

1 Appendix - Opcodes

In this Appendix we list the opcodes for decoded instructions on each of the distinct ISAs we have explored. We group Compute Capability 3.0 with 2.x, rather than the rest of the 3.x generation. The first column in each table is the opcode's string and the operand types. We use 'reg' for general register operands, 'p' for predicate registers, 'lit' for literal (hexadecimal or decimal) values, 'mem' for memory, 'const' for constant memory, 'tex' for texture shapes, 'channel' for texture channels, 'bitfield' for bitfield operands, and 'misc' for operands without a clear type.

The second column is the binary, with zeros and ones for opcode bits, and the character 'x' in place of bits that are not controlled by the opcode, with the least significant bit on the left. Bits which affect the types of the operands are treated as opcode bits.

1.1 Opcodes on Compute Capabilities 2.x and 3.0

TODO (We didn't decode this one automatically, we mostly got it from asfermi's wiki, so formatting it like the tables below is going to be time-consuming.)

1.2 Opcodes on Compute Capability 3.x

Table 1. Opcode lookup table: opcodeTable3x

Instruction	Bits
MOV reg reg lit	01xx1100100111
MOV reg reg	01xx1111xxxxxxxx1100100111
MOV reg const lit	01xx1100100110
MOV reg const	01xx1111xxxxxxxx1100100110
MOV32I reg lit lit	01xx0001011110
MOV32I reg lit	01xxxxxxxxxxxxxxxx1111xx0001011110
LD reg mem	00xx1001000111
LDL reg mem	01xx0001011110
LDS reg mem	01xx1001011110
LDC reg const	01xx0100111110
ST mem reg	00xx1001001111
STL mem reg	01xx0101011110
STS mem reg	01xx1101011110
FADD reg reg lit	10xx1101010011
FADD reg reg const	01xx1101000110
FADD reg reg reg	01xx1101000111
FADD32I reg reg lit	00xx000000010
FMUL reg reg const	01xx1011000110
FMUL reg reg lit	10xx1011000011
FMUL reg reg reg	01xx1011000111
FMUL32I reg reg lit	01xx000000100
FFMA reg reg const reg	01xx00110010
FFMA reg reg reg reg	01xx0000110011
FFMA reg reg lit reg	10xx0000111001
FFMA reg reg reg const	01xx000110001
FSETP p p reg const p	01xx110111010
FSETP p p reg reg p	01xx1110111011
FSETP p p reg lit p	10xx1110101101
DSETP p p reg lit p	10xx0000101101
DSETP p p reg const p	01xx000111010
DSETP p p reg reg p	01xx1000111011
FCMP reg reg reg reg	01xx0010111011
FCMP reg reg const reg	01xx010111010
MUFU reg reg	01xx0000100001
DADD reg reg const	01xx0111000110

