CCITT SGXV
Working Party XV/1
Specialists group on Coding for Visual Telephony

Document #458
(Ver.2)
March, 1989

SOURCE: Japan
TITLE : Type4 in Flexible Hardware Specification

1. INTRODUCTION

This document describes possibility of sending motion vector (MCV) information for each 8×8 block. The following candidates are considered for TYPE4 attribute.
(1) Sending MCV for each 8×8 block
(2) Sending MC and Loop Filter ON/OFF FLAG for each block in a macro block

2. EXPERIMENTS

Simulation has been carried out on the QCIF and FCIF at the rate of 64kbit/s. The simulation conditions are as follows.

2.1 MCV for each 8×8 block (QCIF)
(1) Quantizer is controlled at every line of 11 macro block for the stability of SNR.
(2) Motion vector is calculated for each 8×8 block. (Y only)
(3) VLC for motion vector is the same as RM7. Differential vector is defined compared to the left neighboring block motion vector.
(4) Block type for 8×8 block is not defined. If one or more blocks have non-zero motion vector in a macro block, then MB is declared as MC and 4 vectors are sent.
(5) Motion vectors of U/V are always set at "0" , because the mean square error increases when the average of the 4 vectors is applied to U/V.
(6) Loop filter ON/OFF is controlled by motion vector (zero or not zero) for each 8×8 block.

2.2 MC and Loop filter ON/OFF FLAG for each block in a macro block
(1) Motion vector is calculated for each 16×16 block.
(2) MC ON/OFF is determined for each 8×8 block in a macro block declared MC ON. (Y only)
(3) VLC for motion vector is the same as RM7. Differential vector is defined compared to the left neighboring block motion vector.
(4) Loop filter ON/OFF is controlled by MC flag for each block.
(5) Bit assignment for MC ON/OFF flag is 4-bits FLC indicating one of the 14 combinations. (No.1-14 in table 4)

3. RESULTS

The summary of results are as follows.
RM7 = Normal Reference Model 7
8×8 MCV = Sending MCV for each 8×8 block
8×8 MC ON/OFF = Sending MC and Loop filter ON/OFF FLAG for each 8×8 block in a macro block

		SNR.(Y) RM7	SNR.(Y) 8×8 MC ON/OFF	
FCIF	Miss A.	37.937	37.792	
	Claire	38.221	38.075	
	Salesman	31.595	31.667	

		SNR.(Y) RM7	SNR.(Y) 8×8MCV		SNR.(Y) 8×8 MC ON/OFF	
	Miss A.	39.41	39.09	↓.32	39.31	↓.1
QCIF	Claire	39.09	38.91	↓.18	39.09	–
	Salesman	34.39	34.71	+.32	34.42	+.03
	Swing	39.12	38.75	↓.37	-	

For further detail , Figures 1 to 4 and Tables 1 to 2 show the simulation results for item 2.1 and Tables 3 to 5 show the simulation results for item 2.2 . Conclusion of the simulations are as follows.

(1) Differences of SNR and subjective picture quality among these 8×8 MC methods and RM7 seem very small.
(2) The numbers of motion vector bits are resonable.

4.CONCLUSION

From these results and other results shown in Doc.#404 and Doc.#455, comparing RM6/7 and RM4 at higher bitrate, we conclude that one MC vector for each Macro Block is sufficient for p×64 FH as well as for the recommendation.

Fig.1 : 16x16MC vs 8x8MC (RM7_9step,SNR-Y in QCIF)
(Claire,QCIF,p=1,10Hz,165frames)

