

MEDIATEK

Symmetric Intra Block Copy

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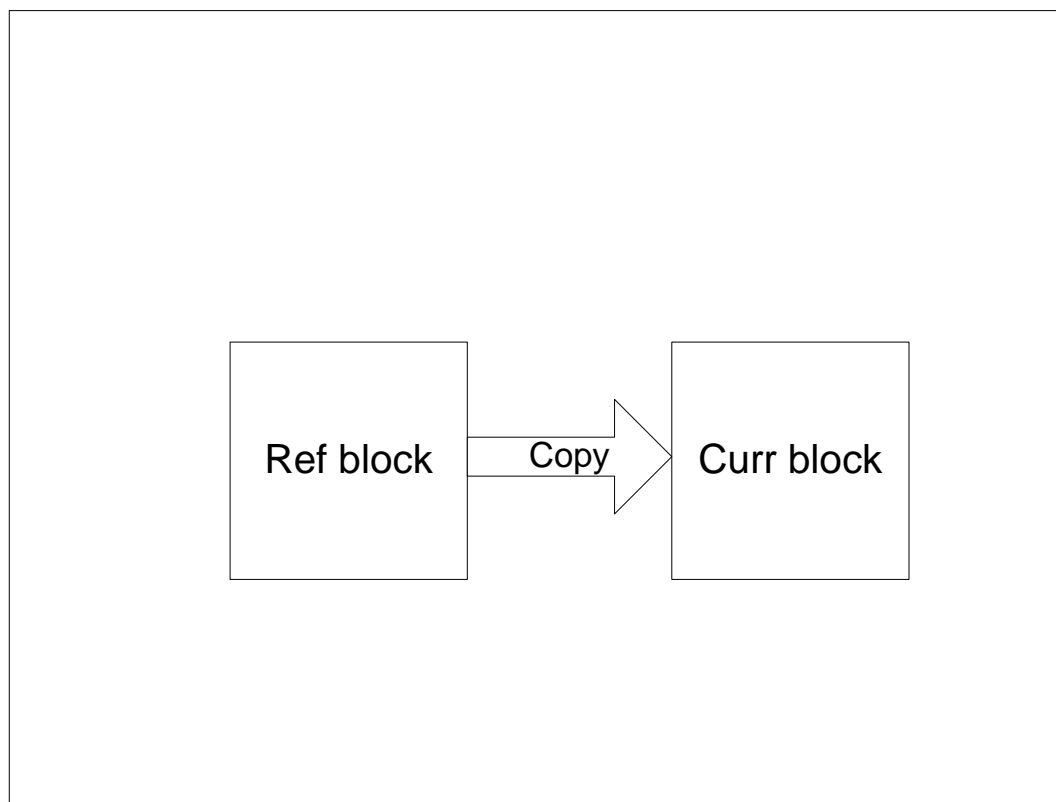
Presented by Tzu-Der (Peter) Chuang
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Overall summary

- Problem
 - Intra-block copy can deal with reduplicated patterns in a picture, but not symmetric patterns
- Proposed
 - Apply symmetric intra-block copy to deal with symmetric patterns in a picture by flipping the reference block
- Results
 - 0.9% for YUV SC sequences under CTC of RExt
 - 2.0% for YUV, text & graphics with motion, 1080p under CTC of SCC CfP

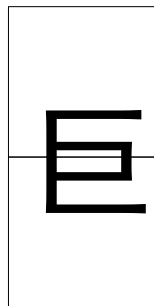
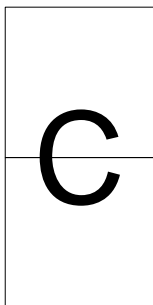
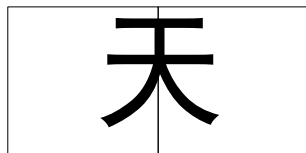
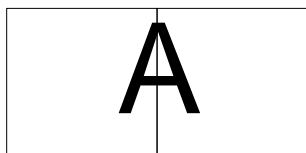
Intra Block Copy

- In HEVC-RExt , intra block copy (**IBC**) is adopted to consider reduplicated patterns in a picture



