

# JVET-X0122

## Non-EE2: Unification of negative modes processing in TIMD

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# Background

## Casual directional intra prediction modes

predModelIntra	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	2	3	4
intraPredAngle	512	341	256	171	128	102	86	73	64	57	51	45	39	35	32	29	26
predModelIntra	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
intraPredAngle	23	20	18	16	14	12	10	8	6	4	3	2	1	0	-1	-2	-3
predModelIntra	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
intraPredAngle	-4	-6	-8	-10	-12	-14	-16	-18	-20	-23	-26	-29	-32	-29	-26	-23	-20
predModelIntra	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
intraPredAngle	-18	-16	-14	-12	-10	-8	-6	-4	-3	-2	-1	0	1	2	3	4	6
predModelIntra	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
intraPredAngle	8	10	12	14	16	18	20	23	26	29	32	35	39	45	51	57	64
predModelIntra	73	74	75	76	77	78	79	80									
intraPredAngle	73	86	102	128	171	256	341	512									

$$\text{invAngle} = \text{Round} \left( \frac{512 * \text{32}}{\text{intraPredAngle}} \right)$$

9+5=14 bits

5 bits

9 bits

## TIMD modes

predModelIntra	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12
IntraPredAngleExt	1024	853	682	597	512	427	342	299	256	230	204	188	172	159	146	137	128
predModelIntra	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	2	3	4	5	6	7
IntraPredAngleExt	121	114	108	102	96	90	84	78	74	70	67	64	61	58	55	52	49
predModelIntra	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
IntraPredAngleExt	46	43	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12
predModelIntra	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
IntraPredAngleExt	10	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6	-7
predModelIntra	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
IntraPredAngleExt	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-40
predModelIntra	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
IntraPredAngleExt	-43	-46	-49	-52	-55	-58	-61	-64	-61	-58	-55	-52	-49	-46	-43	-40	-38
predModelIntra	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
IntraPredAngleExt	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-7	-6
predModelIntra	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
IntraPredAngleExt	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	12	14
predModelIntra	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
IntraPredAngleExt	16	18	20	22	24	26	28	30	32	34	36	38	40	43	46	49	52
predModelIntra	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
IntraPredAngleExt	55	58	61	64	67	70	74	78	84	90	96	102	108	114	121	128	137
predModelIntra	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158		
IntraPredAngleExt	146	159	172	188	204	230	256	299	342	427	512	597	682	853	1024		

$$\text{invAngle} = \text{Round} \left( \frac{512 * \text{64}}{\text{intraPredAngleExt}} \right)$$

9+6=15 bits

6 bits

9 bits

# Proposal

The value of “bExtIntraDir” flag determines precision of the inverse angle. It is set equal to true when an intra prediction for a block was derived using TIMD.

$$\text{invAngle} = \begin{cases} \text{Round} \left( \frac{512 \cdot 32}{\text{intraPredAngle}} \right), & \text{if bExtIntraDir is false} \\ \text{Round} \left( \frac{512 \cdot 64}{\text{intraPredAngleExt}} \right), & \text{otherwise} \end{cases}$$

If intraPredAngle is less than 0, the main reference sample array is extended as follows:

- The value of fractional offset frac32precision is derived as follows:

$$\text{frac32precision} = \text{bExtIntraDir} ? ((x * \text{invAngle} + 16) \gg 5) : ((x * \text{invAngle} + 8) \gg 4)$$

, with  $x = -nTbH..1$

- The index variable iIdx and the multiplication factor iFact are derived as follows:

$$\text{iIdx} = \text{frac32precision} \gg 5$$

$$\text{iFact} = \text{frac32precision} \& 31$$

The interpolation filter coefficients fT[ j ] with  $j = 0..3$  are derived as follows:

$$\text{fT}[j] = \text{fC}[\text{iFact}][j]$$

The value of sample ref[ -x ][ -refIdx ] is derived as follows:

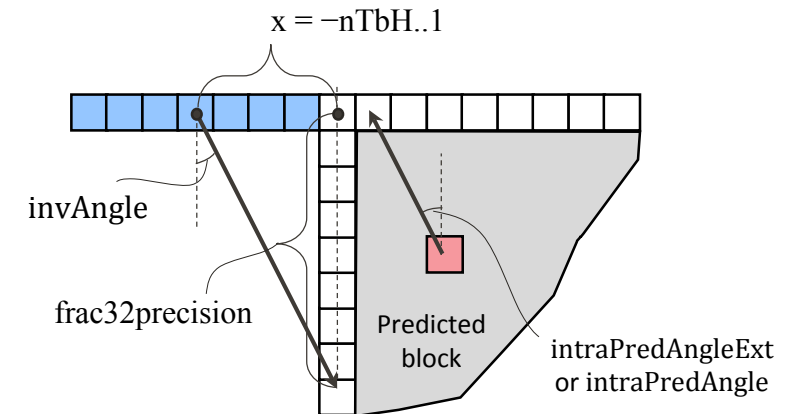
$$\text{ref}[-x][-\text{refIdx}] = \text{Clip1Y}((\sum_{i=0}^3 \text{fT}[i] * p[-\text{refIdx}][-\text{refIdx} + \text{iIdx} + i]) + 32) \gg 6)$$

**Proposal:**  
Remove TIMD flag (bExtIntraDir) check  
in frac32precision calculation

$$\text{frac32precision} = (x * \text{invAngle} + 8) \gg 4$$

5 bits                      9 bits

... the main reference sample array is extended as follows:



