				
46	32.74	33.84	37.22	96	33.03	32.64	36.43				
47	32.29	33.41	36.77	97	32.66	33.08	36.56				
48	32.04	33.03	36.54	98	32.35	33.19	36.74				
49	31.13	32.67	35.91	99	33.36	33.86	37.49				

Bitcount per frame

0	857817	50	275177	100	262167
1	262460	51	402323	101	278420
2	289276	52	309532	102	407220
3	357628	53	288672	103	288728
4	271973	54	808130	104	279801
5	277183	55	305133	105	396256
6	389026	56	301444	106	289301
7	282507	57	385717	107	277157
8	280374	58	256203	108	857550
9	827557	59	268368	109	261440
10	295451	60	361639	110	285409
11	298342	61	291524	111	346364
12	326156	62	282237	112	304708
13	258024	63	822702	113	290253
14	266428	64	260724	114	359660
15	339639	65	286417	115	261791
16	257360	66	346658	116	274379
17	259268	67	268215	117	878665
18	841051	68	266314	118	234282
19	279833	69	386489	119	262029
20	259210	70	289020	120	351741
21	354638	71	277360	121	281987
22	274889	72	825211	122	275943
23	283634	73	293945		
24	389086	74	294983		
25	265501	75	343838		
26	250434	76	297315		
27	858955	77	290520		
28	273439	78	342031		
29	269236	79	292107		
30	352881	80	286071		
31	272005	81	823729		
32	300524	82	244668		
33	351705	83	289893		
34	299255	84	321771		
35	262509	85	269448		
36	916475	86	262234		
37	222167	87	403592		
38	246748	88	245198		
39	353658	89	242069		
40	233076	90	876430		
41	252068	91	218995		
42	377337	92	242736		
43	257277	93	424935		
44	256254	94	233595		
45	914477	95	237662		
46	270386	96	392944		
47	289903	97	264118		
48	384111	98	258389		
49	278062	99	880297		

Appendix D

Simulation results for the 60Hz sequences

Simulation results for the 7 processed sequences are depicted in this appendix. All sequences are processed in the MPEG1 compatible mode, with about 1 Mbit/s in the MPEG1 channel. The sequences are:

- Flower Garden coded at 4Mbit/s
- Flower Garden coded at 9Mbits/s
- Popple coded at 9Mbit/s
- Table Tennis coded at 4Mbit/s
- Table Tennis coded at 9Mbit/s
- Mobile and Calendar coded at 4Mbit/s
- Mobile and Calendar coded at 9Mbit/s

Per coded sequence the following results are given:

- SM3/RM8 like statistics
- Accumulated bitcount
- SNR for Y,U,V for each frame
- Bitcount for each frame

Code files with size in 512 byte blocks, VMS dir/size command.

OUT_MPEG2_FLO91.CODE	1498
OUT_MPEG2_FLO91.CODE2	9853
OUT_MPEG2_MOB91.CODE	1204
OUT_MPEG2_MOB91.CODE2	9383
OUT_MPEG2_POP91.CODE	1203
OUT_MPEG2_POP91.CODE2	9874
OUT_MPEG2_TAB91.CODE	1223
OUT_MPEG2_TAB91.CODE2	9747
OUT_MPEG2_FLO41.CODE	1199
OUT_MPEG2_FLO41.CODE2	3653
OUT_MPEG2_MOB41.CODE	1229
OUT_MPEG2_MOB41.CODE2	3658
OUT_MPEG2_TAB41.CODE	1263
OUT_MPEG2_TAB41.CODE2	3682

Flower Garden 4 Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			10.55	8.77	11.32	10.49
SNR for luminance			27.66	29.27	27.05	27.71
SNR for chrominance			30.91	31.89	30.29	31.04
SNR for chrominance			33.55	34.25	33.25	33.58
Mean value of QP1			44.67	15.88	44.13	48.62
Mean value of QP2			24.72	9.54	24.82	26.66
Non-zero coeffs/cod blck			7.75	16.33	4.79	2.57
Non-zero coeffs_ref/cod blck			5.40	0.01	9.37	6.15
Non-zero coeffs_hf/cod blck			0.17	0.10	0.24	0.17
Zero coeffs/coded block			23.72	15.45	28.64	26.26
Zero coeffs_ref/coded block			33.30	0.02	43.05	55.41
Zero coeffs_hf/coded block			0.94	0.18	1.43	1.13
Intra	Pred	Interp				
C	Fixed	Fixed		330	0	8
	MC+C	Int NC			257	168
	noMC+C	Int C				0
	MC noC	Bak NC				73
	Intra	Bak C				0
		For NC				14
		For C				23
		Intra				0
No. of coded MB			325	330	330	322
No. of coded blocks			538	1980	791	255
Diff DC			1124	13053	0	0
MBTYPE			994	508	1249	960
Quantiser			581	891	966	395
MB address			332	330	330	333
Vector data			2384	0	2261	2741
Vector mp2 data			12755	0	11617	14846
CBP			662	0	1098	582
EOB			1077	3960	1582	510
Coeffs Y			24082	161324	25815	5582
Coeffs U			1133	12399	216	16
Coeffs V			731	8284	64	3
Extra data			645	632	639	649
Seq. Extra data			6			
Total			32620	188327	34217	11762
Coeffs VLC REF			17642	82	42903	10326
Coeffs FLC REF			1878	21818	0	0
Coeffs EOB REF			5322	7	5899	5794
Total ref			26622	21907	50782	18054
bits EOB HF			1950	1980	1980	1934
Coeffs Y HF			1836	2284	2431	1552
Coeffs U HF			325	332	330	322
Coeffs V HF			331	338	344	325
Total hf			18414	6086	18151	20116

Item		All	Refresh	Normal
RMS for luminance		10.20	8.56	10.35
SNR for luminance		27.96	29.48	27.83
SNR for chrominance		30.32	31.32	30.23
SNR for chrominance		33.56	34.10	33.51
Mean value of QP		30.73	24.10	31.36
Non-zero coeffs/cod blck		3.44	6.05	3.08
Zero coeffs/coded block		23.67	26.29	23.32
Code	Intra		0	0
N Code	Intra		0	0
Code	Interp		384	99
N Code	Interp		133	38
Code	Next		45	20,
N Code	Next		0	0
Code	Previous		85	6
N Code	Previous		1	1
Code	Copy		0	365
N Code	Copy		0	112
No. of coded MB		642	649	641
No. of coded blocks		1593	2185	1537
Diff DC		2	9	1
MBTYPE		1824	1754	1831
Quantiser		785	827	781
MB address		671	665	671
No. Vector data		8981	13586	8544
of CBP		2119	2288	2103
bits EOB		4779	6554	4611
Coeffs Y		34899	84161	30225
Coeffs U		104	76	107
Coeffs V		103	203	93
Extra data		634	628	635
Seq. Extra data		0		
Total		**54329**	**110171**	**49031**

Frame	Accum. Bitcount
12	1478953
24	3048251
36	4582659
48	6183387
60	7801547
72	9364993
84	10936903
96	12493692
108	14301005
120	15853083
132	17388979

SNR Y, U,V per frame

0	30.12	32.43	35.19	50	28.00	31.06	33.83	100	26.71	30.58	33.42
1	28.90	32.07	34.81	51	27.93	30.84	33.77	101	26.67	30.17	33.22
2	28.58	31.66	34.53	52	27.78	30.89	33.63	102	26.30	29.89	32.99
3	28.44	31.30	34.33	53	27.41	30.59	33.50	103	25.92	29.71	32.74
4	28.57	31.24	34.22	54	27.46	30.49	33.50	104	25.81	29.39	32.56
5	28.29	30.87	33.98	55	27.36	30.32	33.30	105	25.93	29.35	32.51
6	27.96	30.46	33.73	56	27.43	30.13	33.27	106	26.03	30.44	33.03
7	28.30	30.48	33.64	57	26.96	29.99	33.24	107	26.21	30.54	33.10
8	28.19	30.26	33.58	58	27.97	30.95	33.80	108	27.84	30.78	33.34
9	28.16	30.11	33.53	59	28.31	31.11	33.93	109	26.81	30.65	33.23
10	28.26	30.93	34.00	60	29.50	31.64	34.27	110	26.36	30.42	33.09
11	28.48	31.74	34.43	61	28.04	31.40	34.03	111	25.88	30.06	32.94
12	30.04	32.37	34.84	62	27.60	31.01	33.84	112	25.94	30.04	32.73
13	28.55	31.93	34.50	63	27.37	30.70	33.68	113	25.83	29.53	32.50
14	28.42	31.66	34.30	64	27.57	30.51	33.51	114	25.81	29.50	32.56
15	28.16	31.26	34.14	65	27.25	30.25	33.31	115	25.83	29.42	32.40
16	27.97	31.16	34.07	66	27.13	30.08	33.24	116	25.71	29.19	32.28
17	27.77	31.02	33.93	67	27.71	30.01	33.16	117	25.63	29.05	32.28
18	27.69	30.66	33.67	68	27.68	29.88	33.14	118	26.73	30.18	32.90
19	27.51	30.45	33.48	69	27.51	29.86	33.15	119	27.04	30.22	33.03
20	27.43	30.17	33.29	70	28.46	30.89	33.72	120	28.28	30.72	33.50
21	27.51	30.08	33.27	71	28.48	30.89	33.84	121	27.71	30.63	33.43
22	28.43	31.22	33.94	72	29.65	31.89	34.29	122	27.30	30.54	33.38
23	28.63	31.31	34.09	73	28.82	31.84	34.28	123	26.65	30.08	33.19
24	29.93	32.14	34.56	74	28.44	31.58	34.11	124	26.86	30.00	33.02
25	28.75	31.85	34.31	75	27.56	31.15	33.96	125	26.96	29.88	32.90
26	28.98	31.68	34.25	76	28.04	30.89	33.80	126	26.70	29.70	32.84
27	29.05	31.36	34.22	77	28.16	30.73	33.73	127	26.68	29.59	32.66
28	28.85	31.21	34.12	78	27.63	30.41	33.59	128	26.43	29.25	32.53
29	28.51	30.93	33.95	79	27.88	30.28	33.46	129	26.33	29.20	32.53
30	28.68	30.71	33.88	80	27.90	30.17	33.37	130	27.00	30.15	32.96
31	28.81	30.68	33.85	81	28.17	30.14	33.43	131	27.07	30.16	33.01
32	28.65	30.47	33.71	82	28.49	30.92	33.80	132	28.14	30.52	33.25
33	28.32	30.47	33.77	83	28.60	31.02	33.85	133	27.94	30.51	33.25
34	28.63	31.64	34.41	84	29.99	31.89	34.30	134	27.53	30.31	33.18
35	29.04	31.64	34.45	85	29.43	31.77	34.18	135	27.04	29.99	33.02
36	30.43	32.35	34.80	86	28.87	31.43	34.05	136	27.53	29.90	32.99
37	29.68	32.22	34.70	87	28.23	31.06	33.82	137	27.54	29.84	32.95
38	29.16	31.91	34.51	88	28.73	30.92	33.75	138	27.28	29.59	32.83
39	28.52	31.52	34.36	89	28.46	30.63	33.57	139	27.50	29.53	32.77
40	28.55	31.35	34.20	90	28.08	30.25	33.39	140	27.37	29.35	32.66
41	28.27	30.92	33.92	91	28.21	30.10	33.32	141	27.51	29.27	32.70
42	27.99	30.56	33.79	92	27.89	29.89	33.18	142	28.58	30.39	33.24
43	27.79	30.39	33.60	93	27.79	29.72	33.16	143	28.40	30.36	33.23
44	27.51	30.05	33.37	94	28.61	30.70	33.74	144	29.13	30.98	33.61
45	27.39	29.80	33.24	95	28.58	30.75	33.74	145	28.13	30.77	33.41
46	28.03	30.79	33.70	96	29.83	31.74	34.28	146	27.77	30.52	33.31
47	28.34	30.90	33.79	97	28.24	31.54	34.14	147	27.30	30.01	33.09
48	29.41	31.57	34.20	98	27.65	31.10	33.89	148	27.46	29.83	32.98
49	28.31	31.28	34.00	99	27.27	30.79	33.67	149	27.02	29.59	32.79