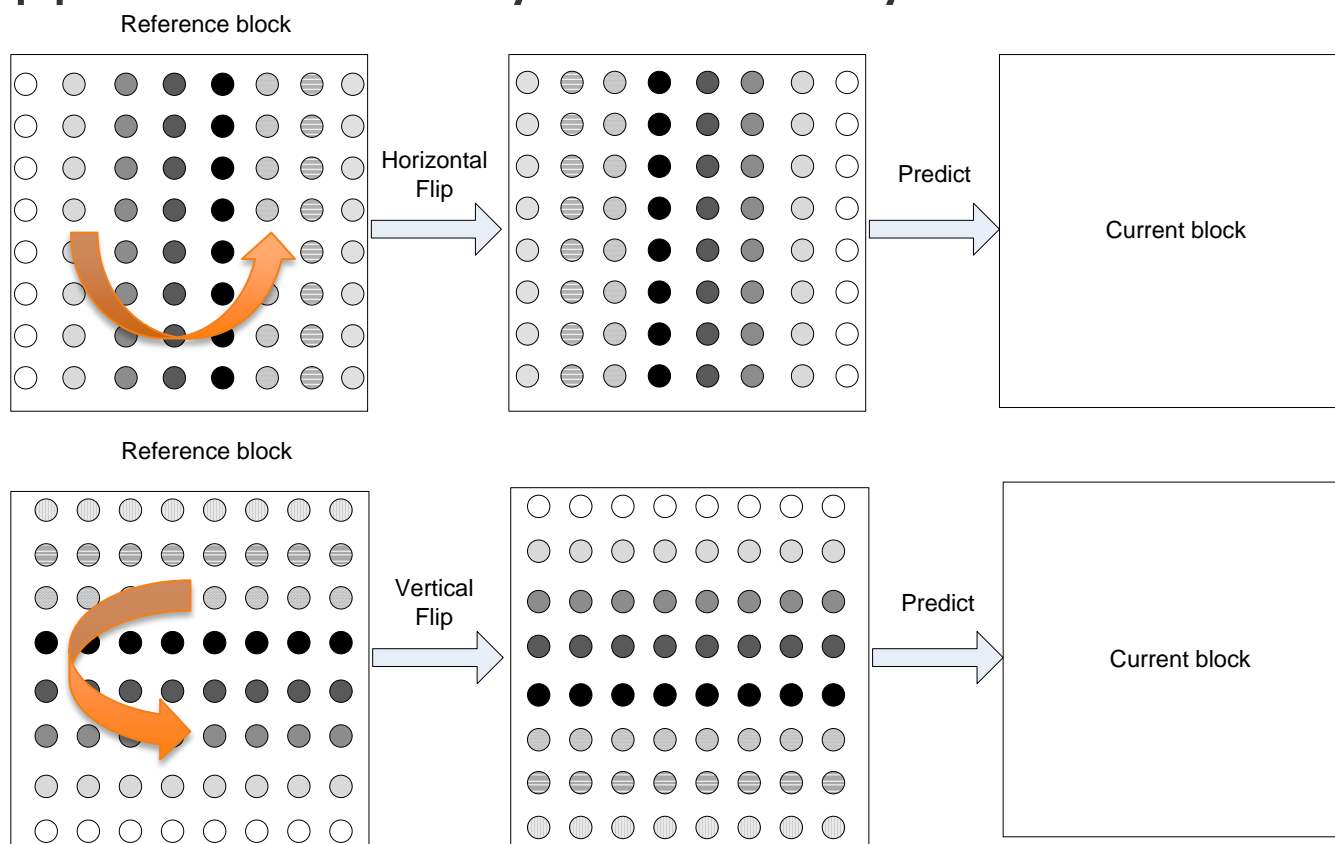
Problem of Intra Block Copy

- Besides reduplication, symmetry is often observed in natural or screen-content pictures
 - IBC cannot deal with these cases efficiently
- Symmetry examples:



Proposed Method

- Symmetric intra block copy (**SIBC**) is proposed
 - When SIBC is applied, the reference block is flipped horizontally or vertically



Details of the Proposed Method

- In the proposed design
 - SIBC is only allowed for CUs with $2N \times 2N$ partition
 - A flag is signaled to indicate whether the current CU chooses SIBC or normal IBC
 - When $|BV_x|$ is larger than 1, horizontal symmetric copy is applied; otherwise, vertical symmetric copy is applied