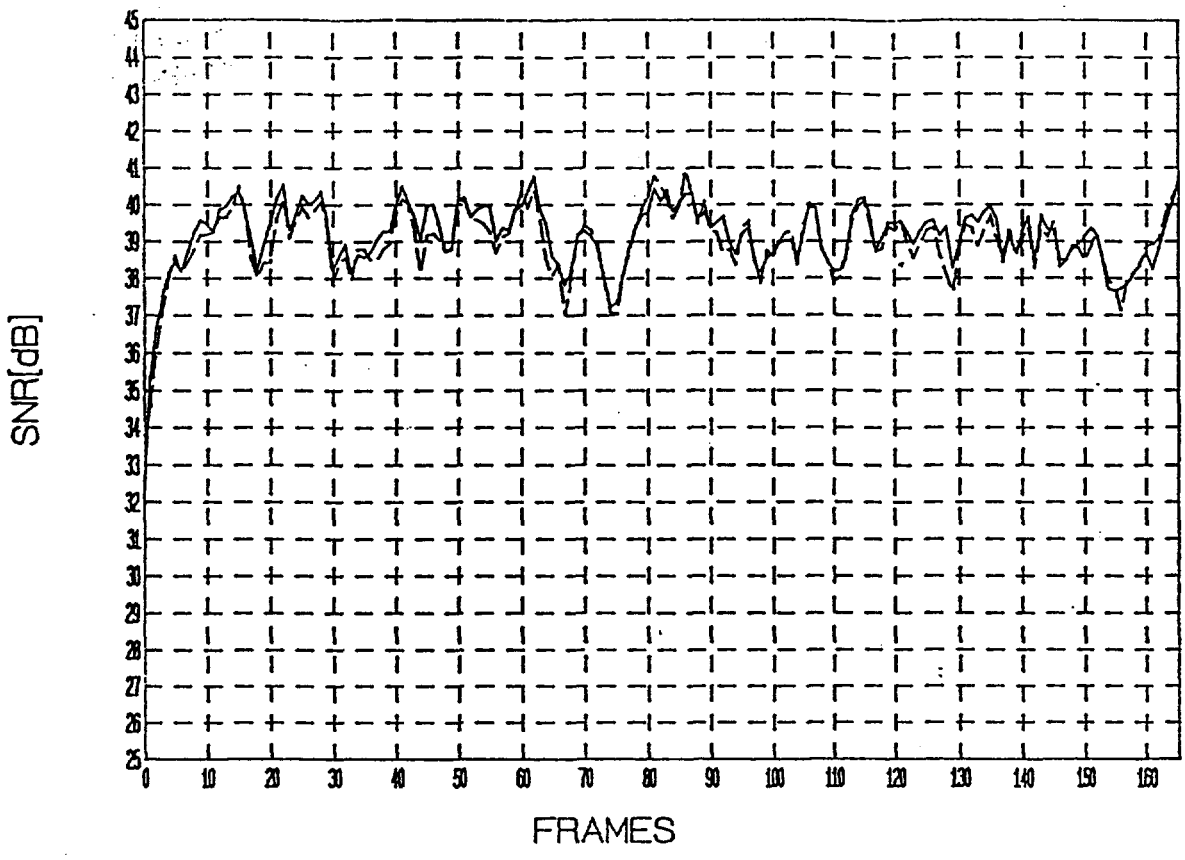

Fig.2 : 16x16MC vs 8x8MC (RM7_9step,SNR-Y in QCIF)
(salesman,QCIF,p=1,10Hz,150frames)