Bitcount per frame

0	282119	50	102577	100	124306
1	85729	51	132859	101	123782
2	91361	52	133083	102	160007
3	109733	53	144564	103	116382
4	91629	54	148289	104	121007
5	102407	55	91556	105	167351
6	152889	56	111697	106	120460
7	96011	57	153420	107	102506
8	95438	58	85128	108	291013
9	143046	59	90927	109	89513
10	112165	60	319242	110	115512
11	116426	61	100187	111	131174
12	300719	62	117489	112	120430
13	99122	63	149260	113	123997
14	88693	64	102167	114	139482
15	130305	65	106015	115	113639
16	115002	66	148254	116	114131
17	121797	67	86108	117	152195
18	176519	68	90923	118	83403
19	100448	69	158002	119	77589
20	95376	70	99158	120	308649
21	153890	71	86641	121	74942
22	93719	72	360145	122	111660
23	93708	73	73042	123	154534
24	313014	74	101243	124	103350
25	98967	75	162149	125	81026
26	90725	76	83771	126	141072
27	128719	77	86312	127	123449
28	106467	78	175059	128	113356
29	95587	79	92398	129	165672
30	146001	80	91881	130	75401
31	94185	81	149366	131	82785
32	98407	82	96298	132	332429
33	167497	83	100246	133	72959
34	116561	84	354483	134	101061
35	78278	85	76396	135	139645
36	341599	86	98850	136	86138
37	80578	87	140948	137	88014
38	95976	88	87884	138	135859
39	138566	89	97624	139	100521
40	106152	90	151788	140	90571
41	96584	91	105089	141	156555
42	166760	92	92781	142	75221
43	121494	93	177238	143	77315
44	117299	94	89799	144	375890
45	167942	95	83909	145	85070
46	84515	96	347849	146	115308
47	83263	97	121557	147	181939
48	317259	98	137421	148	95576
49	106801	99	164685	149	79834

Flower Garden 9Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			5.60	4.60	5.30	5.84
SNR for luminance			33.17	34.87	33.64	32.81
SNR for chrominance			32.71	33.91	32.25	32.74
SNR for chrominance			36.21	37.37	36.03	36.14
Mean value of QP1			45.56	16.17	45.27	49.49
Mean value of QP2			9.85	3.40	9.64	10.77
Non-zero coeffs/cod blck			7.93	16.89	4.67	2.53
Non-zero coeffs_ref/cod blck			25.25	9.59	35.00	29.98
Non-zero coeffs_hf/cod blck			2.77	1.49	3.97	2.69
Zero coeffs/coded block			23.45	15.37	28.39	26.01
Zero coeffs_ref/coded block			55.54	13.16	55.49	99.12
Zero coeffs_hf/coded block			12.30	3.34	17.15	15.86
Intra	Pred	Interp				
C	Fixed	Fixed		330	0	7
	MC+C	Int NC			254	163
	noMC+C	Int C				0
	MC noC	Bak NC				76
	Intra	Bak C				0
		For NC				17
		For C				30
		Intra				0
No. of coded MB			325	330	330	323
No. of coded blocks			529	1980	767	251
Diff DC			1124	13053	0	0
MBTYPE			987	427	1220	972
Quantiser			513	483	922	361
MB address			332	330	330	332
Vector data			2313	0	2261	2633
Vector mp2 data			12322	0	11617	14192
CBP			655	0	1092	574
EOB			1059	3960	1533	501
Coeffs Y			24131	166804	24529	5432
Coeffs U			1173	12907	207	15
Coeffs V			760	8638	57	3
Extra data			645	632	639	649
Seq. Extra data			6			
Total			32566	194180	32787	11463
Coeffs VLC REF			73678	78	15350	42747
Coeffs FLC REF			6314	73336	0	0
Coeffs EOB REF			5615	54	5449	5699
Total ref			87387	15707	16093	50382
bits EOB HF			1951	1980	1980	1937
Coeffs Y HF			9537	1701	1805	5329
Coeffs U HF			339	370	364	326
Coeffs V HF			575	896	1009	368
Total hf			25780	20987	34186	23209

Item		All	Refresh	Normal
RMS for luminance		4.92	4.00	5.01
SNR for luminance		34.29	36.09	34.13
SNR for chrominance		32.78	33.50	32.71
SNR for chrominance		36.50	36.49	36.50
Mean value of QP		11.68	8.83	11.95
Non-zero coeffs/cod blck		9.70	17.98	8.92
Zero coeffs/coded block		29.89	28.88	29.99
Code	Intra		0	0
N Code	Intra		0	0
Code	Interp		401	80
N Code	Interp		133	97
Code	Next		42	15.
N Code	Next		0	0
Code	Previous		71	4
N Code	Previous		1	1
Code	Copy		0	416
N Code	Copy		0	36
No. of coded MB		650	649	650
No. of coded blocks		2186	2182	2186
Diff DC		1	3	0
MBTYPE		1810	1735	1818
Quantiser		906	1003	896
MB address		664	665	664
No. Vector data		9395	13699	8986
of CBP		2252	2286	2249
bits EOB		6557	6546	6558
Coeffs Y		129520	274490	115763
Coeffs U		1313	1148	
Coeffs V		2580	3081	2532
Extra data		634	628	635
Seq. Extra data		0		
Total		**155060**	**306609**	**140680**

Frame	Accum. Bitcount
12	3608069
24	7163936
36	10707908
48	14285666
60	17988319
72	21524170
84	25087870
96	28618519
108	32444979
120	35992794
132	39515584