Experimental Results

- Anchor: HM-13.0+RExt-6.0
- Condition: AHG8 CTC
- 0.8% / 0.9% / 0.9% for Class F sequences, RGB SC sequences, and YUV SC sequences under AI-MT

BD-rate Y	AI-MT	AI-HT	AI-SHT	RA-MT	RA-HT	LB-MT	LB-HT
Class F	-0.8%	-0.6%	-0.5%	-0.6%	-0.5%	-0.5%	-0.4%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC RGB 444	-0.9%	-0.8%	-0.8%	-0.7%	-0.6%	-0.5%	-0.5%
Animation RGB 444	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%
SC YUV 444	-0.9%	-0.9%	-0.8%	-0.6%	-0.6%	-0.6%	-0.7%
Animation YUV 444	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RangeExt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC(444) GBR Optional	-1.2%	-1.3%	-1.3%	-0.9%	-1.0%	0.5%	-0.1%
SC(444) YUV Optional	-2.6%	-2.6%	-2.6%	-2.6%	-2.7%	-2.4%	-2.4%

Experimental Results

- Anchor: HM-13.0+RExt-6.0
- Condition: SCC CfP test condition
- 2.0% and 0.9% for YUV, text & graphics with motion 1080p and 720p
- 1.1% and 0.4% for YUV mixed content, 1440p and 1080p

	All Intra			Random Access			Low delay B		
	Y	U	V	Y	U	V	Y	U	V
RGB, text & graphics with motion, 1080p	-1.8%	-1.8%	-1.7%	-1.1%	-1.1%	-1.1%	-1.0%	-1.0%	-1.0%
RGB, text & graphics with motion, 720p	-0.7%	-0.8%	-0.7%	-0.7%	-0.6%	-0.6%	-0.3%	-0.4%	-0.4%
RGB, mixed content, 1440p	-1.1%	-1.1%	-1.1%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.4%
RGB, mixed content, 1080p	-0.4%	-0.4%	-0.4%	-0.1%	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%
YUV, text & graphics with motion, 1080p	-2.0%	-2.0%	-2.0%	-1.4%	-1.4%	-1.5%	-1.0%	-0.9%	-0.8%
YUV, text & graphics with motion, 720p	-0.9%	-0.9%	-1.0%	-0.6%	-0.7%	-0.7%	-0.4%	-0.3%	-0.7%
YUV, mixed content, 1440p	-1.1%	-1.2%	-1.2%	-0.7%	-0.8%	-0.7%	-0.3%	-0.9%	-0.6%
YUV, mixed content, 1080p	-0.4%	-0.4%	-0.4%	-0.2%	-0.3%	-0.3%	0.0%	-0.2%	-0.1%
YUV, Animation, 720p	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.3%	0.0%	-0.3%	0.0%
Enc Time[%]	108%			101%			101%		
Dec Time[%]	99%			97%			95%		

Conclusions

- Proposed a symmetric intra-block copy to deal with symmetric patterns in a picture by flipping the reference block
 - SIBC is only allowed for CUs with $2N \times 2N$ partition with a explicit enable flag
- Results
 - 0.9% for YUV SC sequences under CTC of RExt
 - 2.0% for YUV, text & graphics with motion, 1080p under CTC of SCC CfP

APPENDIX

Experimental Results (Cont.)