1	DADD reg reg lit	10xx0111000011	56
2	DADD reg reg reg	01xx0111000111	57
3	DMUL reg reg reg	01xx0000100111	58
4	DMUL reg reg lit	10xx0000110011	59
5	DMUL reg reg const	01xx0000100110	60
6	DFMA reg reg lit reg	10xx0111001101	61
7	DFMA reg reg reg const	01xx111011001	62
8	DFMA reg reg const reg	01xx111011010	63
9	DFMA reg reg reg reg	01xx0111011011	64
10	IADD reg reg const	01xx0100000110	65
11	IADD reg reg reg	01xx0100000111	66
12	IADD reg reg lit	10xx0100000011	67
13	IADD32I reg reg lit	10xx000000010	68
14	IMNMX reg reg lit p	10xx0010000011	69
15	IMNMX reg reg reg p	01xx0010000111	70
16	IMNMX reg reg const p	01xx0010000110	71
17	IMUL reg reg const	01xx1110000110	72
18	IMUL reg reg lit	10xx1110000011	73
19	IMUL reg reg reg	01xx1110000111	74
20	IMUL32I reg reg lit	01xx001110100	75
21	IMAD reg reg lit reg	10xx0010000101	76
22	IMAD reg reg const reg	01xx10001010	77
23	IMAD reg reg reg reg	01xx0010001011	78
24	IMAD reg reg reg const	01xx010001001	79
25	ISCADD reg reg lit lit	10xx1100000011	80
26	ISCADD reg reg reg lit	01xx1100000111	81
27	ISCADD reg reg const lit	01xx1100000110	82
28	ISSET reg reg const p	01xx101011010	83
29	ISSET p p reg lit p	10xx1011001101	84
30	ISSET p p reg reg p	01xx1011011011	85
31	ISSET p p reg const p	01xx011011010	86
32	ICMP reg reg lit reg	10xx1001011101	87
33	ICMP reg reg reg reg	01xx0001011011	88
34	ICMP reg reg const reg	01xx001011010	89
35	I2F reg const	01xx1110100110	90
36	I2F reg reg	01xx1110100111	91
37	I2I reg const	01xx0001100110	92
38	I2I reg reg	01xx0001100111	93
39	I2I reg lit	10xx0001110011	94
40	F2I reg reg	01xx0110100111	95
41	F2I reg const	01xx0110100110	96
42	F2F reg reg	01xx1010100111	97
43	F2F reg const	01xx1010100110	98
44	LOP reg reg const	01xx0001000110	99
45	LOP reg reg lit	10xx0001000011	100
46	LOP reg reg reg	01xx0001000111	101
47	LOP32I reg reg lit	00xx000000100	102
48	SHL reg reg const	01xx1001000110	103
49	SHR reg reg lit	10xx1010000011	104
50	SHR reg reg const	01xx1010000110	105
51	BFE reg reg lit	10xx0000000011	106
52	BFE reg reg const	01xx0000000110	107
53	BFI reg reg lit reg	10xx0111101101	108
54	SEL reg reg reg p	01xx0010100111	109
55			110

111	SEL reg reg lit p	01xxx0010100011	166
112	SEL reg reg const p	01xxx0010100110	167
113	SSY const	00xxxxxx1xxx100101000	168
114	SSY lit	00xxxxxx0xxx0100101000	169
115	BRA const	00111101xxx001001000	170
116	BRA misc const	00xxxxxx1xxx001001000	171
117	BRA lit	00111100xxx0001001000	172
118	BRA misc lit	00xxxxxx0xxx0001001000	173
119	BRX misc reg lit	00xxxxxx0xxx0101001000	174
120	BRX reg lit	00111100xxx0101001000	175
121	BRX const	00111101xxx101001000	176
122	BRX misc const	00xxxxxx1xxx101001000	177
123	PCNT const	00xxxxxx1xxx110101000	178
124	PCNT lit	00xxxxxx0xxx0110101000	179
125	CONT misc	00xxx0101011000	180
126	CONT	0011110xxx0101011000	181
127	PBK lit	00xxxxxx0xxx0010101000	182
128	PBK const	00xxxxxx1xxx010101000	183
129	BRK misc	00xxx0001011000	184
130	BRK	0011110xxx0001011000	185
131	CAL const	00xxxxxx1xxx011001000	186
132	CAL lit	00xxxxxx0xxx0011001000	187
133	RET misc	00xxx0010011000	188
134	RET	0011110xxx0010011000	189
135	EXIT misc	00xxx0000011000	190
136	EXIT	0011110xxx0000011000	191
137	NOP misc lit	01xxx0110100001	192
138	NOP lit	01xxxxxxxxxx11110xxx0110100001	193
139	BPT lit	00xxx0000000000	194
140	S2R reg sreg	01xxx1001100001	195
141	PSETP p p p p p	01xxx0100100001	196
142	PSET reg p p p	01xxx1000100001	197
143	FLO reg reg	01xxx0110000111	198
144	FLO reg const	01xxx0110000110	199
145	P2R reg misc reg lit	10xxx1001100011	200
146	P2R reg misc reg const	01xxx1001100110	201
147	R2P misc reg lit	10xxx000101100011	202
148	R2P misc reg const	01xxx100101100110	203
149	TEX reg reg lit tex lit	10xxxxxxxxxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxxx110	204
150	TEX reg reg reg lit tex lit	xxx110	205
151	TEXDEPBAR lit	01xxx0011101110	206
152	RRO reg reg	01xxx0100100111	207
153	RRO reg const	01xxx0100100110	208
154	PRMT reg reg lit reg	10xxx0001101101	209
155	DMNMX reg reg reg p	01xxx0101000111	210
156	DMNMX reg reg const p	01xxx0101000110	211
157	FMNMX reg reg lit p	10xxx0011000011	212
158	FMNMX reg reg reg p	01xxx0011000111	213
159	FMNMX reg reg const p	01xxx0011000110	214
160	VOTE p p	011111111xx1101100001	215
161	VOTE reg p p	01xxx1101100001	216
162	POPC reg reg reg	01xxx1000000111	217
163	POPC reg reg const	01xxx1000000110	218
164	MEMBAR	01xxx1100111110	219
165		3	220

