

## **Intel® Processors based on Gracemont Microarchitecture**

Instruction Throughput and Latency

February 2022

Revision 1.0

350391-001US

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Proceedings	Г	I			T
### COMPANY OF THE PROPERTY OF	Instruction ADC/SBB r32. imm8	Throughput 0.5	Throughput VEX256	Latency 2	MSROM N
## SEMPLE OF THE PROPERTY OF T					
ACCOUNTY					
AURICANOSCOPPOLICITATION   1					
Description					
Description of Control   Description of Cont	·				
March   Marc	ADDPD/ADDSUBPD/MAXPD/MINPD/SUBPD xmm, xmm	0.5	1	3	N
### ADMINISTRATES OF THE PROPERTY OF THE PROPE	ADDPS/ADDSD/ADDSS/ADDSUBPS/SUBPS/SUBSD/SUBSS	0.5	1	3	N
ACCEPTATION	MAXPS/MAXSD/MAXSS/MINPS/MINSD/MINSS xmm, xmm	0.5	1	3	N
Additional Content   Additio	ANDNPD/ANDNPS/ANDPD/ANDPS/ORPD/ORPS/XORPD/XORPS	0.33	0.66	1	N
### APPLICATION OF THE PROPERTY OF THE PROPERT			1		
SOFTENDED 200 200			1		
MARCHANGANO AMERINANI		0.3	'		
SECONDO   SECO	BEXTR r64, r64, r64	1		4	N
### PREPAYERS SAME AND ADMINISTRATION OF A PROPERTY OF A P	BLENDPD/BLENDPS xmm, xmm, imm8	0.33	0.66	1	N
CAPTION   CAPT		0.5		3	N
State   State		1	4		'
## SMNC SATE ALL ALL ALL ALL ALL ALL ALL ALL ALL AL		1			
Miles   Mile		1			
No Monta, Mariana No Monta, Ma		1			
SEPSISHER		1			
SEADLE 2-2-2  FOR 19 1	BSF/BSR r32, r32	1		3	Υ
SMAPLYSHS		1			
REFASE DE SALES  1					
### 10.5   1 N   1 N   2011   1 N   2011   2	BT r32, r32	0.25		1	N
### STREMENS SALE AND					
SERTIFICATE COLOR					
CREATEDITECTOR   CONTROLLED		1		3	N
GAD		1			
COMPANDED   CONTROL   CO		0.25			
DEPOSE AND ADDRESS AND A THEN STREET AND ADDRESS AND ADDRE		0.25			
CMPSOICHPSOCMPS xmm, xmm, imm	CMOVxx r32, r32	0.5		2	N
DPACKED ACT	CMPPD xmm, xmm, imm	0.5	1	3	N
Developer   Deve		0.5	1		
MADDINESTICIONES xerus xerus   1		<u> </u>			
CRUID     CREST   CR		1			
CREST AFA, FA		~58			
VTDQ2PDCVTDQ2PSCVTPQ2DSVCVTPQ2PS xmm. xmm		1			
OVERTION		1			
CVITTPEPD xmm. mm		1			
OVI_TISP2D xmm, xmm		1			
VTTISD2SS/CVTS2520 xmm, xmm		1	2		
CVTSUSSOSS xmm, r32  CVTSUSSOSS y 22, xmm  1	CVTPS2PD xmm, xmm	1	2	4	N
VISINGENERAL   1		1			
DECUMC (F64   0.5		1			
DECUNIC (64)         0.5         1. N           DW 76         4.5.6         9.12. N           DW 76         4.5.65         10.77 Y           DW 72         4.5.25         10.25 Y           DW 64         4.5.205         10.41 Y           DWPD         16         32         2.1 N           DWSD         16         32         2.1 N           DWSD         16         32         2.1 N           DWSD         16         32         1.1 N           DWSD         16         32         1.1 N           DWSD         16         32         1.1 N           DWSD         16         13 N         1.0 N           DWSD         16         13 N         1.0 N           DWSD         6         6         16 Y           DWSD         6         6         16 Y           DWSD         7         23         1.2 N           DWSD         6         6         16 Y           DWSD         6         6         6         16 Y           DWSD         6         6         16 Y         10 Y           DWSD         7         7         23         10		0.5			