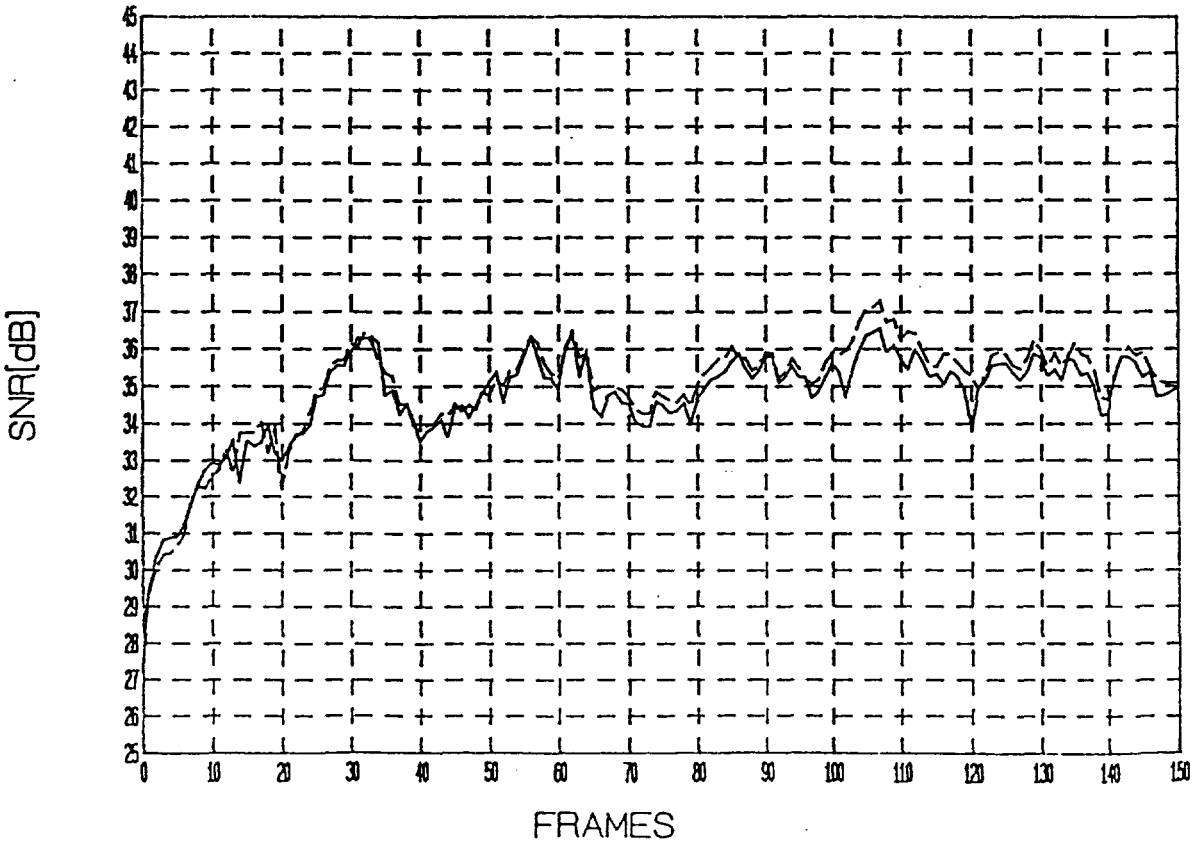

Fig.3 : 16x16MC vs 8x8MC (RM7_9step,SNR-Y in QCIF)
(Miss.america,QCIF,p=1,10Hz,50frames)