SNR Y,U,V per frame

0	37.55	35.60	38.82	50	33.61	32.86	36.31	100	32.05	31.96	35.48
1	35.15	34.94	38.12	51	34.41	32.84	36.60	101	31.88	31.48	35.19
2	35.31	34.66	37.97	52	33.57	32.36	36.01	102	31.91	31.22	35.00
3	36.08	34.70	38.40	53	32.64	32.02	35.81	103	31.03	30.96	34.70
4	35.06	34.32	37.73	54	34.53	32.38	36.44	104	30.99	30.73	34.52
5	34.76	33.78	37.32	55	33.56	32.35	36.16	105	31.76	30.79	34.55
6	35.10	33.39	37.21	56	33.57	32.23	36.08	106	31.60	31.54	35.04
7	34.77	33.45	37.05	57	33.06	31.92	35.88	107	31.52	31.82	35.28
8	34.78	33.39	37.08	58	33.56	32.82	36.50	108	34.38	32.96	36.11
9	35.09	33.31	37.15	59	34.05	33.11	36.78	109	32.51	32.57	35.83
10	34.49	33.28	36.95	60	35.02	33.28	36.52	110	32.11	31.91	35.32
11	34.19	33.75	37.24	61	32.95	32.89	36.28	111	31.64	31.64	35.20
12	36.79	34.90	37.89	62	32.61	32.31	35.96	112	31.34	31.40	34.83
13	34.08	34.04	37.22	63	33.65	32.25	36.08	113	31.08	30.78	34.43
14	34.26	34.04	37.19	64	33.44	32.28	36.01	114	31.62	30.93	34.76
15	33.92	33.64	37.14	65	33.22	32.08	35.82	115	31.51	30.96	34.70
16	33.30	33.25	36.83	66	33.97	32.27	36.14	116	31.31	30.73	34.60
17	33.06	32.87	36.61	67	34.40	32.60	36.44	117	31.99	30.80	34.76
18	34.07	32.49	36.36	68	34.38	32.68	36.58	118	32.67	31.96	35.57
19	33.21	32.37	36.15	69	34.39	32.50	36.48	119	33.10	32.27	35.92
20	33.44	32.34	36.10	70	33.97	33.11	36.66	120	34.19	32.59	36.00
21	34.19	32.47	36.41	71	33.95	33.22	36.83	121	33.03	32.55	36.04
22	34.48	33.51	37.04	72	35.17	33.40	36.71	122	32.89	32.34	35.95
23	34.52	33.80	37.30	73	33.38	33.42	36.73	123	33.66	31.97	35.89
24	36.47	34.64	37.79	74	33.38	33.17	36.66	124	33.12	32.02	35.81
25	34.55	34.20	37.36	75	33.77	32.84	36.52	125	33.52	32.24	35.96
26	34.68	34.22	37.45	76	33.69	32.81	36.42	126	33.22	32.07	35.88
27	35.59	34.19	37.70	77	34.21	32.97	36.61	127	32.13	31.66	35.48
28	34.36	33.81	37.10	78	34.01	32.65	36.40	128	31.74	31.18	35.10
29	34.24	33.50	36.89	79	33.77	32.66	36.42	129	33.06	31.27	35.32
30	35.17	33.53	37.17	80	34.10	32.81	36.51	130	32.67	32.05	35.73
31	34.72	33.55	37.04	81	35.23	32.95	36.83	131	32.90	32.04	35.79
32	34.69	33.45	36.99	82	34.21	32.98	36.65	132	33.64	32.18	35.60
33	35.01	33.27	36.97	83	34.19	33.53	37.02	133	33.08	32.31	35.82
34	33.90	33.56	36.94	84	36.12	34.16	37.28	134	33.08	32.28	35.98
35	34.13	33.75	37.07	85	34.46	34.07	37.14	135	34.52	32.32	36.17
36	36.73	34.78	37.68	86	34.34	33.79	37.04	136	33.97	32.50	36.20
37	35.09	34.52	37.67	87	34.81	33.55	36.97	137	34.01	32.56	36.31
38	34.73	34.14	37.48	88	34.71	33.62	36.93	138	34.18	32.41	36.23
39	34.83	33.76	37.29	89	34.58	33.49	36.87	139	33.50	32.21	36.07
40	33.71	33.36	36.85	90	34.59	33.11	36.75	140	33.27	32.23	36.01
41	33.69	32.88	36.45	91	33.90	32.81	36.40	141	34.24	32.24	36.19
42	33.96	32.60	36.49	92	33.70	32.69	36.27	142	34.17	33.00	36.56
43	33.04	32.23	36.11	93	34.28	32.50	36.35	143	34.05	32.96	36.50
44	32.61	31.88	35.84	94	34.23	33.32	36.85	144	34.56	32.76	36.22
45	33.92	31.92	36.05	95	34.28	33.42	36.93	145	32.69	32.48	35.94
46	33.40	32.61	36.37	96	35.89	34.05	37.31	146	32.46	32.11	35.77
47	33.94	32.87	36.56	97	33.04	33.36	36.61	147	33.92	31.94	35.90
48	35.34	33.51	36.55	98	32.26	32.50	36.01	148	33.29	31.94	35.73
49	33.80	33.13	36.46	99	33.29	32.39	36.00	149	33.33	31.71	35.47

Bitcount per frame

0	677831	50	204675	100	261254
1	208592	51	338501	101	251317
2	234836	52	283236	102	343389
3	355766	53	281316	103	236011
4	209986	54	411477	104	244459
5	240144	55	209531	105	375568
6	380387	56	260985	106	277480
7	222725	57	348790	107	238590
8	226076	58	203704	108	643160
9	323157	59	227460	109	226979
10	258212	60	615351	110	259062
11	270357	61	240759	111	296202
12	664102	62	243215	112	260798
13	241287	63	366135	113	261386
14	211013	64	232792	114	303881
15	276687	65	233784	115	263911
16	234433	66	364716	116	248857
17	248476	67	220379	117	361447
18	420012	68	230389	118	208566
19	218472	69	356793	119	213566
20	209530	70	221327	120	633846
21	373987	71	210211	121	188058
22	227517	72	689220	122	252236
23	230351	73	179797	123	426046
24	686049	74	242784	124	234515
25	236562	75	423342	125	201845
26	218735	76	198383	126	299422
27	338541	77	212987	127	265858
28	231696	78	379221	128	220738
29	204552	79	201758	129	412983
30	351024	80	213792	130	185814
31	211037	81	374210	131	201429
32	224876	82	214996	132	661586
33	407695	83	233210	133	182965
34	258577	84	719106	134	230388
35	174628	85	184260	135	438883
36	755536	86	231801	136	220487
37	194712	87	364989	137	222674
38	216775	88	215361	138	326875
39	370746	89	230882	139	241310
40	213474	90	335676	140	205280
41	196139	91	232382	141	369563
42	356048	92	203450	142	189988
43	244392	93	386722	143	201804
44	226601	94	210345	144	715209
45	419199	95	215675	145	193452
46	188850	96	686030	146	229886
47	195286	97	258807	147	517809
48	677987	98	252965	148	214435
49	254991	99	400590	149	182384

Popple 9 Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			4.59	4.38	4.34	4.72
SNR for luminance			34.89	35.29	35.39	34.66
SNR for chrominance			34.48	37.78	34.16	34.25
SNR for chrominance			38.34	40.55	38.31	38.10
Mean value of QP1			33.23	10.03	33.49	36.15
Mean value of QP2			7.70	2.84	7.79	8.30
Non-zero coeffs/cod blck			5.03	9.90	4.32	3.13
Non-zero coeffs_ref/cod blck			15.80	3.09	22.85	18.33
Non-zero coeffs_hf/cod blck			7.01	2.18	11.73	7.04
Zero coeffs/coded block			13.42	10.92	15.11	13.78
Zero coeffs_ref/coded block			33.13	7.70	42.88	40.21
Zero coeffs_hf/coded block			26.06	3.82	54.59	23.00
Intra	Pred	Interp			I	
C	Fixed	Fixed		330	0	3
	MC+C	Int NC			188	163
	noMC+C	Int C				2
	MC noC	Bak NC				14
	Intra	Bak C				0
		For NC				1
		For C				11
		Intra				0
No. of coded MB			328	330	330	327
No. of coded blocks			717	1980	687	564
Diff DC			982	11352	0	7
MBTYPE			1040	384	1201	1065
Quantiser			627	272	737	631
MB address			330	330	330	330
Vector data			5965	0	4673	7231
Vector mp2 data			29621	0	21762	36458
CBP			999	0	1207	1050
EOB			1434	3960	1374	1128
Coeffs Y			16053	90178	13378	7434
Coeffs U			3574	20131	231	1902
Coeffs V			3110	17816	195	1636
Extra data			645	632	639	649
Seq. Extra data			6			
Total			33777	133703	27806	23046
Coeffs VLC REF			65525	26	92436	60395
Coeffs FLC REF			2496	28954	0	4
Coeffs EOB REF			5509	31	5695	5749
Total ref			75326	58408	10011	68108
bits EOB HF			1967	1980	1980	1961
Coeffs Y HF			2892	2600	4807	22030
Coeffs U HF			776	808	957	703
Coeffs V HF			2137	1728	2731	1965
Total hf			64267	31055	76387	63979

Item		All	Refresh	Normal
RMS for luminance		4.32	3.81	4.37
SNR for luminance		35.42	36.50	35.33
SNR for chrominance		35.37	37.16	35.21
SNR for chrominance		38.79	39.78	38.70
Mean value of QP		9.44	6.53	9.71
Non-zero coeffs/cod blck		9.67	17.56	8.97
Zero coeffs/coded block		24.59	25.38	24.53
Code	Intra		2	2
N Code	Intra		0	0
Code	Interp		306	241
N Code	Interp		298	288
Code	Next		22	17
N Code	Next		1	1
Code	Previous		29	18
N Code	Previous		1	1
Code	Copy		0	88
N Code	Copy		0	4
No. of coded MB		659	659	659
No. of coded blocks		1548	1443	1557
Diff DC		86	78	86
MBTYPE		2185	2012	2201
Quantiser		764	842	757
MB address		660	660	660
No. Vector data		24240	25125	24156
of CBP		2167	2139	2169
bits EOB		4643	4330	4672
Coeffs Y		78793	152036	71842
Coeffs U		4864	8276	4540
Coeffs V		10271	15322	9792
Extra data		634	628	635
Seq. Extra data		0		
Total		**128650**	**210800**	**120855**

Frame	Accum. Bitcount
12	3739517
24	7330336
36	10907703
48	14481807
60	18117700
72	21723204
84	25340114
96	28982983
108	32649581
120	36260702
132	39865235