DIV   16					
DIV 122  45.125  10.25 Y  DIV 164  45.205  10.41 Y  DIVPO  116  32  21 N  DIVSD  100  2015 N  B  B  B  B  B  B  B  B  B  B  B  B  B					
DIV F64  16 32 27   N  DIVPD  16 32 21   N  DIVPD  DIVPD  10 20 15   N  DIVPD  DIVPS  10 20 15   N  DIVSD  B					
DIVPS					
DIVSD DIVSS DIVSS DEPS XMM, XMM, IMM DEPS XMM, XMM,	DIVPD	16		21	N
DIVSS DPPD xmm, xmm, imm DPPD xmm, xmm, imm DPPD xmm, xmm, imm DPPS xm					
DPPD xmm, xmm, imm         4         4         10         Y           DPPS xmm, xmm, imm         6         6         16         Y           CMTSACTES 522, xmm         1         5         N           EXTRACTES 522, xmm         1         5         N           EXTRACTES 522, xmm         1         5         N           F2XM1         -80         -80         1         N           F2XM1         -80         -80         1         N           FCOM         1         3         N         N           FCOM         1         3         N         N           FCOS         -154         -154         Y         N           FCOS         -154         -154         Y         N           FDIV         S(SP)9(0P)99(EP)         10(SP)/13(DP)/14(EP)         N           FLDZ         1         1         4         N           FDIV         2         5         N         P           FDIV         2         5         N         P           FDIV         2         5         N         P         P         P         N         P         N         P         N <td></td> <td></td> <td></td> <td></td> <td></td>					
EMMS         -23         -23         Y           EXTRACTPS 732, xmm         1         5         N           FZM1         ~87         ~87         Y           FABS/FCHS         0.5         1         N           FCOM         1         3         N           FCOM         1         3         N           FCOS         1         3         N           FCOS         *154         *154         Y           FDECSTP/FINCSTP         0.5         1         N           FOV         \$(SP)/B(OP)/9(EP)         10(SP)/13(OP)/14(EP)         N           FDUZ         1         4         N           FPUL         2         5         N           FPUL         2         5         N           FPRAIN/FYL2X/FYL2XP1         *303         *303 Y         *303 Y           FPRAIN/FYLSX/FYL2XFYL2XP1         *303         *303 Y         *304 Y           FRNDINT         *41         *41         Y           FSCALE         *32         *32 Y         *32 Y           FSIN         *140         *140 Y         *4         Y           FGCPBAFFINEQB/GF2PBAFFINEINVQB         6	DPPD xmm, xmm, imm		_	10	Υ
EXTRACTPS r32, xmm			6		
F2XM1		~23			
FCOM FADD/FSUB FADD/FSUB FADD/FSUB FOUT FORCS FO		~87			