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	-0.8%	-0.8%	-0.8%	-0.6%	-0.6%	-0.6%	-0.5%	-0.5%	-0.5%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	-0.9%	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
RGB 4:4:4 Animation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	-0.9%	-0.9%	-1.0%	-0.9%	-0.8%	-0.9%	-0.8%	-0.7%	-0.8%
YCbCr 4:4:4 Animation	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%
RangeExt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	-1.2%	-1.0%	-1.0%	-1.3%	-1.2%	-1.1%	-1.3%	-1.2%	-1.2%
YCbCr 4:4:4 SC (Optional)	-2.6%	-2.4%	-2.4%	-2.6%	-2.4%	-2.4%	-2.6%	-2.5%	-2.5%
Enc Time[%]	108%			107%			107%		
Dec Time[%]	100%			101%			101%		
	Random Access Main-tier			Random Access High-tier					
	Y	U	V	Y	U	V			
Class F	-0.6%	-0.5%	-0.5%	-0.5%	-0.4%	-0.5%			
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
RGB 4:4:4 SC	-0.7%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%			
RGB 4:4:4 Animation	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%			
YCbCr 4:4:4 SC	-0.6%	-0.7%	-0.6%	-0.6%	-0.6%	-0.5%			
YCbCr 4:4:4 Animation	0.0%	-0.1%	-0.2%	0.0%	0.0%	0.0%			
RangeExt	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%			
RGB 4:4:4 SC (Optional)	-0.9%	-0.8%	-0.8%	-1.0%	-1.0%	-0.9%			
YCbCr 4:4:4 SC (Optional)	-2.6%	-2.4%	-2.4%	-2.7%	-2.6%	-2.6%			
Enc Time[%]	102%			102%					
Dec Time[%]	102%			102%					
	Low delay B Main-tier			Low delay B High-tier					
	Y	U	V	Y	U	V			
Class F	-0.5%	-0.7%	-1.0%	-0.4%	-0.8%	-0.7%			
Class B	0.0%	-0.4%	-0.2%	0.0%	-0.2%	-0.1%			
RGB 4:4:4 SC	-0.5%	-0.5%	-0.5%	-0.5%	-0.6%	-0.5%			
RGB 4:4:4 Animation	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%			
YCbCr 4:4:4 SC	-0.6%	-0.5%	-0.7%	-0.7%	-0.6%	-0.8%			
YCbCr 4:4:4 Animation	0.0%	-0.1%	0.0%	0.0%	0.1%	0.0%			
RangeExt	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%			
RGB 4:4:4 SC (Optional)	0.5%	0.6%	0.4%	-0.1%	0.0%	-0.2%			
YCbCr 4:4:4 SC (Optional)	-2.4%	-2.3%	-2.5%	-2.4%	-2.4%	-2.2%			
Enc Time[%]	102%			102%					
Dec Time[%]	102%			103%					

Experimental Results (Cont.)

	Average bit-rate increase		
	AI	RA	LB
Class F	-0.3%	-0.2%	-0.1%
Class B	0.0%	0.0%	0.0%
RGB 4:4:4 SC	-0.6%	-0.4%	-0.5%
RGB 4:4:4 Animation	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	-0.6%	-0.5%	-0.4%
YCbCr 4:4:4 Animation	0.0%	0.0%	0.0%
RangeExt	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	-1.2%	-1.2%	-0.7%
YCbCr 4:4:4 SC (Optional)	-2.4%	-2.3%	-1.5%
Enc Time[%]	109%	102%	102%
Dec Time[%]	101%	103%	101%

Experimental Results (Cont.)