SNR Y, U,V per frame

0	36.74	38.88	41.30	50	35.62	36.70	39.89	100	34.78	33.74	37.63
1	35.45	36.63	39.81	51	36.12	36.41	40.02	101	34.69	33.53	37.54
2	35.46	36.72	39.85	52	35.30	35.93	39.36	102	34.85	33.36	37.55
3	36.58	37.48	40.64	53	35.30	35.92	39.39	103	34.21	32.88	36.88
4	35.55	36.51	39.70	54	35.88	36.04	39.85	104	34.31	32.84	36.93
5	35.44	36.30	39.69	55	35.14	35.70	39.14	105	34.61	32.85	37.02
6	36.68	36.80	40.39	56	35.14	35.61	39.14	106	34.17	32.76	36.74
7	35.67	36.38	39.75	57	35.98	35.96	39.72	107	34.29	33.00	36.99
8	35.58	36.16	39.73	58	35.42	36.29	39.63	108	34.98	35.42	38.57
9	36.21	36.07	39.86	59	35.49	36.52	39.87	109	34.31	33.04	37.03
10	35.33	36.15	39.49	60	36.44	38.93	41.35	110	34.35	32.92	36.91
11	35.35	36.43	39.61	61	35.54	36.78	39.91	111	34.67	33.33	37.22
12	36.10	38.60	40.80	62	35.33	36.41	39.89	112	34.24	32.73	36.85
13	35.36	36.49	39.60	63	35.90	36.26	39.95	113	34.46	32.69	36.91
14	35.45	36.48	39.64	64	35.25	35.80	39.32	114	34.50	32.61	36.73
15	36.04	36.35	39.76	65	35.26	35.72	39.39	115	34.34	32.60	36.72
16	35.44	36.03	39.35	66	35.83	35.69	39.63	116	34.52	32.78	36.87
17	35.44	35.99	39.36	67	35.48	35.74	39.42	117	34.31	32.49	36.56
18	35.88	35.85	39.59	68	35.69	35.69	39.42	118	33.98	32.62	36.59
19	35.38	35.68	39.20	69	36.13	35.80	39.86	119	34.14	32.74	36.82
20	35.34	35.70	39.28	70	36.00	36.36	40.04	120	34.62	34.99	38.09
21	35.90	35.78	39.61	71	36.09	36.60	40.08	121	33.45	32.36	36.20
22	35.46	36.15	39.53	72	36.96	39.27	41.79	122	33.61	32.18	36.20
23	35.48	36.32	39.68	73	36.71	37.29	40.46	123	33.67	32.49	36.30
24	36.47	38.83	41.18	74	36.66	37.08	40.37	124	33.26	31.88	35.84
25	35.61	36.77	40.02	75	37.05	36.82	40.58	125	33.36	31.75	35.86
26	35.60	36.64	39.87	76	36.65	36.68	40.22	126	33.44	31.93	35.94
27	36.14	36.53	39.93	77	36.80	36.98	40.31	127	33.19	31.75	35.78
28	35.41	36.06	39.52	78	37.18	36.63	40.41	128	33.41	31.79	35.87
29	35.44	36.18	39.66	79	36.81	36.88	40.25	129	33.39	31.66	35.72
30	35.96	36.18	39.85	80	36.92	37.21	40.31	130	33.26	32.02	35.90
31	35.39	35.95	39.54	81	37.51	37.19	40.76	131	33.60	32.23	36.17
32	35.44	35.98	39.52	82	37.12	38.09	40.87	132	34.25	34.69	37.80
33	35.97	35.93	39.83	83	37.06	38.15	40.90	133	33.17	31.99	35.86
34	35.49	36.33	39.80	84	37.42	40.46	42.44	134	33.23	31.97	35.84
35	35.55	36.58	39.87	85	37.10	38.22	40.72	135	33.21	32.15	35.88
36	36.54	39.08	41.22	86	37.08	37.78	41.07	136	32.79	31.50	35.35
37	35.66	36.92	40.07	87	37.38	37.05	40.78	137	33.03	31.50	35.48
38	35.65	36.85	40.03	88	36.68	36.53	40.11	138	32.99	31.64	35.54
39	36.16	36.64	40.22	89	36.75	36.51	40.17	139	32.82	31.50	35.47
40	35.49	36.20	39.62	90	37.05	35.98	40.07	140	33.20	31.55	35.68
41	35.45	36.12	39.60	91	36.43	35.92	39.68	141	33.03	31.42	35.40
42	36.03	36.11	39.96	92	36.38	35.66	39.58	142	32.94	31.78	35.62
43	35.43	35.90	39.53	93	36.66	35.54	39.70	143	33.21	31.93	35.83
44	35.38	35.89	39.53	94	35.74	35.05	38.85	144	34.21	34.67	37.80
45	36.02	35.94	39.88	95	35.74	35.07	38.92	145	33.03	32.01	35.81
46	35.46	36.23	39.60	96	36.12	37.24	40.36	146	33.33	31.92	35.81
47	35.51	36.57	39.83	97	35.51	34.86	38.67	147	34.03	32.61	36.43
48	36.28	38.82	41.17	98	35.41	34.59	38.41	148	32.88	31.53	35.56
49	35.61	36.80	39.87	99	35.62	34.55	38.65	149	32.73	30.83	35.02

Bitcount per frame

0	501517	50	260347	100	304923
1	242212	51	331046	101	289554
2	254223	52	260272	102	316851
3	445162	53	264832	103	299442
4	265299	54	351123	104	290282
5	254163	55	264688	105	322491
6	394120	56	257535	106	290797
7	260766	57	355741	107	281653
8	259711	58	263099	108	348370
9	352608	59	252491	109	314387
10	253368	60	477206	110	291068
11	256368	61	277360	111	309521
12	515861	62	270615	112	298386
13	252279	63	345538	113	293438
14	261311	64	268497	114	293367
15	339940	65	264029	115	293543
16	259747	66	317414	116	294021
17	261141	67	260683	117	286291
18	329319	68	261861	118	293484
19	257901	69	316863	119	295245
20	257382	70	280557	120	366155
21	340155	71	264881	121	302726
22	258409	72	437044	122	295900
23	257374	73	295582	123	288307
24	514472	74	276798	124	298526
25	257623	75	316439	125	296013
26	265894	76	264003	126	294937
27	326117	77	268126	127	300015
28	260331	78	306924	128	290089
29	258731	79	260711	129	287923
30	330740	80	272961	130	293947
31	255731	81	327055	131	289995
32	255814	82	307611	132	368425
33	338276	83	283656	133	302760
34	258856	84	352822	134	294658
35	254782	85	309306	135	293505
36	517803	86	291281	136	294201
37	255010	87	314198	137	289749
38	261277	88	275309	138	302220
39	333384	89	293370	139	292662
40	254713	90	331612	140	284421
41	256513	91	287707	141	293838
42	341923	92	293075	142	298256
43	251351	93	325865	143	282171
44	256806	94	282943	144	383195
45	342018	95	285381	145	305592
46	250895	96	340868	146	286659
47	252411	97	307063	147	405632
48	517839	98	295038	148	300630
49	256880	99	327636	149	151071

Table Tennis 4 Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			7.79	7.67	7.87	7.77
SNR for luminance			30.30	30.44	30.21	30.32
SNR for chrominance			39.04	40.80	38.45	39.04
SNR for chrominance			38.77	40.63	38.23	38.74
Mean value of QP1			19.41	8.89	20.08	20.63
Mean value of QP2			17.23	6.30	17.74	18.57
Non-zero coeffs/cod blck			8.47	12.95	5.98	6.28
Non-zero coeffs_ref/cod blck			3.20	0.94	4.83	3.91
Non-zero coeffs_hf/cod blck			3.59	2.17	4.50	4.15
Zero coeffs/coded block			22.34	15.40	25.27	26.68
Zero coeffs_ref/coded block			16.35	1.10	23.67	24.93
Zero coeffs_hf/coded block			14.76	4.04	16.56	24.26
Intra	Pred	Interp				
C	Fixed	Fixed		330	1	36
	MC+C	Int NC			206	167
	noMC+C	Int C				2
	MC noC	Bak NC				95
	Intra	Bak C				0
		For NC				11
		For C				13
		Intra				0
No. of coded MB			306	330	329	294
No. of coded blocks			536	1980	730	262
Diff DC			921	9795	0	20
MBTYPE			859	438	1055	846
Quantiser			452	540	655	365
MB address			332	330	330	333
Vector data			2355	0	2093	2781
Vector mp2 data			12680	0	11389	14933
CBP			614	0	1108	516
EOB			1072	3960	1459	524
Coeffs Y			26049	137542	26728	10188
Coeffs U			647	5466	347	84
Coeffs V			1171	8009	100	275
Extra data			645	632	639	649
Seq. Extra data			7			
Total			34195	156916	35415	16553
Coeffs VLC REF			10031	76	21084	6279
Coeffs FLC REF			1401	15110	0	0
Coeffs EOB REF			4944	40	5828	5253
Total ref			18026	23126	28889	13292
bits EOB HF			1835	1980	1977	1763
Coeffs Y HF			1285	2787	2029	8002
Coeffs U HF			307	333	331	294
Coeffs V HF			316	348	359	296
Total hf			28837	31331	35405	26058

Item		All	Refresh	Normal
RMS for luminance		7.38	6.60	7.46
SNR for luminance		30.77	31.73	30.68
SNR for chrominance		39.09	39.98	39.00
SNR for chrominance		39.05	39.88	38.96
Mean value of QP		21.52	17.11	21.97
Non-zero coeffs/cod blck		4.95	12.21	3.97
Zero coeffs/coded block		29.23	29.64	29.17
Code	Intra	2	1	
N Code	Intra	0	0	
Code	Interp	421	122	
N Code	Interp	163	88	
Code	Next	33	10	
N Code	Next	1	1	
Code	Previous	17	5	
N Code	Previous	1	2	
Code	Copy	0	259	
N Code	Copy	0	125	
No. of coded MB		615	637	613
No. of coded blocks		1080	1375	1050
Diff DC		32	73	28
MBTYPE		1786	1689	1796
Quantiser		382	439	376
MB address		679	674	680
No. Vector data		9501	15778	8855
of CBP		1735	1967	1711
bits EOB		3240	4126	3149
Coeffs Y		35024	27392	
Coeffs U		39	138	29
Coeffs V		268	246	
Extra data		634	628	635
Seq. Extra data		0		
Total		**52720**	**134515**	**44300**

Frame	Accum. Bitcount
12	2965292
24	4975867
36	6413825
48	7537810
60	8747080
72	10156639
84	11406194
96	12756081
108	14431889
120	15878414
132	17571643