FADD/FSUB FCOS				1	N
FECS - 154 Y FDECSTP/FINCSTP		1			
FDECSTP/FINCSTP FDIV 5(SP)/8(DP)/9(EP) 10(SP)/13(DP)/14(EP) N FPLDZ 1 1 4 N FMUL 2 5 S N FPATAN/FYLZX/FYLZXP1 303 303 4033 4033 4033 4033 4033 4033		~154			
FLDZ         1         4         N           PMUL         2         5         N           FPATAN/FYLZX/FYLZXP1         3303         3303         Y           PFTAN/FSINCOS         2877         2877         2878         Y           FRNDINT         41         41         41         Y           FSCALE         32         32         Y         32         Y           FSIN         740         740         740         Y         34         Y         34 <td>FDECSTP/FINCSTP</td> <td>0.5</td> <td></td> <td>1</td> <td>N</td>	FDECSTP/FINCSTP	0.5		1	N
FMUL         2         5         N           FPATAN/FYL2X/FYL2X/P1         ~303         ~303         Y           FPTAN/FSINCOS         ~287         ~287         Y           FRNDINT         ~41         ~41         Y           FSCALE         ~32         ~32         Y           FSIN         ~140         ~140         Y           FSQRT         6(SP)/12(DP)/14(EP)         11(SP)/17(DP)/19(EP)         N           GF2P8AFFINEQB/GF2P8AFFINEINVQB         0.5         1         4         N           GF2P8MULB         1         2         4         N           GF2P8MULB         5         5         5         Y           HADDPD/HSUBPD xmm, xmm         6         6         6         Y           HDIV 18         4.5         9-12         N           IDIV 16         4.5-85         9-17         Y           IDIV 17         4.5-12.5         9-25         Y           IDIV 164         4.5-20.5         9-25         Y           IDIV 17         4.5-12.5         9-25         Y           IDIV 18         4.5-20.5         9-25         Y           IDIV 18         4.5-20.5         9-25 <td></td> <td>5(SP)/8(DP)/9(EP)</td> <td></td> <td></td> <td></td>		5(SP)/8(DP)/9(EP)			
FPATAN/FYL2X/FYL2XP1         ~303         ~303         Y           FPTAN/FSINCOS         ~287         Y         ************************************		1 2			
FPTANI/FSINCOS         ~287         ~287         Y           FRNDINT         ~41         —41         Y           FSCALE         ~32         —32         Y           FSIN         ~140         —140         Y           FSQRT         6(SP)/12(DP)/14(EP)         11(SP)/17(DP)/19(EP)         N           GF2PBAFFINEQB/GF2PBAFFINEINVQB         —5         1         4         N           GF2PBMUB         —5         5         5         Y         H           HADDDP/HSUBPD xmm, xmm         —5         5         5         Y         H					