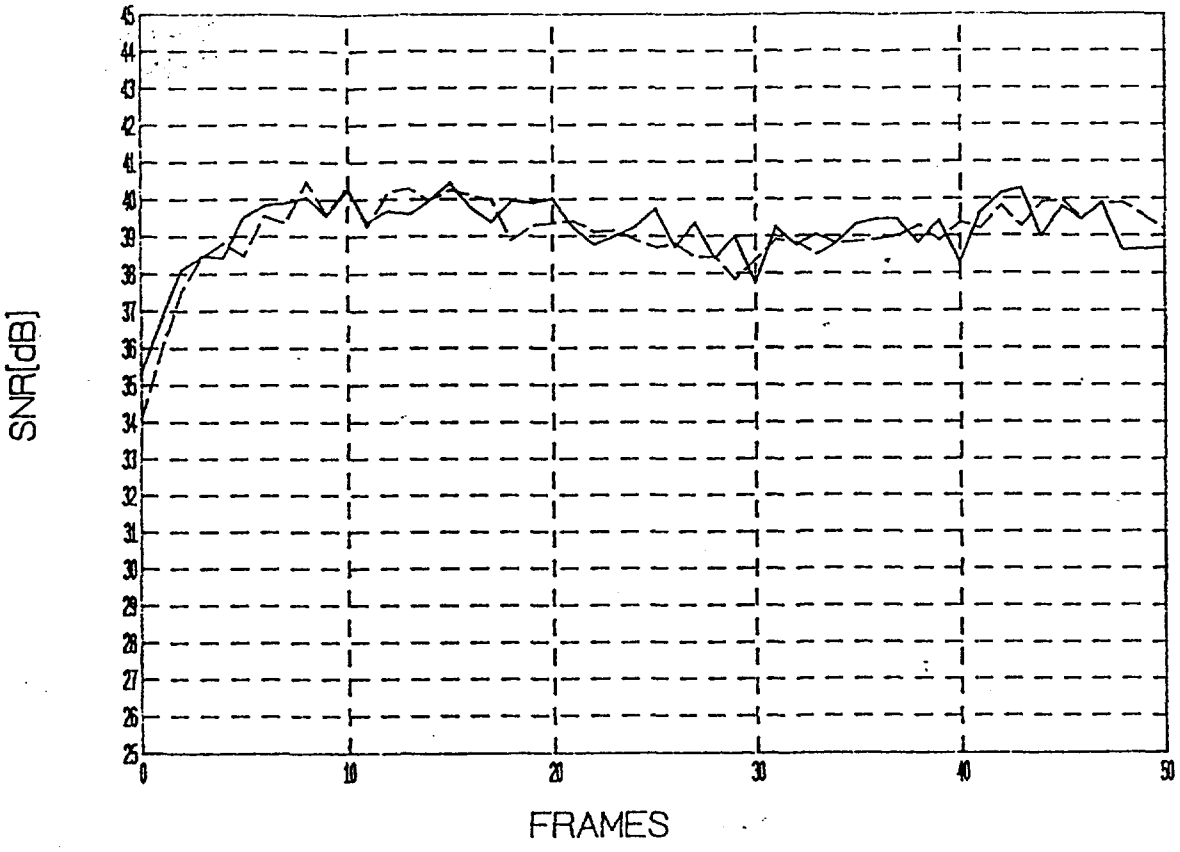

Fig.4 : 16x16MC vs 8x8MC (RM7_9step,SNR-Y in QCIF)
(swing,QCIF,p=1,10Hz,125frames)