# ECM-2.0 source code changes

```
1100 1100    // Extend the Main reference to the left.
1101 1101    int sizeSide = bIsModeVer ? height : width;
1102 1102    // left extend by 1
1103 1103    for (int k = -(sizeSide + 1); k <= -1; k++)
1104 1104    {
1105 1105    -#if JVET_W0123_TIMD_FUSION
1106 1106    -    int frac32precision = bExtIntraDir ? ((-k * absInvAngle + 16) >> 5) : ((-k * absInvAngle + 8) >> 4);
1107 1107    -#else
1108 1105    int frac32precision = (-k * absInvAngle + 8) >> 4;
1109 1109    -#endif
1110 1106    int intpel = frac32precision >> 5;
1111 1107    int fracpel = frac32precision & 31;
1112 1108    //std::cout << " fracPel: " << fracpel << std::endl;
1113 1109    int left_minus1 = refSide[Clip3(0, sizeSide + 2 + multiRefIdx, intpel - 1)];
1114 1110    int left        = refSide[Clip3(0, sizeSide + 2 + multiRefIdx, intpel)];
1115 1111    int right       = refSide[Clip3(0, sizeSide + 2 + multiRefIdx, intpel + 1)];
1116 1112    int right_plus1 = refSide[Clip3(0, sizeSide + 2 + multiRefIdx, intpel + 2)];
1117 1113
1118 1114    const TFilterCoeff* f = InterpolationFilter::getWeak4TapFilterTable(fracpel);
1119 1115    int val = ((int)f[0] * left_minus1 + (int)f[1] * left + (int)f[2] * right + f[3] * (int)right_plus1 + 32) >> 6;
1120 1116    refMain[k] = (Pel)ClipPel(val, clpRng);
1121 1117    }
```

Many thanks to Alibaba that independently found this flaw and already submitted a merge request on that.

# Results

	All Intra Main10				
	Over ECM-2.0				
	Y	U	V	EncT	DecT
Class A1	-0.06%	-0.14%	-0.19%	101%	100%
Class A2	-0.08%	-0.09%	-0.10%	100%	100%
Class B	-0.07%	-0.10%	-0.09%	100%	101%
Class C	-0.10%	-0.07%	-0.15%	100%	100%
Class E	-0.18%	-0.28%	-0.23%	100%	100%
Overall	-0.09%	-0.13%	-0.14%	100%	100%
Class D	-0.05%	0.03%	-0.09%	100%	101%
Class F	-0.08%	-0.26%	-0.20%	100%	100%

	Random Access Main 10				
	Over ECM-2.0				
	Y	U	V	EncT	DecT
Class A1	-0.04%	-0.10%	-0.03%	101%	101%
Class A2	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class B	-0.07%	0.01%	0.09%	100%	100%
Class C	-0.05%	0.09%	0.09%	101%	100%
Class E					
Overall	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class D	0.00%	-0.21%	0.08%	100%	100%
Class F	-0.06%	0.05%	0.08%	100%	100%

15	Class A2	CatRobot1	22	15511.84	40.33	42.02	43.81	2034007.31	889.89	565.00	15509.03	40.33	42.02	43.82	2065564.44	901.52	573.77	1.02	1.01	-0.05%	0.10%	0.05%	-0.03%	0.06%	0.06%
16	4K		27	7109.27	39.65	41.57	42.84	1123112.38	806.77	311.98	7106.68	39.65	41.57	42.84	1128281.05	808.96	313.41	1.00	1.00						
17			32	3592.64	38.53	40.95	41.57	707536.08	755.42	196.54	3591.74	38.53	40.94	41.57	719314.27	761.70	199.81	1.02	1.01						
18			37	1960.00	37.00	40.15	40.10	477396.83	732.81	132.61	1955.82	37.00	40.16	40.09	483601.11	741.48	134.33	1.01	1.01						
19		DaylightRoad2	22	19729.00	37.95	45.97	43.70	2896418.81	971.34	804.56	19730.08	37.95	45.97	43.70	2908869.69	981.03	808.02	1.00	1.01	-0.10%	-0.09%	-0.04%	-0.06%	-0.11%	-0.04%
20			27	7228.95	37.41	45.27	42.95	1259744.02	911.62	349.93	7222.90	37.41	45.27	42.95	1277990.96	913.91	355.00	1.01	1.00						
21			32	3490.29	36.59	44.38	42.03	738633.93	846.82	205.18	3487.43	36.59	44.38	42.03	743742.09	859.01	206.60	1.01	1.01						
22			37	1816.12	35.41	43.18	40.34	509216.57	811.71	141.45	1812.53	35.41	43.18	40.36	517348.56	817.46	143.71	1.02	1.01						
23		ParkRunning3	22	91949.97	43.73	37.52	38.56	4001791.39	1249.64	1111.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
24			27	36495.65	39.98	34.91	36.31	2518920.67	1243.91	699.70	36491.08	39.98	34.91	36.31	2560611.19	1266.53	711.28	1.02	1.02						
25			32	16032.13	36.70	33.05	34.78	1709439.79	1198.86	474.84	16027.70	36.70	33.05	34.78	1716230.32	1209.85	476.73	1.00	1.01						
26			37	7365.46	33.81	31.45	33.13	1080234.27	1076.71	300.07	7361.35	33.81	31.45	33.13	1087792.21	1088.13	302.16	1.01	1.01						

Great thanks to Sony for crosschecking our proposal (crosscheck report JVET-X0165)

**THANK YOU**