

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

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	01xxxxxxxxxxxx1111xx0001011110
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
DADD reg reg lit	10xx0111000011
DADD reg reg reg	01xx0111000111

1	DMUL reg reg reg	01xxx0000100111	56
2	DMUL reg reg lit	10xxx0000110011	57
3	DMUL reg reg const	01xxx0000100110	58
4	DFMA reg reg lit reg	10xxx0111001101	59
5	DFMA reg reg reg const	01xxx111011001	60
6	DFMA reg reg const reg	01xxx111011010	61
7	DFMA reg reg reg reg	01xxx0111011011	62
8	IADD reg reg const	01xxx0100000110	63
9	IADD reg reg reg	01xxx0100000111	64
10	IADD reg reg lit	10xxx0100000011	65
11	IADD32I reg reg lit	10xxx0000000010	66
12	IMNMX reg reg lit p	10xxx0010000011	67
13	IMNMX reg reg reg p	01xxx0010000111	68
14	IMNMX reg reg const p	01xxx0010000110	69
15	IMUL reg reg const	01xxx1110000110	70
16	IMUL reg reg lit	10xxx1110000011	71
17	IMUL reg reg reg	01xxx1110000111	72
18	IMUL32I reg reg lit	01xxx001110100	73
19	IMAD reg reg lit reg	10xxx0010000101	74
20	IMAD reg reg const reg	01xxx10001010	75
21	IMAD reg reg reg reg	01xxx0010001011	76
22	IMAD reg reg reg const	01xxx010001001	77
23	ISCADD reg reg lit lit	10xxx1100000011	78
24	ISCADD reg reg reg lit	01xxx1100000111	79
25	ISCADD reg reg const lit	01xxx1100000110	80
26	ISSET reg reg const p	01xxx101011010	81
27	ISSETP p p reg lit p	10xxx1011001101	82
28	ISSETP p p reg reg p	01xxx1011011011	83
29	ISSETP p p reg const p	01xxx011011010	84
30	ICMP reg reg lit reg	10xxx1001011101	85
31	ICMP reg reg reg reg	01xxx0001011011	86
32	ICMP reg reg const reg	01xxx001011010	87
33	I2F reg const	01xxx1110100110	88
34	I2F reg reg	01xxx1110100111	89
35	I2I reg const	01xxx0001100110	90
36	I2I reg reg	01xxx0001100111	91
37	I2I reg lit	10xxx0001110011	92
38	F2I reg reg	01xxx0110100111	93
39	F2I reg const	01xxx0110100110	94
40	F2F reg reg	01xxx1010100111	95
41	F2F reg const	01xxx1010100110	96
42	LOP reg reg const	01xxx0001000110	97
43	LOP reg reg lit	10xxx0001000011	98
44	LOP reg reg reg	01xxx0001000111	99
45	LOP32I reg reg lit	00xxx000000100	100
46	SHL reg reg const	01xxx1001000110	101
47	SHR reg reg lit	10xxx1010000011	102
48	SHR reg reg const	01xxx1010000110	103
49	BFE reg reg lit	10xxx0000000011	104
50	BFE reg reg const	01xxx0000000110	105
51	BFI reg reg lit reg	10xxx0111101101	106
52	SEL reg reg reg p	01xxx0010100111	107
53	SEL reg reg lit p	10xxx0010100011	108
54	SEL reg reg const p	01xxx0010100110	109
55			110