SNR Y,U,V per frame

0	33.32	41.42	41.78	50	32.65	38.83	37.90	100	31.84	39.52	39.60
1	31.64	40.84	40.78	51	32.50	38.17	37.49	101	31.64	39.37	39.48
2	31.46	40.82	40.70	52	32.45	37.86	37.36	102	31.54	39.17	39.43
3	31.20	40.77	40.91	53	32.42	37.36	37.13	103	31.57	39.00	39.24
4	29.17	40.10	39.83	54	32.29	36.61	36.67	104	31.37	38.93	39.16
5	28.24	39.73	39.38	55	32.38	36.77	37.07	105	31.27	38.86	39.06
6	28.21	39.74	39.37	56	32.42	36.45	36.96	106	31.38	38.64	38.98
7	27.51	39.06	38.58	57	32.38	36.34	36.97	107	31.26	38.59	38.92
8	27.19	38.97	38.66	58	32.81	38.21	38.30	108	31.20	38.61	38.95
9	26.78	38.93	38.48	59	32.91	38.77	38.79	109	31.52	39.43	39.50
10	26.74	39.59	39.01	60	33.68	40.07	39.79	110	31.46	39.52	39.62
11	27.03	39.98	39.34	61	32.98	38.85	38.72	111	31.38	40.04	40.05
12	26.87	41.24	40.45	62	32.95	38.35	38.52	112	31.83	39.85	39.84
13	26.74	40.78	39.69	63	32.74	37.82	38.12	113	31.74	39.78	39.73
14	26.55	40.70	39.38	64	32.75	37.66	37.84	114	31.81	39.73	39.69
15	26.06	40.50	39.09	65	32.60	37.44	37.74	115	31.83	39.39	39.32
16	26.19	39.96	38.63	66	32.49	36.85	37.42	116	31.71	39.26	39.12
17	26.23	39.88	38.55	67	31.09	38.99	39.12	117	31.67	39.10	39.17
18	25.84	39.70	38.31	68	31.21	39.17	39.23	118	31.76	38.74	38.90
19	25.90	39.18	38.08	69	31.80	39.46	39.91	119	31.55	38.56	38.85
20	25.91	38.96	37.94	70	32.07	39.11	39.29	120	31.43	38.64	38.91
21	25.63	38.91	37.75	71	32.05	38.87	39.09	121	31.38	39.33	39.33
22	25.55	39.31	38.24	72	32.13	38.62	38.81	122	31.34	39.58	39.57
23	25.50	39.98	38.84	73	32.10	38.53	38.93	123	31.30	40.01	39.86
24	26.60	41.19	40.34	74	32.05	38.36	38.93	124	31.23	39.58	39.31
25	26.26	40.36	39.21	75	32.05	38.25	38.66	125	31.37	39.37	39.20
26	26.73	40.18	39.05	76	32.08	38.27	38.72	126	31.58	39.16	39.01
27	26.83	39.76	38.39	77	32.08	38.14	38.65	127	30.89	38.61	38.69
28	27.16	39.22	38.30	78	32.18	38.16	38.60	128	31.11	38.49	38.60
29	27.27	39.11	38.10	79	32.42	38.86	39.30	129	31.17	38.31	38.41
30	27.25	38.73	37.85	80	32.43	39.03	39.38	130	30.92	37.94	38.23
31	27.82	38.36	37.89	81	32.39	39.55	40.00	131	30.84	37.69	38.11
32	28.03	38.26	37.78	82	32.70	39.30	39.60	132	31.05	37.76	38.19
33	28.29	38.17	37.64	83	32.65	39.33	39.60	133	31.34	38.75	38.86
34	29.45	39.86	39.16	84	32.81	39.16	39.44	134	31.15	39.04	39.17
35	30.00	40.39	39.66	85	32.82	38.99	39.39	135	31.21	39.81	39.55
36	30.94	42.11	41.04	86	32.85	39.02	39.36	136	31.11	39.27	38.99
37	30.67	41.00	39.89	87	32.89	38.85	39.27	137	31.33	39.19	39.01
38	30.85	40.65	39.66	88	32.91	38.76	39.31	138	31.30	39.02	38.86
39	30.75	40.27	38.92	89	32.90	38.67	39.30	139	31.26	38.65	38.62
40	31.13	39.96	38.63	90	33.01	38.64	39.33	140	30.58	38.41	38.51
41	31.20	39.40	38.36	91	33.25	39.27	39.84	141	30.86	38.30	38.47
42	31.08	38.84	37.89	92	33.28	39.47	39.83	142	30.62	37.81	38.11
43	31.42	38.45	37.63	93	33.14	39.95	40.41	143	30.55	37.67	38.06
44	31.51	37.98	37.33	94	33.36	39.77	40.00	144	30.64	37.81	38.01
45	31.58	37.73	37.02	95	33.34	39.65	40.02	145	30.62	38.64	38.65
46	32.35	39.51	38.38	96	33.43	39.44	39.80	146	30.47	38.82	38.79
47	32.66	40.24	38.87	97	31.98	39.37	39.34	147	30.55	39.39	39.49
48	33.67	41.76	40.78	98	31.54	39.52	39.70	148	30.42	38.96	38.93
49	32.82	39.33	38.63	99	31.90	39.83	40.22	149	30.43	38.43	38.51

Bitcount per frame

0	490484	50	65776	100	43720
1	102817	51	80638	101	44601
2	113001	52	66877	102	106527
3	236521	53	65377	103	39389
4	52761	54	86931	104	40938
5	72769	55	63516	105	104096
6	182253	56	63496	106	38444
7	63882	57	89591	107	37609
8	74646	58	60137	108	103063
9	159367	59	57734	109	33194
10	79855	60	134769	110	33488
11	66931	61	63232	111	236021
12	205601	62	60903	112	36063
13	76547	63	86860	113	35268
14	68212	64	64545	114	88953
15	136201	65	63163	115	36661
16	56983	66	95213	116	38735
17	58704	67	36443	117	87917
18	123751	68	33463	118	41421
19	61834	69	162877	119	41062
20	60957	70	47550	120	102411
21	114780	71	46103	121	48519
22	72648	72	81950	122	42475
23	91071	73	48382	123	238847
24	185110	74	46639	124	69936
25	81927	75	76090	125	43341
26	72821	76	46967	126	101555
27	79623	77	45997	127	62135
28	63525	78	78183	128	51707
29	64188	79	34645	129	106217
30	72598	80	37876	130	45227
31	62549	81	186210	131	46264
32	60602	82	42762	132	105973
33	68500	83	40735	133	48647
34	112649	84	83422	134	54687
35	67228	85	43387	135	215688
36	116946	86	44737	136	65341
37	58955	87	80000	137	55838
38	61484	88	43753	138	91819
39	69652	89	42700	139	52075
40	60902	90	82596	140	50067
41	61491	91	38039	141	93763
42	73103	92	38981	142	65792
43	61157	93	212735	143	60323
44	63704	94	41762	144	99972
45	77088	95	43163	145	67060
46	62077	96	88845	146	62357
47	60051	97	86365	147	206473
48	118747	98	48664	148	58908
49	62886	99	248720	149	13305

Table Tennis 9 Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			5.05	5.08	4.62	5.20
SNR for luminance			34.07	34.02	34.83	33.82
SNR for chrominance			40.24	41.55	40.06	40.13
SNR for chrominance			41.17	42.54	41.38	40.91
Mean value of QP1			19.19	8.56	20.18	20.31
Mean value of QP2			7.09	2.71	7.43	7.58
Non-zero coeffs/cod blck			8.62	13.50	5.95	6.12
Non-zero coeffs_ref/cod blck			16.09	6.40	21.79	20.64
Non-zero coeffs_hf/cod blck			13.23	4.78	17.97	17.44
Zero coeffs/coded block			22.56	15.88	25.33	26.89
Zero coeffs_ref/coded block			46.24	11.23	67.24	62.27
Zero coeffs_hf/coded block			40.33	7.80	59.28	55.81
Intra	Pred	Interp				
C	Fixed	Fixed		330	0	36
	MC+C	Int NC			204	165
	noMC+C	Int C				2
	MC noC	Bak NC				97
	Intra	Bak C				0
		For NC				12
		For C				15
		Intra				0
No. of coded MB			306	330	330	294
No. of coded blocks			530	1980	717	258
Diff DC			918	9795	0	14
MBTYPE			863	389	1060	857
Quantiser			430	293	655	367
MB address			331	330	330	332
Vector data			2317	0	2094	2723
Vector mp2 data			12419	0	11392	14538
CBP			613	0	1103	517
EOB			1060	3960	1434	516
Coeffs Y			26100	142662	26223	9736
Coeffs U			665	5730	333	79
Coeffs V			1195	8411	963	271
Extra data			645	632	639	649
Seq. Extra data			7			
Total			34220	162406	34832	16038
Coeffs VLC REF			47843	52	91983	30856
Coeffs FLC REF			4255	45753	0	19
Coeffs EOB REF			5036	35	5416	5108
Total ref			58785	10179	99380	37743
bits EOB HF			1836	1980	1980	1762
Coeffs Y HF			4196	6069	7543	26962
Coeffs U HF			342	364	424	309
Coeffs V HF			517	538	902	371
Total hf			57772	64105	90976	44599

Item		All	Refresh	Normal
RMS for luminance		4.57	4.27	4.60
SNR for luminance		34.93	35.52	34.87
SNR for chrominance		40.69	41.18	40.64
SNR for chrominance		41.34	41.34	41.34
Mean value of QP		8.83	7.17	9.01
Non-zero coeffs/cod blck		12.1	26.71	10.93
Zero coeffs/coded block		39.91	31.32	40.63
Code	Intra		1	0
N Code	Intra		0	0
Code	Interp		427	131
N Code	Interp		163	168
Code	Next		27	10
N Code	Next		1	2
Code	Previous		17	5
N Code	Previous		1	3
Code	Copy		0	318
N Code	Copy		0	4
No. of coded MB		641	637	641
No. of coded blocks		1646	1374	1674
Diff DC		19	55	15
MBTYPE		1804	1678	1817
Quantiser		582	561	584
MB address		670	674	669
No. Vector data		10221	15830	9643
of CBP		1808	1966	1792
bits EOB		4938	4121	5023
Coeffs Y		126199	258950	112533
Coeffs U		328	269	
Coeffs V		1569	2173	1506
Extra data		634	628	635
Seq. Extra data		0		
Total		**148182**	**286907**	**133901**