FSCALE         ~32         ~32         Y           FSIN         ~140         ~140         ~140         Y           FSQRT         6(SP)/12(DP)/14(EP)         11(SP)/17(DP)/19(EP)         N           GF2P8AFFINEQB/GF2P8AFFINEINVQB         0.5         1         4         N           GF2P8MULB         1         2         4         N           HADDPD/HSUBPD xmm, xmm         5         5         5         Y           HADDPS/HSUBPS xmm, xmm         6         6         6         Y           IDIV r8         4.5-6         9-12         N           IDIV r16         4.5-85         9-17         Y           IDIV r22         4.5-12.5         9-25         Y           IDIV r32         4.5-12.5         9-25         Y           IDIV r64         4.5-20.5         9-9-17         Y           MUL r32, r32 (single dest)         0.5         9-9-17         Y           MUL r32 (dual dest)         1         3 (4, EDX)         N           IMUL r64, r64 (single dest)         0.5         5         N           IMUL r64, r64 (single dest)         1         5 (6,RDX)         N           IMUL r64, r64 (single dest)	FPTAN/FSINCOS	~287		~287	Υ
FSIN         —140         —2140         —					
FSQRT   6(SP)/12(DP)/14(EP)   11(SP)/17(DP)/19(EP)   N					
FERRINGE   1   2   4   N					
HADDPD/HSUBPD xmm, xmm       5       5       7         HADDPS/HSUBPS xmm, xmm       6       6       6       7         IDIV r8       4.5-6       9-12       N         IDIV r16       4.5-8.5       9-17       Y         IDIV r32       4.5-12.5       9-25       Y         IDIV r64       4.5-20.5       9-41       Y         IMUL r32, r32 (single dest)       0.5       9-41       Y         IMUL r32 (dual dest)       3 (4, EDX)       N         IMUL r64, r64 (single dest)       0.5       5 (6,RDX)       N         IMUL r64 (dual dest)       0.33       1       N         INSERTPS xmm, xmm, imm8       0.33       1       N         LZCNT r32, r32       1       N       N	GF2P8AFFINEQB/GF2P8AFFINEINVQB	0.5	1	4	N
HADDPS/HSUBPS xmm, xmm		1			
IDIV r8       4.5-6       9-12       N         IDIV r16       4.5-8.5       9-17       Y         IDIV r32       4.5-12.5       9-25       Y         IDIV r64       4.5-20.5       9-41       Y         IMUL r32, r32 (single dest)       9-41       Y         IMUL r32 (dual dest)       3 (4, EDX)       N         IMUL r64, r64 (single dest)       9-12       N         IMUL r64 (dual dest)       9-12       5 (6,RDX)       N         IMUL r64 (dual dest)       9-12       N       N         INSERTPS xmm, xmm, imm8       9-13       N       N         LZCNT r32, r32       1       3 (3, EDX)       N       N			3	3	1
IDIV r16       4.5-8.5       9-17       Y         IDIV r32       4.5-12.5       9-25       Y         IDIV r64       4.5-20.5       9-41       Y         IMUL r32, r32 (single dest)       0.5       3 (4, EDX)       N         IMUL r32 (dual dest)       0.5       5 (5,RDX)       N         IMUL r64, r64 (single dest)       0.5       5 (6,RDX)       N         IMUL r64 (dual dest)       1       5 (6,RDX)       N         INSERTPS xmm, xmm, imm8       0.33       1       N         LZCNT r32, r32       1       3 (4, EDX)       N					