111	SSY const	00xxxxx1xx100101000	166
112	SSY lit	00xxxxx0xx0100101000	167
113	BRA const	00111101xx001001000	168
114	BRA misc const	00xxxxx1xx001001000	169
115	BRA lit	00111100xx0001001000	170
116	BRA misc lit	00xxxxx0xx0001001000	171
117	BRX misc reg lit	00xxxxx0xx0101001000	172
118	BRX reg lit	00111100xx0101001000	173
119	BRX const	00111101xx101001000	174
120	BRX misc const	00xxxxx1xx101001000	175
121	PCNT const	00xxxxx1xx110101000	176
122	PCNT lit	00xxxxx0xx0110101000	177
123	CONT misc	00xx0101011000	178
124	CONT	0011110xx0101011000	179
125	PBK lit	00xxxxx0xx0010101000	180
126	PBK const	00xxxxx1xx010101000	181
127	BRK misc	00xx0001011000	182
128	BRK	0011110xx0001011000	183
129	CAL const	00xxxxx1xx011001000	184
130	CAL lit	00xxxxx0xx0011001000	185
131	RET misc	00xx0010011000	186
132	RET	0011110xx0010011000	187
133	EXIT misc	00xx0000011000	188
134	EXIT	0011110xx0000011000	189
135	NOP misc lit	01xx0110100001	190
136	NOP lit	01xxxxxxxx11110xx0110100001	191
137	BPT lit	00xx0000000000	192
138	S2R reg sreg	01xx1001100001	193
139	PSETP p p p p p	01xx0100100001	194
140	PSET reg p p p	01xx1000100001	195
141	FLO reg reg	01xx0110000111	196
142	FLO reg const	01xx0110000110	197
143	P2R reg misc reg lit	10xx1001100011	198
144	P2R reg misc reg const	01xx1001100110	199
145	R2P misc reg lit	10xx000101100011	200
146	R2P misc reg const	01xx100101100110	201
147	TEX reg reg lit tex lit	10xxxxxxxxxxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx110	202
148	TEX reg reg reg lit tex lit	xx110	203
149	TEXDEPBAR lit	01xx0011101110	204
150	RRO reg reg	01xx0100100111	205
151	RRO reg const	01xx0100100110	206
152	PRMT reg reg lit reg	10xx0001101101	207
153	DMNMX reg reg reg p	01xx0101000111	208
154	DMNMX reg reg const p	01xx0101000110	209
155	FMNMX reg reg lit p	10xx0011000011	210
156	FMNMX reg reg reg p	01xx0011000111	211
157	FMNMX reg reg const p	01xx0011000110	212
158	VOTE p p	011111111xx1101100001	213
159	VOTE reg p p	01xx1101100001	214
160	POPC reg reg reg	01xx1000000111	215
161	POPC reg reg const	01xx1000000110	216
162	MEMBAR	01xx1100111110	217
163	CSETP p p misc p	01xx0010100001	218
164	ISCADD32I reg reg lit lit	00xx0xxxxx101	219
165		3	220

221	TLD reg reg lit tex lit	01xxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx1110	276
222	TLD reg reg reg lit tex lit	01xx1110	277
223	SHF reg reg reg reg	01xx111111011	278
224	SHF reg reg lit reg	10xx111101101	279
225	FCHK p reg reg	01xx1000100111	280
226	FCHK p reg const	01xx1000100110	281
227	ISUB reg const reg	01xx01x0100000110	282
228	ISUB reg reg const	01xx10x0100000110	283
229	ISUB reg reg reg	01xx10x0100000111	284
230	ISUB reg lit reg	10xx01x0100000011	285
231	ISUB reg reg lit	10xx10x0100000011	286
232	LDG reg mem	10xxxxxxxxxxxxxxxxxxxx11111110xx1111xxx000100011xxxxxxxxxxx110	287
233			288

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

234			289
235			290
236	Instruction	Bits	291
237	MOV reg const	xx111xxxxxxxx1100100110010	292
238	MOV reg const lit	xx1100100110010	293
239	MOV reg reg	xx111xxxxxxxx1100100111010	294
240	MOV reg reg lit	xx1100100111010	295
241	MOV32I reg lit	xxxxxxxxxxxx1111xx000010000000	296
242	MOV32I reg lit lit	xx000010000000	297
243	LD reg mem p	xx1001xxxxxxxx1	298
244	LDL reg mem	xx0001011110111	299
245	LDS reg mem	xx1001011110111	300
246	LDC reg const	xx0100111101111	301
247	ST mem reg p	xx101	302
248	STL mem reg	xx0101011110111	303
249	STS mem reg	xx1101011110111	304
250	FADD reg reg reg	xx1101000111010	305
251	FADD reg reg const	xx1101000110010	306
252	FADD reg reg lit	xx1101010011100	307
253	FADD32I reg reg lit	xx000000010000	308
254	FMUL reg reg reg	xx1011000111010	309
255	FMUL reg reg lit	xx1011000011100	310
256	FMUL reg reg const	xx1011000110010	311
257	FMUL32I reg reg lit	xx000001111000	312
258	FFMA reg reg reg const	xx0000110001010	313
259	FFMA reg reg lit reg	xx0000101001100	314
260	FFMA reg reg const reg	xx0000110010010	315
261	FFMA reg reg reg reg	xx0000110011010	316
262	FSET reg reg lit p	xx1001100001100	317
263	FSET reg reg reg p	xx1000100011010	318
264	FSETP p p reg lit p	xx1110101101100	319
265	FSETP p p reg reg p	xx1110111011010	320
266	FSETP p p reg const p	xx0110111010010	321
267	DSETP p p reg reg p	xx1000111011010	322
268	DSETP p p reg lit p	xx0000101101100	323
269	DSETP p p reg const p	xx1000111010010	324
270	FCMP reg reg reg reg	xx0010111011010	325
271	FCMP reg reg const reg	xx1010111010010	326
272	FCMP reg reg lit reg	xx1010101101100	327
273	MUFU reg reg	xx0000100001010	328
274	DADD reg reg reg	xx0111000111010	329
275			330

