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| *Title:* | **HEVC Screen Content Coding Core Experiment 1 (SCCE1): Intra Block Copying Extensions** | | |
| *Status:* | Output Document to JCT-VC | | |
| *Purpose:* | SCCE description | | |
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# Abstract

This document is a description of the HEVC Screen Content Coding Core Experiment 1 on intra block copying extensions.

# Introduction

This document defines the HEVC Screen Content Coding Core Experiment 1 (SCCE1) on intra block copying extensions to be performed for the upcoming 18th JCT-VC meeting.

The CE is studying four aspects of intra block copying (IBC): search area size trade-offs, IBC modes, BV prediction and binarization, and flipping the copied block.

# Participants

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# Tests

## IBC search range

### Test 1.1: Search area, (JCTVC-Q0139, Qualcomm)

JCTVC-Q0139 provides results of the trade-off between IBC search area and BD-rate gains. Following are discussed in JCTVC-Q0139 and in the BoG on SCC (JCTVC-Q0244):

* Search area is 2 CTU (left and current)
* Search area is surrounding the current CTU (3×5 CTUs, 2×3 CTUs)
* Search area is the entire frame
* Search area is the entire frame for intra frames and local search (e.g., 2 CTUs) for inter frames

**Test 1.2: Additional search area, (meeting discussion, Broadcom & Huawei)**

Additional search areas:

* Search area is 3CTUs (current CTU + 2 left CTU)
* Search area is 4CTUs (current CTU + 3 left CTU)
* Search area is 4CTUs (current CTU + 3 left CTU) + 4 rows above

## IBC modes

### Test 2.1: IBC as inter PU (JCTVC-Q0132, MediaTek)

The harmonization of IBC and inter prediction is investigated in JCTVC-Q0132. Several aspects of IBC are modified to align it with inter predicted CU and PU syntax including:

* Signaling of the block vector (BV) predictor;
* IBC related syntax are moved from coding\_unit() to prediction\_unit() and harmonized with inter PU syntax.

Results with and without 4x4 IBC will be provided. Deblocking behavior which was discussed during the meeting will be investigated in the test too.

### Test 2.2: Skip mode (JCTVC-Q0035, Microsoft)

IBC skip mode means 2N×2N partition IBC mode without residue. A flag is signaled for each CU to indicate the usage of the IBC skip mode.

### Test 2.3: Merge mode (JCTVC-Q0035, Microsoft)

IBC merge mode will be investigated in this test. For IBC merge mode, the BV used for the current CU could be predicted perfectly from the BV used in the left part or the BV used in the above part. No BV difference is signaled for IBC merge mode. A flag is signaled for each CU to indicate the usage of IBC merge mode. Another flag is signaled to indicate which BV will be used for the current CU.

### Test 2.4: AMP mode (JCTVC-Q0035, Microsoft)

AMP for IBC will be investigated in this test, which introduces the motion partitions of 2N×nU, 2N×nD, nL×2N, and nR×2N into the IBC design.

## IBC block vector coding

### 3.3.A IBC block vector prediction

### Test 3.1: BV prediction (JCTVC-Q0114, Qualcomm)

The block vector prediction method of IBC is modified to use either an spatial neighboring BV or default vector is used as block vector predictor (JCTVC-Q0114).

### Test 3.2: Ping-Pong BV prediction (JCTVC-Q0134, Microsoft)

Ping-Pong block vector predictor will be investigated in this test. Two block vector prediction values are maintained as state information. For each BV to be sent, a flag is sent to select between them for the BV prediction value.

### Test 3.3: BV prediction (JCTVC-Q0062, Canon)

The BV predictor scheme for IBC is changed. The predictor is selected among a predictors list that includes the three last decoded BVs. The selected predictor is indicated through a syntax element. Additional fixed predictor values are added when the full list does not contain three elements.

### Test 3.4 AMVP prediction (JCTVC-Q0132, MediaTek)

AMVP based block vector prediction will be investigated in this test. Either a spatial neighboring BV or default vector is used as block vector predictor.