	AI											
	Compression ratio								Bit-rate increase			
	Total		Average		Min		Max		Total	Avg	Min	Max
	Ref.	Tested	Ref.	Tested	Ref.	Tested	Ref.	Tested				
Class F	4.66	4.67	5.69	5.71	2.27	2.27	11.29	11.34	-0.2%	-0.3%	-0.5%	0.0%
Class B	2.25	2.25	2.26	2.26	2.08	2.08	2.44	2.44	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	10.41	10.46	13.7	13.76	7.06	7.07	25.32	25.73	-0.4%	-0.6%	-1.6%	-0.2%
RGB 4:4:4 Animation	2.85	2.85	2.9	2.87	2.43	2.43	3.15	3.15	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	12.17	12.22	15.3	15.45	8.45	8.47	26.69	27.10	-0.4%	-0.6%	-1.5%	-0.2%
YCbCr 4:4:4 Animation	3.06	3.06	3.2	3.23	2.63	2.63	3.99	3.99	0.0%	0.0%	0.0%	0.0%
RangeExt	2.01	2.01	2.47	2.47	1.55	1.55	4.48	4.48	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	41.21	41.64	44.99	45.61	23.47	23.59	61.89	63.08	-1.0%	-1.2%	-1.9%	-0.5%
YCbCr 4:4:4 SC (Optional)	44.48	45.30	49.56	51.25	27.31	27.43	77.05	81.43	-1.8%	-2.4%	-5.4%	-0.4%
Enc Time[%]	109%											
Dec Time[%]	101%											
	RA											
	Compression ratio								Bit-rate increase			
	Total		Average		Min		Max		Total	Avg	Min	Max
	Ref.	Tested	Ref.	Tested	Ref.	Tested	Ref.	Tested				
Class F	8.67	8.68	36.67	36.78	3.01	3.01	91.85	92.10	0.0%	-0.2%	-0.4%	0.0%
Class B	2.60	2.60	2.60	2.60	2.57	2.57	2.64	2.64	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	61.38	61.45	170.9	172.23	21.02	21.02	374.89	381.03	-0.1%	-0.4%	-1.6%	0.1%
RGB 4:4:4 Animation	3.87	3.87	3.9	3.91	3.50	3.50	4.23	4.23	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	74.11	74.25	187.4	189.04	25.51	25.52	395.24	401.28	-0.2%	-0.5%	-1.5%	0.0%
YCbCr 4:4:4 Animation	3.91	3.92	4.5	4.54	2.82	2.82	5.73	5.73	0.0%	0.0%	0.0%	0.0%
RangeExt	2.15	2.15	2.59	2.59	1.61	1.61	4.52	4.52	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	99.44	99.96	425.35	432.18	28.25	28.36	662.63	673.72	-0.5%	-1.2%	-1.6%	-0.4%
YCbCr 4:4:4 SC (Optional)	120.82	121.63	472.15	489.40	34.90	35.00	798.63	841.78	-0.7%	-2.3%	-5.1%	-0.3%
Enc Time[%]	102%											
Dec Time[%]	103%											
	LB											
	Compression ratio								Bit-rate increase			
	Total		Average		Min		Max		Total	Avg	Min	Max
	Ref.	Tested	Ref.	Tested	Ref.	Tested	Ref.	Tested				
Class F	8.87	8.87	56.98	57.10	3.00	3.00	165.85	166.17	0.0%	-0.1%	-0.3%	0.0%
Class B	2.61	2.61	2.61	2.61	2.57	2.57	2.64	2.64	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	68.91	68.99	609.93	617.82	22.19	22.19	2709.29	2753.55	-0.1%	-0.5%	-1.6%	0.0%
RGB 4:4:4 Animation	3.89	3.89	3.93	3.93	3.50	3.50	4.27	4.27	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	83.86	83.95	650.46	657.64	26.82	26.82	2837.80	2877.91	-0.1%	-0.4%	-1.4%	0.0%
YCbCr 4:4:4 Animation	3.94	3.94	4.59	4.59	2.82	2.82	5.79	5.79	0.0%	0.0%	0.0%	0.0%
RangeExt	2.15	2.15	2.59	2.59	1.61	1.61	4.52	4.52	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	109.20	109.61	1772.07	1782.06	28.56	28.66	4093.99	4106.26	-0.4%	-0.7%	-1.5%	-0.3%
YCbCr 4:4:4 SC (Optional)	135.54	136.07	1749.01	1775.83	35.40	35.50	3373.22	3367.27	-0.4%	-1.5%	-4.5%	0.2%
Enc Time[%]	102%											
Dec Time[%]	101%											