221	CSETP p p misc p	01xx0010100001	276
222	ISCADD32I reg reg lit lit	00xx0xxxxx101	277
223	TLD reg reg lit tex lit	01xxxxxxxxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx1110	278
224	TLD reg reg reg lit tex lit	01xx1110	279
225	SHF reg reg reg reg	01xx111111011	280
226	SHF reg reg lit reg	10xx111101101	281
227	FCHK p reg reg	01xx1000100111	282
228	FCHK p reg const	01xx1000100110	283
229	ISUB reg const reg	01xx01x0100000110	284
230	ISUB reg reg const	01xx10x0100000110	285
231	ISUB reg reg reg	01xx10x0100000111	286
232	ISUB reg lit reg	10xx01x0100000011	287
233	ISUB reg reg lit	10xx10x0100000011	288
234	LDG reg mem	10xxxxxxxxxxxxxxxxxxxxxxxxxx11111110xx1111xx000100011xxxxxxxxxx110	289

1.3 Opcodes on Compute Capabilities 5.x and 6.x

Table 2. Opcode lookup table: opcodeTable5x6x

[illegible]

331	FCMP reg reg const reg	XX1010111010010	386
332	FCMP reg reg lit reg	XX1010101101100	387
333	MUFU reg reg	XX0000100001010	388
334	DADD reg reg reg	XX0111000111010	389
335	DADD reg reg lit	XX0111000011100	390
336	DADD reg reg const	XX0111000110010	391
337	DMUL reg reg reg	XX0000100111010	392
338	DMUL reg reg lit	XX0000110011100	393
339	DMUL reg reg const	XX0000100110010	394
340	DFMA reg reg reg reg	XX0111011011010	395
341	DFMA reg reg lit reg	XX0111001101100	396
342	DFMA reg reg const reg	XX0111011010010	397
343	DFMA reg reg reg const	XX0111011001010	398
344	IADD reg reg reg	XX0100000111010	399
345	IADD reg reg const	XX0100000110010	400
346	IADD reg reg lit	XX0100000011100	401
347	IADD32I reg reg lit	XX000000111000	402
348	IMNMX reg reg const p	XX0010000110010	403
349	IMNMX reg reg reg p	XX0010000111010	404
350	IMNMX reg reg lit p	XX0010000011100	405
351	ISCADD reg reg reg lit	XX1100000111010	406
352	ISCADD reg reg lit lit	XX1100000011100	407
353	ISCADD reg reg const lit	XX1100000110010	408
354	ISSET reg reg reg p	XX0101011011010	409
355	ISSET reg reg const p	XX1101011010010	410
356	ISSET reg reg lit p	XX0101001101100	411
357	ISSETP p p reg reg p	XX1011011011010	412
358	ISSETP p p reg lit p	XX1011001101100	413
359	ISSETP p p reg const p	XX1011011010010	414
360	ICMP reg reg reg reg	XX0001011011010	415
361	ICMP reg reg lit reg	XX1001011101100	416
362	ICMP reg reg const reg	XX1001011010010	417
363	I2F reg reg	XX1110100111010	418
364	I2F reg const	XX1110100110010	419
365	I2I reg lit	XX0011110011100	420
366	I2I reg reg	XX0011100111010	421
367	I2I reg const	XX0011100110010	422
368	F2I reg reg	XX0110100111010	423
369	F2F reg reg	XX1010100111010	424
370	F2F reg const	XX1010100110010	425
371	F2F reg lit	XX1010100011100	426
372	LOP reg reg lit	XX1110001000011100	427
373	LOP p reg reg reg	XX1000111010	428
374	LOP reg reg reg	XX1110001000111010	429
375	LOP p reg reg const	XX1000110010	430
376	LOP reg reg const	XX1110001000110010	431
377	LOP p reg reg lit	XX1000011100	432
378	LOP32I reg reg lit	XX000000100000	433
379	SHL reg reg lit	XX1001000011100	434
380	SHL reg reg reg	XX1001000111010	435
381	SHR reg reg lit	XX1010000011100	436
382	SHR reg reg reg	XX1010000111010	437
383	BFE reg reg lit	XX0000000011100	438
384	BFI reg reg lit reg	XX0111101101100	439
385			440