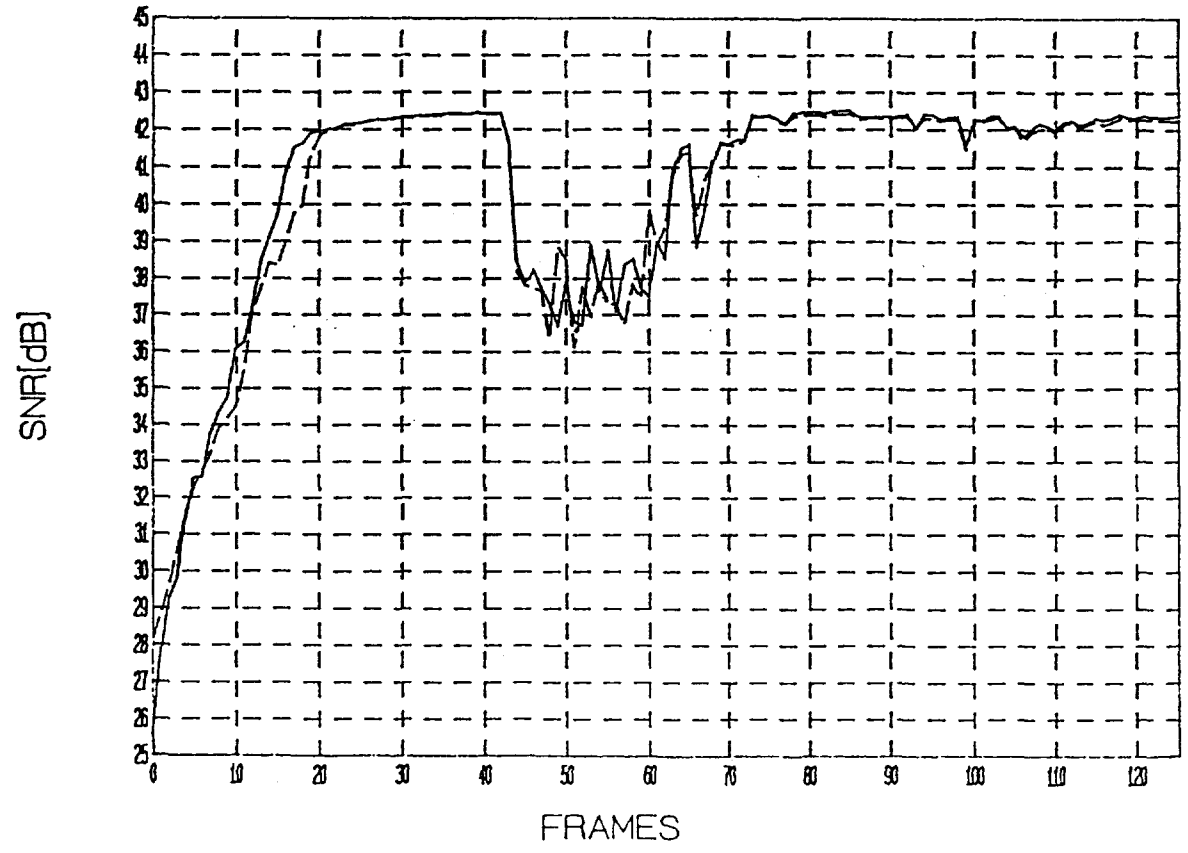

TABLE 2 RM7, QCIF, 1steps/11MB

STATISTICS RM7 DATE : 1989. 2. 21
SEQUENCE : FRAME RATE : 10Hz
MODIFICATION :1_step/11MB, QCIF

SEQUENCE		CLAIRE	SALES	Miss. A	SWING
RMS for Y (in QCIF)		2. 83	4. 87	2. 73	2. 82
SNR for Y (in QCIF)		39. 09	34. 39	39. 41	39. 12
SNR for U		39. 89	40. 09	39. 18	38. 29
SNR for V		42. 89	40. 87	39. 04	40. 04
SNR for C		41. 14	30. 64	39. 11	39. 08
RMS for Y (in FCIF)		6. 23	9. 63	4. 31	17. 64
SNR for Y (in FCIF)		33. 75	28. 46	35. 43	23. 20
SNR for U		38. 10	30. 90	31. 74	30. 54
SNR for V		41. 42	30. 39	30. 61	32. 53
SNR for C		39. 45	30. 64	31. 14	31. 42
MEAN STEP SIZE		10. 11	13. 01	10. 84	8. 97
MEAN Numb. of NONZERO Coeff.	Y	6. 80	6. 38	5. 23	3. 43
	C	3. 08	1. 80	2. 75	3. 62
MEAN Numb. of ZERO Coeff.	Y	13. 39	16. 47	9. 56	17. 43
	C	8. 76	4. 97	7. 54	10. 14
Block Type of MACRO	INTRA	0	0	0	0
	FIXED	48	46	35	39
	CODED MC	9	5	19	2
	FIXED MC	0	0	1	0
	CODED	42	48	44	59
Block Type of Y	FIXED	279	269	239	297
	CODED MC	29	17	51	5
	FIXED MC	8	3	28	2
	CODED	81	107	78	92
Block Type of UV	FIXED	171	181	134	168
	CODED	27	17	64	30
MACRO ATTRIB.		357	363	463	440
End of Block		369	383	526	398
Motion Vector		44	28	89	13
INTRA DC		0	4	0	4
Coeff. Y		4340	4823	3820	2056
Coeff. UV		445	162	987	653
Coeff. TOTAL		5565	5764	5875	3564