Frame	Accum. Bitcount
12	4430479
24	8231803
36	11275826
48	14458859
60	17920222
72	21689782
84	25050970
96	28556768
108	32167191
120	35650458
132	39306519

SNR Y,U,V per frame

0	35.15	41.51	41.99	50	36.81	40.86	41.91	100	35.25	40.75	41.38
1	33.46	40.97	41.19	51	37.68	40.87	42.56	101	35.09	40.65	41.25
2	33.40	40.98	41.12	52	36.62	40.47	41.21	102	35.61	40.51	41.51
3	34.11	41.01	41.63	53	36.86	40.53	41.78	103	35.24	40.28	41.30
4	31.60	40.30	40.52	54	37.90	40.78	42.48	104	35.18	40.25	41.29
5	30.97	39.77	39.92	55	36.72	40.57	41.54	105	36.08	40.23	41.65
6	31.00	39.91	40.19	56	36.88	40.75	41.69	106	35.48	40.13	41.35
7	30.26	39.29	39.53	57	37.81	40.78	42.55	107	35.37	40.15	41.31
8	30.04	39.31	39.55	58	36.49	40.74	41.09	108	36.26	40.36	41.68
9	30.17	39.26	39.59	59	36.68	41.06	41.76	109	35.59	40.79	41.59
10	30.23	39.61	39.70	60	37.16	41.60	42.81	110	35.58	40.90	41.73
11	30.37	40.12	40.03	61	36.59	40.89	41.58	111	35.50	41.11	41.75
12	29.98	41.25	40.72	62	36.69	40.84	41.93	112	35.65	41.00	41.84
13	29.95	40.84	40.17	63	37.74	40.82	42.60	113	35.59	40.93	41.74
14	29.83	40.70	40.00	64	36.46	40.26	41.47	114	36.65	40.97	42.06
15	29.77	40.47	39.86	65	36.53	40.26	41.69	115	35.84	40.60	41.57
16	29.75	39.96	39.43	66	37.93	40.41	42.45	116	35.71	40.56	41.43
17	29.99	39.86	39.40	67	35.41	40.49	41.49	117	36.47	40.53	41.80
18	29.76	39.73	39.33	68	35.56	40.64	42.18	118	35.69	40.38	41.31
19	29.89	39.29	39.11	69	36.53	41.20	42.57	119	35.62	40.31	41.49
20	29.94	39.10	39.03	70	36.03	40.82	42.19	120	36.39	40.47	41.74
21	29.82	39.21	39.16	71	36.18	40.67	42.25	121	35.22	40.58	41.47
22	29.59	39.22	39.09	72	37.23	40.65	42.46	122	35.13	40.80	41.76
23	29.33	40.05	39.51	73	36.36	40.40	41.97	123	35.39	40.92	41.60
24	30.03	41.18	40.64	74	36.27	40.35	42.07	124	35.11	40.54	41.09
25	29.67	40.40	39.78	75	37.12	40.37	42.37	125	34.99	40.46	41.00
26	30.04	40.21	39.85	76	36.32	40.28	41.88	126	35.76	40.32	41.22
27	30.37	39.83	39.57	77	36.37	40.25	42.03	127	34.84	39.72	40.62
28	31.12	39.38	39.48	78	37.42	40.43	42.36	128	34.73	39.69	40.58
29	31.25	39.39	39.60	79	36.64	40.76	42.15	129	35.31	39.70	40.80
30	31.49	39.21	39.69	80	36.59	40.86	42.30	130	34.63	39.45	40.56
31	32.20	38.87	39.72	81	36.51	41.05	42.23	131	34.56	39.39	40.53
32	32.43	38.96	39.77	82	36.47	40.85	42.02	132	35.26	39.58	40.93
33	32.93	39.19	40.00	83	36.44	40.93	42.20	133	35.06	40.08	41.02
34	33.84	40.32	40.69	84	37.87	41.00	42.66	134	35.35	40.40	41.35
35	34.14	41.11	41.32	85	36.69	40.77	42.24	135	35.40	41.02	41.64
36	34.57	42.63	42.50	86	36.64	40.82	42.34	136	35.18	40.52	41.00
37	35.06	41.54	41.33	87	37.80	40.84	42.73	137	35.11	40.41	41.02
38	35.23	41.46	41.50	88	36.66	40.80	42.33	138	35.92	40.40	41.33
39	35.47	41.25	41.63	89	36.68	40.71	42.38	139	35.18	40.02	41.08
40	35.70	40.91	41.30	90	37.88	40.91	42.78	140	35.11	39.95	41.03
41	35.95	40.80	41.56	91	36.83	41.12	42.58	141	35.63	39.89	41.25
42	36.63	40.87	42.06	92	36.78	41.20	42.32	142	35.00	39.48	40.72
43	36.27	40.57	41.43	93	36.63	41.23	42.42	143	34.88	39.55	40.81
44	36.49	40.73	41.86	94	36.59	41.13	42.26	144	35.32	39.77	41.11
45	37.32	40.92	42.54	95	36.62	41.11	42.41	145	34.67	40.26	40.96
46	36.44	41.10	41.68	96	37.71	41.01	42.68	146	34.60	40.16	40.89
47	36.53	41.72	42.35	97	34.93	40.38	40.74	147	35.02	40.77	41.24
48	37.18	42.72	43.33	98	34.50	40.53	41.32	148	34.64	40.12	40.77
49	36.60	41.20	41.95	99	35.57	41.07	41.79	149	35.09	39.87	40.74

Bitcount per frame

0	1025132	50	252818	100	235788
1	252785	51	367364	101	202772
2	277339	52	248602	102	338767
3	556538	53	236553	103	202716
4	251527	54	391708	104	197125
5	241972	55	244944	105	379479
6	359109	56	235615	106	204317
7	225885	57	398910	107	195160
8	270405	58	236570	108	387898
9	441063	59	235641	109	201194
10	250185	60	389210	110	199374
11	278539	61	245397	111	727285
12	607972	62	236337	112	219057
13	267235	63	396811	113	198187
14	274762	64	237578	114	373505
15	361564	65	238725	115	210648
16	194555	66	464485	116	199746
17	270380	67	324073	117	349710
18	346683	68	192066	118	210553
19	242984	69	650090	119	206110
20	246018	70	194368	120	389662
21	342533	71	200420	121	233484
22	299795	72	337009	122	222249
23	346843	73	210235	123	689696
24	462685	74	201669	124	303305
25	255373	75	329094	125	216759
26	222904	76	209770	126	345392
27	249331	77	206367	127	257998
28	223437	78	354071	128	231838
29	220965	79	208229	129	342829
30	256479	80	210442	130	217589
31	215917	81	674710	131	205260
32	213544	82	220127	132	307591
33	266011	83	199465	133	198765
34	241714	84	384930	134	275708
35	215663	85	215915	135	622923
36	358560	86	213573	136	263183
37	245925	87	366457	137	214163
38	233459	88	210579	138	317523
39	281033	89	208534	139	206789
40	223113	90	371770	140	257023
41	227724	91	214015	141	360336
42	320620	92	211899	142	277599
43	238988	93	687054	143	261095
44	238091	94	216807	144	344069
45	353270	95	204265	145	256000
46	239417	96	351409	146	251766
47	222833	97	398296	147	641501
48	368308	98	196781	148	279722
49	244532	99	707835	149	173953

Calendar 4 Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			13.91	14.12	14.16	13.79
SNR for luminance			25.26	25.14	25.11	25.34
SNR for chrominance			30.66	31.24	30.13	30.80
SNR for chrominance			31.22	31.94	30.78	31.31
Mean value of QP1			46.47	20.98	47.30	49.47
Mean value of QP2			29.61	11.59	30.19	31.74
Non-zero coeffs/cod blck			7.72	16.10	4.90	3.35
Non-zero coeffs_ref/cod blck			3.73	0.00	6.54	4.46
Non-zero coeffs_hf/cod blck			1.46	0.61	2.03	1.68
Zero coeffs/coded block			28.54	17.16	32.77	34.15
Zero coeffs_ref/coded block			30.42	0.00	45.39	42.56
Zero coeffs_hf/coded block			10.39	1.59	14.26	14.27
Intra	Pred	Interp				
C	Fixed	Fixed		330	0	26
	MC+C	Int NC			259	126
	noMC+C	Int C				0
	MC noC	Bak NC				71
	Intra	Bak C				0
		For NC				8
		For C				19
		Intra				0
No. of coded MB			313	330	330	304
No. of coded blocks			558	1980	676	328
Diff DC			1266	14672	0	5
MBTYPE			1002	509	1201	990
Quantiser			674	896	911	555
MB address			335	330	330	338
Vector data			1534	0	1422	1775
Vector mp2 data			8869	0	7890	10394
CBP			815	0	1266	750
EOB			1116	3960	1351	656
Coeffs Y			24312	145972	22509	9181
Coeffs U			1292	14056	291	13
Coeffs V			1548	15907	560	57
Extra data			645	632	639	649
Seq. Extra data			6			
Total			33272	182262	30476	14956
Coeffs VLC REF			13213	11	27165	9628
Coeffs FLC REF			2510	29160	0	0
Coeffs EOB REF			5051	1	5807	5420
Total ref			22480	29172	34952	16872
bits EOB HF			1877	1980	1980	1824
Coeffs Y HF			6401	7567	9979	4890
Coeffs U HF			313	330	330	304
Coeffs V HF			317	334	342	306
Total hf			19020	11442	21999	18874