441	SEL reg reg reg p	XX0010100111010	496
442	SEL reg reg lit p	XX0010100011100	497
443	SEL reg reg const p	XX0010100110010	498
444	SSY lit	XXXXX0XX0100101000111	499
445	SSY const	XXXXX1XX0100101000111	500
446	BRA const	111101XX0001001000111	501
447	BRA misc const	XXXXX1XX0001001000111	502
448	BRA lit	111100XX0001001000111	503
449	BRA misc lit	XXXXX0XX0001001000111	504
450	BRX const	111101XX0101001000111	505
451	BRX misc const	XXXXX1XX0101001000111	506
452	BRX reg lit	111100XX0101001000111	507
453	BRX misc reg lit	XXXXX0XX0101001000111	508
454	PCNT lit	XXXXX0XX0110101000111	509
455	PCNT const	XXXXX1XX0110101000111	510
456	CONT	11110XX0101011000111	511
457	CONT misc	XX0101011000111	512
458	PBK lit	XXXXX0XX0010101000111	513
459	PBK const	XXXXX1XX0010101000111	514
460	BRK	11110XX0001011000111	515
461	BRK misc	XX0001011000111	516
462	CAL lit	XXXXX0XX0011001000111	517
463	CAL const	XXXXX1XX0011001000111	518
464	RET	11110XX0010011000111	519
465	RET misc	XX0010011000111	520
466	EXIT	11110XX0000011000111	521
467	EXIT misc	XX0000011000111	522
468	NOP lit	XXXXXXXXX11110XX0110100001010	523
469	NOP misc lit	XX0110100001010	524
470	NOP	XXXXXXXXX11110XXXXXXXXX0000000000000000XXXXXXXXXXXXX0110100001010	525
471	NOP misc	XXXXXXXXXXXXXXXXXXXXX0000000000000000XXXXXXXXXXXXX0110100001010	526
472	BAR lit	XXXXXXXXXXXXXXXXXXXXX00000000000000000001110110000001010100001111	527
473	BAR lit lit	XXXXXXXXXXXXXXXXXXXXX1110110000001010100001111	528
474	S2R reg sreg	XX1001100001111	529
475	PSETP p p p p p	XX0100100001010	530
476	PSET reg p p p	XX1000100001010	531
477	FLO reg reg	XX0110000111010	532
478	TEX reg reg lit tex lit	XXXXXXXXXXXXXXXXXXXXX11111111XXXXXXXXXXXXXXXXXXXXX1110000000011	533
479	TEX reg reg reg lit tex lit	XXXXXXXXXXXXXXXXXXXXX1110000000011	534
480	RRO reg reg	XXXXXXXXXXXXXXXXXXXXX0100100111010	535
481	PRMT reg reg lit reg	XXXXXXXXXXXXXXXXXXXXX0001101101100	536
482	DMNMX reg reg reg p	XXXXXXXXXXXXXXXXXXXXX0101000111010	537
483	DMNMX reg reg lit p	XXXXXXXXXXXXXXXXXXXXX0101000011100	538
484	FMNMX reg reg reg p	XXXXXXXXXXXXXXXXXXXXX0011000111010	539
485	FMNMX reg reg lit p	XXXXXXXXXXXXXXXXXXXXX0011000011100	540
486	RED mem reg	XXXXXXXXXXXXXXXXXXXXX111111010111	541
487	VOTE reg p p	XXXXXXXXXXXXXXXXXXXXX1101100001010	542
488	VOTE p p	11111111XXXXXXXXXXXXXXXXXXXXX1101100001010	543
489	POPC reg reg	XXXXXXXXXXXXXXXXXXXXX1000000111010	544
490	CSETP p p misc p	XXXXXXXXXXXXXXXXXXXXX0010100001010	545
491	ISCADD32I reg reg lit lit	XXXXXXXXXXXXXXXXXXXXX0XXXXX101000	546
492	SHF reg reg lit reg	XXXXXXXXXXXXXXXXXXXXX111101101100	547
493	SHF reg reg reg reg	XXXXXXXXXXXXXXXXXXXXX111111011010	548
494	FCHK p reg reg	XXXXXXXXXXXXXXXXXXXXX1000100111010	549
495			550