TABLE 1 RM7, QCIF, 1step/11MB, 8x8MC

STATISTICS RM7 DATE : 1988. 1. 15
MODIFICATION : 1step/MB 8x8MC QCIF FRAME RATE : 10Hz

SEQUENCE		CLAIRE	SALES	Miss. A	SWING
RMS for Y (in QCIF)		2. 89	4. 69	2. 83	2. 95
SNR for Y (in QCIF)		38. 91	34. 71	39. 09	38. 75
SNR for U		39. 59	40. 32	38. 84	38. 78
SNR for V		42. 46	41. 05	38. 77	40. 01
SNR for C		40. 79	40. 67	38. 81	39. 35
RMS for Y (in FCIF)		5. 28	9. 59	4. 38	17. 66
SNR for Y (in FCIF)		33. 67	28. 50	35. 30	23. 19
SNR for U		37. 96	30. 92	31. 73	30. 64
SNR for V		41. 23	30. 43	30. 59	32. 54
SNR for C		39. 30	30. 67	31. 12	31. 49
MEAN STEP SIZE		10. 70	12. 37	11. 67	9. 43
MEAN Numb. of NONZERO Coeff.	Y	6. 88	6. 01	5. 26	3. 45
	C	3. 06	1. 82	2. 69	3. 64
MEAN Numb. of ZERO Coeff.	Y	14. 31	16. 90	9. 58	17. 42
	C	9. 00	4. 58	7. 11	10. 67
Block Type of MACRO	INTRA	0	0	0	0
	FIXED	41	44	37	38
	CODED MC	21	15	31	3
	FIXED MC	11	1	4	1
	CODED	26	39	27	57
Block Type of Y	FIXED	223	252	216	294
	CODED MC	54	45	74	6
	FIXED MC	76	20	67	7
	CODED	43	79	38	89
Block Type of UV	FIXED	171	179	134	168
	CODED	27	19	64	30
MACRO ATTRIB.		347	363	411	440
End of Block		338	393	485	396
Motion Vector		609	307	732	75
INTRA DC		0	0	0	3
Coeff. Y		3903	4527	3293	1933
Coeff. UV		459	181	947	738
Coeff. TOTAL		5666	5761	5868	3585

Table 3 Simulation result for sending MC and Loop filter ON/OFF FLAG for each block in a macro block

STATISTICS : RM7
SEQUENCE : Claire , Miss A ; Sales
MODIFICATION : MC 8*8 on/off

INSTITUTE : OKI
DATE : Feb. 20 , 1989

FRAME RATE : 10 Hz

		Claire		Miss America		Salesman	
		org.	modif.	org.	modif.	org.	modif.
ITEM		mean	mean	mean	mean	mean	mean
1. RMS for luminance		3.130	3.183	3.234	3.288	6.711	6.656
2. SNR for luminance		38.221	38.075	37.937	37.792	31.595	31.667
for chrominance(U)		39.015	38.968	37.878	37.812	38.758	38.842
. for chrominance(V)		42.139	42.114	38.770	38.696	39.608	39.656
3. Mean value of step size		19.34	19.68	19.24	19.89	25.92	25.78
4. Mean value of the number of non-zero coefficients		2.94	2.90	2.06	2.02	2.79	2.77
5. Mean value of the number of zeroes before the last NZ-coefficient		4.68	4.61	3.84	3.75	7.25	7.29
6. Block type of MACRO	FIXED	276.7	277.1	215.4	217.8	270.8	269.4
	CODED MC	46.5	46.6	72.7	74.5	35.8	36.6
	FIXED MC	7.5	7.9	23.9	25.2	6.6	7.3
	CODED	64.3	63.5	83.9	78.4	81.0	81.1
	INTRA	1.0	1.0	0.0	0.0	1.8	1.5
7. Block type of Y	FIXED	1262.3	1261.6	1122.3	1114.5	1271.0	1266.9
	CODED MC	125.1	123.4	127.7	126.9	90.4	87.1
	FIXED MC	90.7	94.2	258.9	272.1	79.4	88.6
	CODED	105.9	104.8	75.1	70.5	143.1	141.4
8. Block type of UV	FIXED	753.7	754.1	686.6	692.9	774.7	774.7
	CODED	38.3	37.9	105.4	99.1	17.3	17.3
9. Number of bits	Macro attributes	545.3	542.0	714.1	699.4	578.3	578.7
	End of block	1022.0	1012.9	1479.0	1425.8	988.2	986.1
	Motion vectors	346.2	490.1	606.1	895.7	276.0	418.6
	Intra DC coef.	9.5	9.2	1.0	1.0	38.2	33.0
	Coefficients Y	3745.3	3617.8	2436.4	2286.9	3996.6	3848.4
	U	183.9	181.4	324.6	316.0	54.5	59.0
	V	83.6	83.2	344.2	282.2	39.5	42.7
	Total	4022.4	3891.6	3106.1	2386.1	4128.8	3983.1
	Total	5935.9	5936.7	5905.3	5906.9	5971.4	5966.6