Item		All	Refresh	Normal
RMS for luminance		13.07	12.01	13.17
SNR for luminance		25.81	26.54	25.74
SNR for chrominance		29.76	30.88	29.66
SNR for chrominance		30.85	31.65	30.78
Mean value of QP		36.83	30.49	37.43
Non-zero coeffs/cod blck		3.57	5.79	3.20
Zero coeffs/coded block		25.19	24.34	25.33
Code	Intra		2	1
N Code	Intra		0	0
Code	Interp		498	106
N Code	Interp		21	3
Code	Next		68	15
N Code	Next		0	0
Code	Previous		71	8
N Code	Previous		0	0
Code	Copy		0	437
N Code	Copy		0	53
No. of coded MB		625	659	622
No. of coded blocks		1711	2834	1604
Diff DC		27	63	24
MBTYPE		1631	1583	1635
Quantiser		1013	1153	1000
MB address		681	661	683
No. Vector data		7113	13209	6534
of CBP		2868	3417	2816
bits EOB		5132	8503	4812
Coeffs Y		37790	96898	32181
Coeffs U		136	89	140
Coeffs V		1014	2292	893
Extra data		634	628	635
Seq. Extra data		0		
Total		**57442**	**127863**	**50760**

Frame	Accum. Bitcount
12	1732617
24	3231202
36	4770721
48	6372305
60	7983924
72	9611940
84	11189916
96	12752788
108	14236865
120	15819689
132	17344305
148	18893767

SNR Y,U,V per frame

0	25.82	31.74	32.40	50	25.53	30.58	31.37	100	25.65	30.27	31.06
1	25.21	31.50	32.03	51	25.44	30.24	31.06	101	25.56	30.11	30.95
2	24.86	31.20	31.70	52	25.54	30.09	30.93	102	25.48	29.86	30.78
3	24.78	30.79	31.39	53	25.38	29.97	30.83	103	25.72	29.88	30.87
4	24.71	30.65	31.25	54	25.29	29.60	30.52	104	25.68	29.78	30.78
5	24.49	30.40	31.01	55	25.19	29.41	30.45	105	25.52	29.61	30.65
6	24.40	30.10	30.78	56	25.07	29.34	30.44	106	25.78	30.66	31.28
7	24.32	29.94	30.70	57	24.94	29.18	30.30	107	25.77	30.71	31.35
8	24.28	29.62	30.50	58	25.17	29.94	30.86	108	25.97	31.08	31.67
9	24.27	29.50	30.40	59	25.15	29.97	30.94	109	25.78	31.01	31.43
10	24.69	30.57	31.21	60	25.43	30.96	31.61	110	25.67	30.75	31.17
11	24.73	30.60	31.32	61	25.32	30.82	31.24	111	25.51	30.50	30.97
12	25.10	31.01	31.73	62	25.14	30.51	31.00	112	25.48	30.54	31.07
13	24.97	30.86	31.53	63	24.87	30.15	30.69	113	25.66	30.30	30.80
14	24.90	30.70	31.37	64	24.98	30.01	30.65	114	25.73	29.99	30.68
15	24.71	30.51	31.14	65	24.85	29.80	30.46	115	25.72	29.90	30.60
16	24.99	30.42	31.11	66	24.64	29.49	30.27	116	25.67	29.75	30.48
17	24.95	30.15	31.00	67	24.76	29.40	30.30	117	25.88	29.52	30.37
18	24.90	29.87	30.77	68	24.62	29.30	30.13	118	26.22	30.21	30.91
19	25.03	29.74	30.79	69	24.50	29.12	30.00	119	26.29	30.25	30.99
20	25.01	29.69	30.81	70	24.89	30.03	30.77	120	26.26	30.86	31.55
21	24.94	29.41	30.60	71	24.94	30.13	30.86	121	26.34	30.78	31.29
22	25.34	30.17	31.13	72	25.05	30.66	31.36	122	26.15	30.64	31.16
23	25.37	30.25	31.21	73	24.83	30.49	31.04	123	26.15	30.41	31.05
24	25.70	31.22	32.08	74	24.65	30.30	30.80	124	26.23	30.28	30.98
25	25.89	31.01	31.84	75	24.42	29.97	30.49	125	26.32	30.12	30.82
26	25.69	30.76	31.67	76	24.48	29.91	30.45	126	26.31	29.91	30.70
27	25.63	30.38	31.37	77	24.47	29.73	30.28	127	26.46	29.79	30.70
28	25.83	30.17	31.22	78	24.57	29.52	30.22	128	26.62	29.78	30.73
29	25.79	30.05	31.19	79	24.64	29.54	30.25	129	26.85	29.78	30.81
30	25.78	29.61	30.85	80	24.62	29.45	30.16	130	27.46	30.87	31.79
31	25.70	29.53	30.92	81	24.68	29.36	30.14	131	27.19	30.85	31.77
32	25.65	29.37	30.84	82	25.02	30.53	31.11	132	27.25	31.11	32.06
33	25.63	29.18	30.65	83	25.01	30.62	31.17	133	27.32	30.97	31.85
34	25.66	29.97	31.18	84	25.31	30.74	31.41	134	27.29	30.70	31.67
35	25.71	30.04	31.22	85	25.26	30.64	31.22	135	27.20	30.41	31.54
36	25.82	31.23	32.17	86	25.18	30.43	31.00	136	27.33	30.23	31.44
37	25.71	30.99	31.88	87	25.13	30.19	30.78	137	27.18	30.15	31.30
38	25.49	30.59	31.62	88	25.13	30.21	30.84	138	27.09	30.01	31.21
39	25.42	30.26	31.33	89	25.06	30.02	30.67	139	27.08	30.02	31.30
40	25.62	30.18	31.17	90	25.08	29.85	30.52	140	27.04	29.91	31.20
41	25.51	30.01	31.00	91	24.91	29.83	30.65	141	26.92	29.79	31.13
42	25.30	29.67	30.77	92	24.87	29.49	30.31	142	27.25	30.45	31.66
43	25.40	29.47	30.64	93	24.85	29.37	30.19	143	27.20	31.47	31.90
44	25.38	29.33	30.61	94	24.98	30.41	30.98	144	27.00	31.36	32.09
45	25.27	29.09	30.45	95	25.07	30.44	31.03	145	27.07	31.07	31.77
46	25.46	29.88	30.93	96	25.34	30.67	31.32	146	26.92	30.85	31.66
47	25.45	30.00	30.99	97	25.33	30.59	31.20	147	26.99	30.45	31.40
48	25.72	31.15	31.91	98	25.37	30.47	31.14	148	26.65	30.09	31.20
49	25.71	30.92	31.59	99	25.34	30.22	30.94	149	26.69	29.94	31.02

Bitcount per frame

0	345860	50	102406	100	85262
1	110959	51	128583	101	88290
2	125499	52	107420	102	148374
3	162596	53	109465	103	88567
4	118292	54	145759	104	92288
5	119038	55	111675	105	150167
6	158578	56	110202	106	101092
7	116267	57	148680	107	103775
8	110776	58	105262	108	358431
9	154347	59	103461	109	96703
10	107023	60	339787	110	106064
11	103382	61	90507	111	143579
12	308354	62	101722	112	113711
13	96101	63	142035	113	100998
14	104169	64	103670	114	136913
15	124714	65	103606	115	105563
16	98962	66	162168	116	106601
17	98235	67	111365	117	132042
18	135717	68	109981	118	95084
19	102797	69	151070	119	87135
20	101430	70	104768	120	359361
21	141294	71	107337	121	95927
22	94317	72	316744	122	102093
23	92495	73	97999	123	131973
24	346437	74	107521	124	103028
25	80640	75	150846	125	99431
26	96809	76	112361	126	138959
27	127237	77	109830	127	95565
28	96482	78	146262	128	88318
29	95530	79	106416	129	118623
30	134877	80	98585	130	91537
31	112851	81	131348	131	99801
32	109762	82	96350	132	379703
33	129284	83	103714	133	89143
34	106063	84	333030	134	99442
35	103547	85	97169	135	130133
36	357585	86	103974	136	100840
37	94926	87	128709	137	103217
38	109967	88	103452	138	130916
39	132168	89	103247	139	89606
40	98898	90	133544	140	91199
41	100556	91	111365	141	140144
42	142126	92	108200	142	90567
43	106278	93	143725	143	104552
44	102951	94	98527	144	420326
45	141825	95	97930	145	84580
46	108953	96	341494	146	99513
47	105351	97	74972	147	143187
48	352509	98	81778	148	112722
49	86197	99	128018	149	73228