Lossy results for SCC

	All Intra		
	Y	U	V
RGB, text & graphics with motion, 1080p	-1.8%	-1.8%	-1.7%
RGB, text & graphics with motion, 720p	-0.7%	-0.8%	-0.7%
RGB, mixed content, 1440p	-1.1%	-1.1%	-1.1%
RGB, mixed content, 1080p	-0.4%	-0.4%	-0.4%
RGB, Animation, 720p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	-2.0%	-2.0%	-2.0%
YUV, text & graphics with motion, 720p	-0.9%	-0.9%	-1.0%
YUV, mixed content, 1440p	-1.1%	-1.2%	-1.2%
YUV, mixed content, 1080p	-0.4%	-0.4%	-0.4%
YUV, Animation, 720p	-0.1%	-0.1%	-0.1%
Enc Time[%]	108%		
Dec Time[%]	99%		
	Random Access		
	Y	U	V
RGB, text & graphics with motion, 1080p	-1.1%	-1.1%	-1.1%
RGB, text & graphics with motion, 720p	-0.7%	-0.6%	-0.6%
RGB, mixed content, 1440p	-0.6%	-0.6%	-0.6%
RGB, mixed content, 1080p	-0.1%	-0.1%	-0.1%
RGB, Animation, 720p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	-1.4%	-1.4%	-1.5%
YUV, text & graphics with motion, 720p	-0.6%	-0.7%	-0.7%
YUV, mixed content, 1440p	-0.7%	-0.8%	-0.7%
YUV, mixed content, 1080p	-0.2%	-0.3%	-0.3%
YUV, Animation, 720p	0.0%	-0.1%	-0.3%
Enc Time[%]	101%		
Dec Time[%]	97%		
	Low delay B		
	Y	U	V
RGB, text & graphics with motion, 1080p	-1.0%	-1.0%	-1.0%
RGB, text & graphics with motion, 720p	-0.3%	-0.4%	-0.4%
RGB, mixed content, 1440p	-0.6%	-0.6%	-0.4%
RGB, mixed content, 1080p	-0.2%	-0.1%	-0.1%
RGB, Animation, 720p	0.0%	-0.1%	-0.1%
YUV, text & graphics with motion, 1080p	-1.0%	-0.9%	-0.8%
YUV, text & graphics with motion, 720p	-0.4%	-0.3%	-0.7%
YUV, mixed content, 1440p	-0.3%	-0.9%	-0.6%
YUV, mixed content, 1080p	0.0%	-0.2%	-0.1%
YUV, Animation, 720p	0.0%	-0.3%	0.0%
Enc Time[%]	101%		
Dec Time[%]	95%		

Lossless results for SCC

	AI			
	Bit-rate saving (Total)	Bit-rate saving (Average)	Bit-rate saving (Min)	Bit-rate saving (Max)
RGB, text & graphics with motion, 1080p	1.2%	1.2%	1.2%	1.3%
RGB, text & graphics with motion, 720p	0.3%	0.3%	0.2%	0.5%
RGB, mixed content, 1440p	0.2%	0.2%	0.2%	0.3%
RGB, mixed content, 1080p	0.1%	0.1%	0.0%	0.3%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	1.2%	1.3%	1.0%	1.6%
YUV, text & graphics with motion, 720p	0.3%	0.3%	0.2%	0.6%
YUV, mixed content, 1440p	0.2%	0.2%	0.2%	0.3%
YUV, mixed content, 1080p	0.1%	0.1%	0.0%	0.3%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	110%			
Dec Time[%]	100%			

	RA			
	Bit-rate saving (Total)	Bit-rate saving (Average)	Bit-rate saving (Min)	Bit-rate saving (Max)
RGB, text & graphics with motion, 1080p	0.6%	0.8%	0.6%	1.2%
RGB, text & graphics with motion, 720p	0.1%	0.2%	0.0%	0.5%
RGB, mixed content, 1440p	0.0%	0.0%	0.0%	0.0%
RGB, mixed content, 1080p	0.0%	0.0%	0.0%	0.1%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	0.6%	0.7%	0.6%	0.9%
YUV, text & graphics with motion, 720p	0.1%	0.3%	0.0%	0.7%
YUV, mixed content, 1440p	0.0%	0.0%	0.0%	0.0%
YUV, mixed content, 1080p	0.0%	0.0%	0.0%	0.1%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	102%			
Dec Time[%]	100%			

	LB			
	Bit-rate saving	Bit-rate saving	Bit-rate saving	Bit-rate saving
RGB, text & graphics with motion, 1080p	0.6%	0.7%	0.6%	1.0%
RGB, text & graphics with motion, 720p	0.1%	0.2%	0.0%	0.3%
RGB, mixed content, 1440p	0.0%	0.0%	0.0%	0.1%
RGB, mixed content, 1080p	0.0%	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	0.6%	0.7%	0.6%	0.9%
YUV, text & graphics with motion, 720p	0.1%	0.2%	0.0%	0.3%
YUV, mixed content, 1440p	0.0%	0.0%	0.0%	0.1%
YUV, mixed content, 1080p	0.0%	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	103%			
Dec Time[%]	98%			