Table 4 MC ON percentage of each block in a macro block

STATISTICS : RM7
SEQUENCE : Claire , Miss A , Sales
MODIFICATION : MC 8*8 on/off

INSTITUTE : CKI
DATE : Feb. 20, 1989
FRAME RATE : 10 Hz

Pattern	Claire		Miss America		Salesman	
	the number of M.B.	percentage of M.B.	the number of M.B.	percentage of M.B.	the number of M.B.	percentage of M.B.
0	56320	---	14911	---	52699	---
1	187	2.073	104	2.127	185	2.761
2	156	1.729	99	2.025	197	2.940
3	365	4.047	182	3.723	489	7.297
4	243	2.694	115	2.352	118	1.761
5	815	9.035	381	7.793	575	8.581
6	138	1.530	118	2.414	197	2.940
7	623	6.907	314	6.423	595	8.879
8	215	2.384	116	2.373	116	1.731
9	182	2.018	93	1.902	210	3.134
10	660	7.317	398	8.141	463	6.909
11	630	6.984	355	7.261	571	8.521
12	448	4.967	219	4.479	378	5.641
13	576	6.386	340	6.954	502	7.491
14	521	5.776	325	6.648	555	8.282
15	3261	36.153	1730	35.386	1550	23.131

MC ON pattern of each block in a macro block

***1 Y_{00}	**1* Y_{01}
*1** Y_{10}	1*** Y_{11}

In table 4 , pattern number shows the MC ON pattern.

For instance Y00 and Y01 are ON,pattern number shows "0011=3".

Doc #458
8

TABLE 5 MC 8*8 on/off, RM7, QCIF, 9_step

STATISTICS RM7 DATE : 1989. 2. 15
SEQUENCE : FRAME RATE : 10Hz
MODIFICATION :MC 8*8 on/off, 9_step, QCIF

SEQUENCE		CLAIRE	SALES	Miss. A
RMS for Y (in QCIF)		2. 83	4. 85	2. 76
SNR for Y (in QCIF)		39. 09	34. 42	39. 31
SNR for U		39. 90	40. 05	39. 20
SNR for V		42. 81	41. 01	39. 21
SNR for C		41. 11	40. 51	39. 20
RMS for Y (in FCIF)		5. 23	9. 61	4. 33
SNR for Y (in FCIF)		33. 76	28. 47	35. 41
SNR for U		38. 09	30. 90	31. 73
SNR for V		41. 37	30. 42	30. 59
SNR for C		39. 43	30. 65	31. 12
MEAN STEP SIZE		10. 16	12. 72	10. 88
MEAN Numb. of NONZERO Coeff.	Y	6. 90	6. 22	5. 12
	C	3. 08	1. 79	2. 78
MEAN Numb. of ZERO Coeff.	Y	13. 49	16. 35	9. 51
	C	8. 78	4. 79	7. 23
Block Type of MACRO	INTRA	0	0	0
	FIXED	48	45	36
	CODED MC	9	5	19
	FIXED MC	0	0	1
	CODED	42	48	43
Block Type of Y	FIXED	285	268	250
	CODED MC	22	12	42
	FIXED MC	3	2	15
	CODED	86	114	89
Block Type of UV	FIXED	172	181	135
	CODED	26	17	63
MACRO ATTRIB.		356	365	443
End of Block		366	389	523
Motion Vector		69	44	148
INTRA	DC	0	4	1
Coeff.	Y	4331	4796	3790
Coeff.	UV	434	161	971
Coeff.	TOTAL	5556	5758	5875