331	DADD reg reg lit	XX0111000011100	386
332	DADD reg reg const	XX0111000110010	387
333	DMUL reg reg reg	XX0000100111010	388
334	DMUL reg reg lit	XX0000110011100	389
335	DMUL reg reg const	XX0000100110010	390
336	DFMA reg reg reg reg	XX0111011011010	391
337	DFMA reg reg lit reg	XX0111001101100	392
338	DFMA reg reg const reg	XX0111011010010	393
339	DFMA reg reg reg const	XX0111011001010	394
340	IADD reg reg reg	XX0100000111010	395
341	IADD reg reg const	XX0100000110010	396
342	IADD reg reg lit	XX0100000011100	397
343	IADD32I reg reg lit	XX0000000111000	398
344	IMNMX reg reg const p	XX0010000110010	399
345	IMNMX reg reg reg p	XX0010000111010	400
346	IMNMX reg reg lit p	XX0010000011100	401
347	ISCADD reg reg reg lit	XX1100000111010	402
348	ISCADD reg reg lit lit	XX1100000011100	403
349	ISCADD reg reg const lit	XX1100000110010	404
350	ISSET reg reg reg p	XX0101011011010	405
351	ISSET reg reg const p	XX1101011010010	406
352	ISSET reg reg lit p	XX0101001101100	407
353	ISSETP p p reg reg p	XX1011011011010	408
354	ISSETP p p reg lit p	XX1011001101100	409
355	ISSETP p p reg const p	XX1011011010010	410
356	ICMP reg reg reg reg	XX0001011011010	411
357	ICMP reg reg lit reg	XX1001011101100	412
358	ICMP reg reg const reg	XX1001011010010	413
359	I2F reg reg	XX1110100111010	414
360	I2F reg const	XX1110100110010	415
361	I2I reg lit	XX0011110011100	416
362	I2I reg reg	XX00111100111010	417
363	I2I reg const	XX00111100110010	418
364	F2I reg reg	XX0110100111010	419
365	F2F reg reg	XX1010100111010	420
366	F2F reg const	XX1010100110010	421
367	F2F reg lit	XX1010100011100	422
368	LOP reg reg lit	XX1110001000011100	423
369	LOP p reg reg reg	XX100011101010	424
370	LOP reg reg reg	XX1110001000111010	425
371	LOP p reg reg const	XX100011001010	426
372	LOP reg reg const	XX1110001000110010	427
373	LOP p reg reg lit	XX10000111100	428
374	LOP32I reg reg lit	XX000000100000	429
375	SHL reg reg lit	XX1001000011100	430
376	SHL reg reg reg	XX1001000111010	431
377	SHR reg reg lit	XX1010000011100	432
378	SHR reg reg reg	XX1010000111010	433
379	BFE reg reg lit	XX0000000011100	434
380	BFI reg reg lit reg	XX0111101101100	435
381	SEL reg reg reg p	XX0010100111010	436
382	SEL reg reg lit p	XX0010100011100	437
383	SEL reg reg const p	XX0010100110010	438
384	SSY lit	xxxxx0xx0100101000111	439
385			440