IDIV r32       4.5-12.5       9-25       Y         IDIV r64       4.5-20.5       9-41       Y         IMUL r32, r32 (single dest)       0.5       3 (4, EDX)       N         IMUL r32 (dual dest)       3 (4, EDX)       N         IMUL r64, r64 (single dest)       0.5       5 (6,RDX)       N         IMUL r64 (dual dest)       1       5 (6,RDX)       N         INSERTPS xmm, xmm, imm8       0.33       1       1       N         LZCNT r32, r32       1       3       N       N					
IMUL r32, r32 (single dest)       0.5       3 (4, EDX)       N         IMUL r32 (dual dest)       1       3 (4, EDX)       N         IMUL r64, r64 (single dest)       0.5       5 (5,RDX)       N         IMUL r64 (dual dest)       1       5 (6,RDX)       N         INSERTPS xmm, xmm, imm8       0.33       1       1       N         LZCNT r32, r32       1       3       N       N	IDIV r32	4.5-12.5		9-25	Υ
IMUL r32 (dual dest)       1       3 (4, EDX)       N         IMUL r64, r64 (single dest)       0.5       5       N         IMUL r64 (dual dest)       1       5 (6,RDX)       N         INSERTPS xmm, xmm, imm8       0.33       1       1       N         LZCNT r32, r32       1       3       N       N					
IMUL r64, r64 (single dest)       0.5       5       N         IMUL r64 (dual dest)       1       5 (6,RDX)       N         INSERTPS xmm, xmm, imm8       0.33       1       N         LZCNT r32, r32       1       3       N		0.5			
INSERTPS xmm, xmm, imm8         0.33         1         N           LZCNT r32, r32         1         3         N	IMUL r64, r64 (single dest)	0.5		5	
LZCNT r32, r32 1 3 N	IMUL r64 (dual dest)	1			
	INSERTPS xmm, xmm, imm8	0.33			
	1 7 CNT r32 r32			ا ع	[1 <sup>3</sup>

MASKMOVDQU xmm, xmm	4		n/a store to memory	Υ
MOVAPD/MOVAPS/MOVDQA/MOVDQU/MOVUPD/MOVUPS xmm, xmm;	0.25 <sup>[1]</sup> /0.33	0.66		N
MOVBE	0.25 70.55	0.00		N
MOVD r32, xmm; MOVQ r64, xmm	1		5	N
MOVD xmm, r32; MOVQ xmm, r64 MOVDDUP/MOVSHDUP/MOVSLDUP xmm, xmm	0.33	0.66		N N
MOVHLPS/MOVLHPS/MOVLPD/MOVLPS xmm,xmm	0.33	0.00		N
MOVDQ2Q/MOVQ/MOVQ2DQ	0.33			N
MOVSD/MOVSS xmm, xmm MPSADBW	0.33	4		N Y
MUL r32 (dual dest)	1		3 (4, EDX)	N
MUL r64 (dual dest) MULX r32,r32,r32	0.5		· · /	N N
MULX r64,r64,r64	0.5	1		N
MULPD xmm,xmm MULPS xmm,xmm	0.5	1		N N
MULSS/MULSD xmm, xmm NEG/NOT r32	0.5			N N
NEG/NOT r64	0.25			N
PACKSSDW/WB xmm, xmm; PACKUSWB xmm, xmm	0.33	0.66		N
PABSB/D/W xmm, xmm PADDB/D/W xmm, xmm; PSUBB/D/W xmm, xmm	0.33	0.66		N N
PADDQ/PSUBQ/PCMPEQQ xmm, xmm	0.33	0.66		N
PADDSB/W; PADDUSB/W; PSUBSB/W; PSUBUSB/W	0.33	0.66		N
PALIGNR xmm, xmm	0.33	0.66		N
PAND/PANDN/POR/PXOR xmm, xmm	0.33	0.66		N
PAVGB/W xmm, xmm	0.33	0.66		N
PBLENDW xmm, xmm, imm PBLENDVB xmm, xmm, <xmm0></xmm0>	0.33	0.66 1	3	N N
PCLMULQDQ xmm, xmm, imm PCMPEQB/D/W xmm, xmm	0.33	2 0.66		N N
PCMPEQQ xmm,xmm	1	2	4	N
PCMPESTRI xmm, xmm, imm PCMPESTRM xmm, xmm, imm	8		16 <sup>(C)</sup> /17 <sup>(F)[2]</sup> 11 <sup>(X)</sup> /16 <sup>(F)[2]</sup>	γ γ