### 3.3.B IBC block vector coding

### Test 3.5: BV difference coding (JCTVC-Q0095, MediaTek)

The modified context modeling method for coding IBC block vector difference (BVD) will be investigated in this test. Additional contexts are assigned for coding the prefix bins used for representing the absolute value of the BVD component. The variations with reduced contexts will also be evaluated.

### Test 3.6: BV binarization (JCTVC-Q0031, Qualcomm)

## JCTVC-Q0031 includes a different binarization of BV: first, a flag is signaled to indicate whether the difference is zero. When BV difference is not zero, an Exp-Golomb code is used. Block copying modifications

### Test 4.1: Symmetric intra block copy (JCTVC-Q0082, MediaTek)

Symmetric intra block copy (SIBC) is proposed to consider symmetric patterns in a picture by flipping the reference block. When SIBC is applied, the reference block is flipped horizontally or vertically before it is used to predict the current block. A flag is signaled to indicate whether the current block chooses SIBC or normal IBC. The utilization of SIBC can be constrained to some specific PU sizes such as 2N×2N.

### Test 4.2: Blok flipping (JCTVC-Q0035, Microsoft)

IBC flip mode will be investigated in this test. For this mode, the IBC prediction is performed in a vertical flipping manner, which means that the first row in the reference region is used to predict the last row of the current region, and the last row in the reference region is used to predict the first row of the current region. A flag is signaled to indicate the usage of the IBC flip mode.

## Combinations

### Test 5.1: Combination of tests 2.1 + 2.2 + 2.3 + 2.4 (MediaTek, Microsoft)

In this test, the methods that are used in tests 2.2, 2.3 and 2.4 are applied to test 2.1 for enabling skip, merge and AMP modes.

### Test 5.2: Combination of tests 3.1 + 3.6 (Qualcomm)

In this test, the BV prediction method in test 3.1 and the BV coding method in test 3.6 are combined.

# Cross-checks

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| **Test** | **Description** | **Proponent** | **Cross-checker** |
| 1.1 | IBC search area | Qualcomm | Canon |
| 1.2 | IBC search area | Broadcom | Huawei |
| 2.1 | IBC as inter PU | MediaTek | NCTU |
| 2.2 | Skip mode | Microsoft | Qualcomm |
| 2.3 | Merge mode | Microsoft | Interdigital |
| 2.4 | AMP | Microsoft | Canon |
| 3.1 | BV prediction | Qualcomm | MediaTek |
| 3.2 | Ping-Pong BV prediction | Microsoft | Canon |
| 3.3 | BV prediction | Canon | Microsoft |
| 3.4 | BV prediction | Mediatek | Huawei |
| 3.5 | BVD coding | Mediatek | Qualcomm |
| 3.6 | BVD coding | Qualcomm | MediaTek |
| 4.1 | Symmetric IBC | MediaTek | Microsoft |
| 4.2 | Block flipping | Microsoft | MediaTek |
| 5.1 | 2.1 + 2.2 + 2.3 + 2.4 | MediaTek, Microsoft | Canon |
| 5.2 | 3.1 + 3.6 | Qualcomm | MediaTek |

# Test conditions

SCM1.0 and SCC common conditions (JCTVC-Q1015) will be used for the tests.

# Complexity analysis

Analysis on memory bandwidth impact of increase search area for IBC are to be provided (including the one in [1]):

* Both read and write memory access needs to be taken into account.
* K. Chono will provide NEC’s memory bandwidth measurement module for 4:4:4 content to evaluate the memory bandwidth increase of IBC.

# Timeline

* April 18th, 2014: SCCE description finalized and uploaded.
* T1 (April 25th, 2014): SCM1.0 software available.
* May 4th, 2014: Memory bandwidth measurement module available
* T1 + 3 weeks: Proponents for tests 1 to 4 provide software, draft specification text and results to CE participants. Cross-check begins.
* T1 + 5 weeks: Proponents for test 5 provide software, draft specification text and results to CE participants. Cross-check begins.
* June 20th, 2014: Input documents and summary report uploaded.

# References

[1] E. François, A. Tabatabai, and E. Alshina “BoG report: Methodology for evaluating complexity of combined and residual prediction methods in SHVC”, JCTVC-L0440, Geneva, CH, Jan. 2013.