551	JCAL lit	xxxxx0xx010001000111	606
552	JCAL const	xxxxx1xx0010001000111	607
553	LDG reg mem	xx0101101110111	608
554	ATOM reg mem reg reg	xx0111101110111	609
555	XMAD reg reg reg reg	xx0000011011010	610
556	XMAD reg reg lit reg	xx0010001101100	611
557	XMAD reg reg reg const	xx0110010001010	612
558	XMAD reg reg const reg	xx0000001110010	613
559	SYNC	11110xx1111100001111	614
560	SYNC misc	xx1111100001111	615
561	STG mem reg	xx1101101110111	616
562	IADD3 reg reg reg reg	xx0001100111010	617
563	IADD3 reg reg lit reg	xx0001100011100	618
564	IADD3 reg reg const reg	xx0001100110010	619
565	VABSDIFF reg reg reg reg	xx10010000101010	620
566	VABSDIFF reg reg lit reg	xx00010000101010	621
567	DEPBAR sb lit bitfield	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx1xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx0111100001111	622
568	DEPBAR sb lit	000000xxxxxxxxxxxxxxxxxxxxxxxxxxx1xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx0111100001111	623
569	DEPBAR bitfield	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx0xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx0111100001111	624
570	DEPBAR	000000xxxxxxxxxxxxxxxxxxxxxxxxxx0xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx0111100001111	625
571	LOP3 reg reg reg reg lit	xx1110011111011010	626
572	LOP3 p reg reg reg reg lit	xx11111011010	627
573	LOP3 reg reg const reg lit	xx1000000	628
574	LOP3 reg reg lit reg lit	xx111100	629
575	TLDS reg reg reg lit tex channel	xxxxxxxxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx1011011	630
576	TLDS reg reg reg reg lit tex channel	xx1011011	631
577	TEXS reg reg reg lit tex channel	xxxxxxxxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx0011011	632
578	TEXS reg reg reg reg lit tex channel	xx0011011	633
579	LEA reg reg reg lit	xx111010111011010	634
580	LEA reg reg reg	xx00000xxxx111010111011010	635
581	LEA p reg reg reg lit	xx101111011010	636
582	LEA p reg reg reg	xx00000xxxxxxxx101111011010	637
583	LEA reg reg reg reg lit	xx1111101111011010	638
584	LEA reg reg reg reg	xx1111101111011010	639
585	LEA p reg reg reg reg	xx1101111011010	640
586	LEA p reg reg reg reg lit	xx1101111011010	641
587	LEA reg reg lit	xx1110101101101100	642
588	LEA reg reg lit lit	xx1110101101101100	643
589	LEA p reg reg lit	xx101101101100	644
590	LEA p reg reg lit lit	xx101101101100	645
591	DSET reg reg reg p	xx1000010011010	646
592	DSET reg reg const p	xx0000010010010	647
593	DSET reg reg lit p	xx0001001001100	648
594			649
595			650
596			651
597			652
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599			654
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601			656
602			657
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604			659
605			660