PCMPGTB/D/W xmm, xmm	0.33			N N
PCMPGTQ/PHMINPOSUW xmm, xmm	1			N
PCMPISTRI xmm, xmm, imm PCMPISTRM xmm, xmm, imm	8		$\frac{11^{(C)}/12^{(F)[2]}}{6^{(X)}/11^{(F)[2]}}$	Y Y
PDEP r32, r32, r32	1		3	N .
PDEP r64, r64, r64 PEXT r32, r32, r32	1			N N
PEXT r64, r64, r64	1			N
PEXTRB/D/Q r8/r32/r64, xmm, imm	1			N
PEXTRW r32, xmm, imm PINSRB/D/Q xmm, r8/r32/r64, imm	1 1			N N
PINSRW xmm, r32, imm PHADDD/PHSUBD xmm, xmm	1	4		N Y
PHADDW/PHADDSW xmm,xmm	6	6	6	Υ
PHSUBW/PHSUBSW xmm, xmm	6	6	6	
PMADDUBSW/PMADDWD/PMULHRSW/PSADBW xmm, xmm	0.5	0.00		N
PMAXSB/W/D xmm, xmm; PMAXUB/W/D xmm, xmm	0.33	0.66		N
PMINSB/W/D xmm, xmm; PMINUB/W/D xmm, xmm PMOVMSKB r32, xmm	0.33	0.66		N N
PMOVSXBW/BD/BQ/WD/WQ/DQ xmm, xmm	0.33	0.66	1	N
PMOVZXBW/BD/BQ/WD/WQ/DQ xmm, xmm	0.33	0.66	1	N
PMULDQ/PMULUDQ xmm, xmm	0.5	1		N
PMULHUW/PMULHW/PMULLW xmm, xmm	0.5	1		N
PMULLD xmm, xmm POPCNT r32, r32	1	2		N N
POPCNT r64, r64 PSHUFB xmm, xmm	1 1	2		N N
PSHUFD xmm, mem, imm	0.33	0.66	1	N
PSHUFHW; PSHUFLW; PSHUFW PSIGNB/D/W xmm, xmm	0.33 0.33	0.66 0.66		N N
PSLLDQ/PSRLDQ xmm, imm; SHUFPD/SHUFPS	0.33	0.66		N
PSLLD/Q/W xmm, xmm PSRAD/W xmm, imm;	0.33	0.66 0.66		N N
PSRAD/W xmm, xmm;	0.33	0.66	1	N
PSRLD/Q/W xmm, imm; PSRLD/Q/W xmm, xmm	0.33	0.66 0.66		N N
PTEST xmm, xmm (update eflags)	1			N
PUNPCKHBW/DQ/WD; PUNPCKLBW/DQ/WD	0.33	0.66		N
PUNPCKHQDQ; PUNPCKLQDQ RCPPS/RSQRTPS	0.33	0.66 4		N N
RCPSS/RSQRTSS	1	2	4	N
RDTSC ROUNDPD/PS	20	2		N
ROUNDSD/SS	1			N
ROL; ROR; SAL; SAR; SHL; SHR (count in CL)	0.25		,	N
ROL; ROR; SAL; SAR; SHL; SHR (count in imm8)	0.25			N
SHA1MSG1/SHA1MSG2/SHA1NEXTE SHA1RNDS4 xmm, xmm, imm	1			N N
SHA256MSG1/SHA256MSG2	1		3	N
SHA256RNDS2 SAHF	0.25			N N
SARX/SHLX/SHRX/RORX r32, r32, r32	0.25		1 (2 for shift count)	N
SHLD r32, r32, imm	0.5			N
SHRD r32, r32, imm SHLD/SHRD r64, r64, imm	0.5		12	
SHLD/SHRD r64, r64, CL SHLD/SHRD r32, r32, CL	14		14 4	Y Y
SHUFPD/SHUFPS xmm, xmm, imm	0.33		1	N
CORTOR		1		
SQRTPD SQRTPS	24 12	48 24	29 17	

SQRTSS		6	12 11	N
TEST r32, r32	0.1	25	1	N
TZCNT r32, r32		1	3	N
TZCNT r64, r64		1	3	N
UNPCKHPD; UNPCKHPS; UNPCKLPD, UNPCKLPS	0.:	33 (	).66 1	N
VBROADCAST reg VBROADCAST mem	0.3	).5	0.66 1 1 1	N
VCVTPH2PS		1		N
VCVTPS2PH		1	1	N
VEXTRACTI128/F128 xmm, ymm, imm8	n/a	(	0.33	N
VF(N)MADD/SUB	(	).5	1 6	N
VGATHER*PS	~30	~50	~50	Υ
VGATHER*PD	~20	~30	~30	Υ
VINSERT ymm, ymm, xmm, imm8	n/a	(	).66	N
VPMASKMOV/VMASKMOV (load)		1	2 load latency +1	N
VPMASKMOV/VMASKMOV (store)		1	2 4+store latency	N
VPMOVMSKB r64, ymm	n/a		1 5	N
VPBLENDD	0.3	33 (	).66 1	N
VPERMILPS/PD	0.3	33 (	).66	N
VPERMPS/PD; VPERMD/Q	n/a		2 7	N
VPSLLVD/Q; VPSRAVD; VPSRLVQ	0.:	33 (		N
VTESTPD/PS		1	(vmm source), /	N
VZEROALL/VZEROUPPER		5		N
XADD r32, r32		4	4	Υ
XCHG r32, r32		5	5	γ
XCHG r64, r64		5	5	γ

[1]Throughput is 0.25 cycles if move elimination is effect, otherwise 0.33 cycle. [2]Latency values are for ECX/EFLAGS/XMM0 dependency: (C/F/X)