Calendar 9 Mbit/s

Item			All	Intra	Pred	Inter
RMS for luminance			7.87	8.51	7.64	7.87
SNR for luminance			30.21	29.53	30.46	30.21
SNR for chrominance			31.99	32.57	31.67	32.05
SNR for chrominance			34.60	35.45	34.34	34.60
Mean value of QP1			48.52	22.72	49.45	51.52
Mean value of QP2			12.63	5.02	12.95	13.50
Non-zero coeffs/cod blck			8.33	17.67	4.69	3.19
Non-zero coeffs_ref/cod blck			18.33	9.12	24.64	21.26
Non-zero coeffs_hf/cod blck			9.86	3.29	12.75	13.22
Zero coeffs/coded block			27.71	17.31	31.98	33.28
Zero coeffs_ref/coded block			61.78	14.03	79.84	88.56
Zero coeffs_hf/coded block			37.75	6.87	46.19	57.64
Intra	Pred	Interp				
C	Fixed	Fixed		330	0	22
	MC+C	Int NC			248	139
	noMC+C	Int C			0	123
	MC+noC	Bak NC			82	4
	Intra	Bak C			0	13
		For NC				10
		For C				19
		Intra				0
No. of coded MB			315	330	330	308
No. of coded blocks			525	1980	623	299
Diff DC			1263	14672	0	0
MBTYPE			977	454	1178	969
Quantiser			599	622	854	499
MB address			334	330	330	335
Vector data			1522	0	1422	1758
Vector mp2 data			8766	0	7890	10238
CBP			765	0	1203	698
EOB			1051	3960	1246	599
Coeffs Y			24123	159597	20023	8069
Coeffs U			1426	15778	243	10
Coeffs V			1676	17698	488	44
Extra data			645	632	639	649
Seq. Extra data			6			
Total			**33116**	**199071**	**27623**	**13620**
Coeffs VLC REF			52961	69869	89121	37022
Coeffs FLC REF			5942	69014	0	0
Coeffs EOB REF			5262	4777	5373	5283
Total ref			**65885**	**143659**	**96474**	**44151**
bits EOB HF			1891	1980	1980	1846
Coeffs Y HF			30360	37024	45299	23817
Coeffs U HF			323	350	352	309
Coeffs V HF			506	586	815	378
Total hf			**42987**	**40889**	**57615**	**37702**

Item		All	Refresh	Normal
RMS for luminance		6.98	6.08	7.07
SNR for luminance		31.25	32.46	31.15
SNR for chrominance		31.56	32.22	31.50
SNR for chrominance		34.53	35.10	34.47
Mean value of QP		15.97	13.50	16.20
Non-zero coeffs/cod blck		9.19	16.12	8.43
Zero coeffs/coded block		31.74	28.41	32.11
Code	Intra		0	0
N Code	Intra		0	0
Code	Interp		527	96
N Code	Interp		20	11
Code	Next		51	11
N Code	Next		0	0
Code	Previous		60	5
N Code	Previous		0	0
Code	Copy		0	521
N Code	Copy		0	12
No. of coded MB		657	659	657
No. of coded blocks		2477	2826	2444
Diff DC		0	5	0
MBTYPE		1639	1536	1648
Quantiser		1182	1344	1167
MB address		662	661	662
No. Vector data		7221	13516	6624
of CBP		3292	3424	3279
bits EOB		7432	8479	7333
Coeffs Y		131266	273571	117763
Coeffs U		1136	2223	1033
Coeffs V		5362	10898	4837
Extra data		634	628	635
Seq. Extra data		0		
Total		**159258**	**315710**	**144412**

Frame	Accum. Bitcount
12	3841125
24	7347929
36	10931206
48	14515579
60	18129391
72	21744383
84	25354424
96	28911303
108	32388323
120	36026423
132	39571026

SNR Y,U,V per frame

0	31.31	33.21	36.04	50	30.71	32.15	34.87	100	31.63	31.97	34.92
1	29.82	32.82	35.22	51	30.63	31.86	34.54	101	31.55	31.96	34.88
2	29.56	32.56	34.90	52	30.58	31.65	34.31	102	31.66	31.89	34.83
3	30.32	32.31	34.83	53	30.40	31.56	34.25	103	31.86	31.93	34.96
4	29.36	31.97	34.31	54	30.50	31.24	34.00	104	31.84	31.92	35.01
5	29.09	31.62	34.02	55	29.99	31.01	33.77	105	31.42	31.74	34.75
6	29.12	31.45	33.81	56	29.88	30.99	33.79	106	31.03	32.20	34.84
7	28.68	31.25	33.67	57	30.04	30.89	33.75	107	30.83	32.22	34.87
8	28.75	30.96	33.46	58	29.95	31.39	34.06	108	31.05	32.39	35.23
9	29.25	31.04	33.62	59	29.91	31.42	34.12	109	30.96	32.26	34.90
10	29.89	31.80	34.37	60	30.39	32.23	35.03	110	30.80	32.04	34.57
11	29.79	31.83	34.45	61	30.25	32.01	34.55	111	31.05	31.90	34.58
12	30.38	32.45	35.26	62	30.13	31.79	34.44	112	30.59	31.89	34.58
13	30.20	32.22	34.90	63	29.89	31.49	34.08	113	30.71	31.75	34.38
14	30.25	32.13	34.82	64	29.84	31.35	33.94	114	30.95	31.58	34.34
15	30.06	31.99	34.61	65	29.75	31.17	33.81	115	30.83	31.49	34.12
16	30.20	31.86	34.44	66	29.74	31.04	33.65	116	30.77	31.45	34.22
17	30.34	31.75	34.47	67	29.67	30.97	33.64	117	31.50	31.47	34.49
18	30.24	31.54	34.24	68	29.47	30.85	33.50	118	31.41	31.85	34.67
19	30.30	31.42	34.15	69	29.70	30.69	33.42	119	31.63	31.90	34.79
20	30.28	31.47	34.22	70	29.68	31.18	33.91	120	31.21	32.25	35.17
21	30.50	31.30	34.11	71	29.63	31.21	33.97	121	31.39	32.14	34.97
22	30.53	31.80	34.47	72	29.89	31.82	34.59	122	31.17	32.07	34.87
23	30.65	31.88	34.59	73	29.81	31.63	34.24	123	31.60	31.93	34.85
24	30.85	32.69	35.53	74	29.60	31.43	33.94	124	31.26	31.77	34.66
25	31.27	32.49	35.29	75	29.53	31.18	33.65	125	31.40	31.68	34.58
26	31.08	32.40	35.17	76	29.50	31.09	33.61	126	31.88	31.66	34.66
27	31.44	32.14	35.06	77	29.41	30.94	33.48	127	31.97	31.71	34.87
28	31.35	31.98	34.80	78	30.02	31.03	33.70	128	32.27	31.83	34.96
29	31.35	32.02	34.95	79	30.06	31.09	33.79	129	32.64	32.00	35.27
30	31.23	31.66	34.55	80	30.12	30.99	33.76	130	32.92	32.73	35.87
31	30.88	31.62	34.47	81	30.29	31.00	33.86	131	32.45	32.67	35.67
32	30.70	31.51	34.46	82	30.32	31.74	34.55	132	32.42	32.62	35.81
33	31.25	31.38	34.39	83	30.24	31.79	34.49	133	32.36	32.50	35.52
34	30.49	31.72	34.48	84	30.33	32.03	34.86	134	32.46	32.41	35.43
35	30.52	31.66	34.48	85	30.27	31.87	34.56	135	32.64	32.32	35.46
36	30.61	32.44	35.28	86	30.32	31.74	34.44	136	32.47	32.20	35.32
37	30.61	32.23	35.02	87	30.49	31.59	34.38	137	32.38	32.11	35.18
38	30.38	31.99	34.73	88	30.29	31.62	34.37	138	32.59	32.13	35.34
39	30.73	31.75	34.62	89	30.24	31.47	34.18	139	32.51	32.24	35.55
40	30.66	31.64	34.44	90	30.39	31.38	34.19	140	32.78	32.32	35.60
41	30.70	31.61	34.38	91	29.97	31.38	34.14	141	32.40	32.17	35.42
42	30.42	31.31	34.09	92	29.88	31.06	33.78	142	32.30	32.49	35.57
43	30.45	31.21	33.94	93	30.23	31.03	33.90	143	32.32	32.33	35.23
44	30.42	31.18	34.05	94	30.07	31.66	34.41	144	31.99	32.60	35.62
45	30.61	31.02	33.96	95	30.20	31.69	34.38	145	32.00	32.31	35.21
46	30.34	31.52	34.25	96	30.38	31.95	34.88	146	31.97	32.29	35.30
47	30.29	31.53	34.27	97	31.04	31.90	34.91	147	32.63	32.17	35.30
48	30.83	32.52	35.32	98	31.26	31.94	34.91	148	31.70	31.76	34.77
49	30.87	32.26	34.92	99	31.19	31.84	34.78	149	31.80	31.62	34.57

Bitcount per frame

0	698664	50	249780	100	218593
1	248945	51	305763	101	218804
2	267813	52	250685	102	353063
3	410774	53	247615	103	216189
4	258427	54	327906	104	228031
5	259537	55	251589	105	339906
6	337822	56	242788	106	237147
7	247439	57	331256	107	236463
8	243380	58	238666	108	706411
9	352936	59	239150	109	237711
10	261251	60	687509	110	250288
11	254137	61	228031	111	336629
12	653669	62	240837	112	253057
13	236464	63	321395	113	240706
14	262766	64	234114	114	325236
15	301818	65	232013	115	244401
16	234284	66	352782	116	252534
17	237220	67	246573	117	335968
18	309234	68	240586	118	229567
19	237856	69	351353	119	225592
20	234193	70	239656	120	694615
21	338578	71	240143	121	239884
22	230561	72	642940	122	237803
23	230161	73	242439	123	318455
24	706337	74	247651	124	246649
25	208180	75	346322	125	230412
26	241829	76	252894	126	340732
27	336243	77	244789	127	226032
28	228452	78	349029	128	214404
29	232375	79	254433	129	291190
30	317875	80	234963	130	245587
31	261809	81	306275	131	258840
32	248332	82	238238	132	735339
33	315445	83	250068	133	225280
34	245998	84	673498	134	248927
35	240402	85	236850	135	305430
36	694573	86	252653	136	242223
37	236109	87	303448	137	242829
38	260247	88	248255	138	312223
39	324227	89	244578	139	219477
40	227938	90	303970	140	228543
41	237724	91	251124	141	308239
42	320626	92	246249	142	230173
43	235550	93	328773	143	255472
44	235144	94	232062	144	785305
45	333216	95	235419	145	207299
46	243101	96	701282	146	237070
47	235918	97	198701	147	372555
48	711145	98	218661	148	258752
49	217469	99	310180	149	164340