441	SSY const	xxxxx1xx0100101000111	496
442	BRA const	111101xx0001001000111	497
443	BRA misc const	xxxxx1xx0001001000111	498
444	BRA lit	111100xx0001001000111	499
445	BRA misc lit	xxxxx0xx0001001000111	500
446	BRX const	111101xx0101001000111	501
447	BRX misc const	xxxxx1xx0101001000111	502
448	BRX reg lit	111100xx0101001000111	503
449	BRX misc reg lit	xxxxx0xx0101001000111	504
450	PCNT lit	xxxxx0xx0110101000111	505
451	PCNT const	xxxxx1xx0110101000111	506
452	CONT	11110xx0101011000111	507
453	CONT misc	xx0101011000111	508
454	PBK lit	xxxxx0xx0010101000111	509
455	PBK const	xxxxx1xx0010101000111	510
456	BRK	11110xx0001011000111	511
457	BRK misc	xx0001011000111	512
458	CAL lit	xxxxx0xx0011001000111	513
459	CAL const	xxxxx1xx0011001000111	514
460	RET	11110xx0010011000111	515
461	RET misc	xx0010011000111	516
462	EXIT	11110xx0000011000111	517
463	EXIT misc	xx0000011000111	518
464	NOP lit	xxxxxxxxx11110xx0110100001010	519
465	NOP misc lit	xx0110100001010	520
466	NOP	xxxxxxxxx11110xxxxxxxx0000000000000000xxxxxxxxxxxxxxxxxxxx0110100001010	521
467	NOP misc	xxxxxxxxxxxxxxxxxxxxxxxxxxxx0000000000000000xxxxxxxxxxxxxxxxxxxx0110100001010	522
468	BAR lit	xxxxxxxxxxxxxxxxxxxxxxxxxxxx000000000000000000011011000001010100001111	523
469	BAR lit lit	xx111011000001010100001111	524
470	S2R reg sreg	xx1001100001111	525
471	PSETP p p p p p	xx0100100001010	526
472	PSET reg p p p	xx1000100001010	527
473	FLO reg reg	xx0110000111010	528
474	TEX reg reg lit tex lit	xxxxxxxxxxxxxxxxxxxxxxxxxxxx1111111xxxxxxxxxxxxxxxxxxxxxxxxxxxx1110000000011	529
475	TEX reg reg reg lit tex lit	xx1110000000011	530
476	RRO reg reg	xx0100100111010	531
477	PRMT reg reg lit reg	xx0001101101100	532
478	DMNMX reg reg reg p	xx0101000111010	533
479	DMNMX reg reg lit p	xx0101000011100	534
480	FMNMX reg reg reg p	xx0011000111010	535
481	FMNMX reg reg lit p	xx0011000011100	536
482	RED mem reg	xx1111111010111	537
483	VOTE reg p p	xx1101100001010	538
484	VOTE p p	11111111xx1101100001010	539
485	POPC reg reg	xx1000000111010	540
486	CSETP p p misc p	xx0010100001010	541
487	ISCADD32I reg reg lit lit	xx0xxxxx101000	542
488	SHF reg reg lit reg	xx1111101101100	543
489	SHF reg reg reg reg	xx111111011010	544
490	FCHK p reg reg	xx1000100111010	545
491	JCAL lit	xxxxx0xx010001000111	546
492	JCAL const	xxxxx1xx0010001000111	547
493	LDG reg mem	xx0101101110111	548
494	ATOM reg mem reg reg	xx0111101110111	549
495			550

551	XMAD reg reg reg reg	XX0000011011010	606
552	XMAD reg reg lit reg	XX0010001101100	607
553	XMAD reg reg reg const	XX0110010001010	608
554	XMAD reg reg const reg	XX0000001110010	609
555	SYNC	11110XX1111100001111	610
556	SYNC misc	XX1111100001111	611
557	STG mem reg	XX1101101110111	612
558	IADD3 reg reg reg reg	XX0001100111010	613
559	IADD3 reg reg lit reg	XX00011000111100	614
560	IADD3 reg reg const reg	XX0001100110010	615
561	VABSDIFF reg reg reg reg	XX10010000101010	616
562	VABSDIFF reg reg lit reg	XX00010000101010	617
563	DEPBAR sb lit bitfield	XXXXXXXXXXXXXXXXXXXXXXXXXXXX1XXXXXXXXXXXXXXXXXXXXXXXXXXXX0111100001111	618
564	DEPBAR sb lit	000000XXXXXXXXXXXXXXXXXXXX1XXXXXXXXXXXXXXXXXXXXXXXXXXXX0111100001111	619
565	DEPBAR bitfield	XXXXXXXXXXXXXXXXXXXXXXXXXXXX0XXXXXXXXXXXXXXXXXXXXXXXXXXXX0111100001111	620
566	DEPBAR	000000XXXXXXXXXXXXXXXXXXXX0XXXXXXXXXXXXXXXXXXXXXXXXXXXX0111100001111	621
567	LOP3 reg reg reg reg lit	XX1110011111011010	622
568	LOP3 p reg reg reg reg lit	XX1111101101010	623
569	LOP3 reg reg const reg lit	XX1000000	624
570	LOP3 reg reg lit reg lit	XX1111100	625
571	TLDS reg reg reg lit tex channel	XXXXXXXXXXXXXXXXXXXX1111111XXXXXXXXXXXXXXXXXXXXXXXXXXXX1011011	626
572	TLDS reg reg reg reg lit tex channel	XX1011011	627
573	TEXS reg reg reg lit tex channel	XXXXXXXXXXXXXXXXXXXX1111111XXXXXXXXXXXXXXXXXXXXXXXXXXXX0011011	628
574	TEXS reg reg reg reg lit tex channel	XX0011011	629
575	LEA reg reg reg lit	XX1110101111011010	630
576	LEA reg reg reg	XX00000XXXX1110101111011010	631
577	LEA p reg reg reg lit	XX10111101101010	632
578	LEA p reg reg reg	XX00000XXXXXXXX10111101101010	633
579	LEA reg reg reg reg lit	XX111110111101101010	634
580	LEA reg reg reg reg	XX111110111101101010	635
581	LEA p reg reg reg reg	XX110111101101101010	636
582	LEA p reg reg reg reg lit	XX110111101101101010	637
583	LEA reg reg lit	XX11101011011011100	638
584	LEA reg reg lit lit	XX11101011011011100	639
585	LEA p reg reg lit	XX1011011011100	640
586	LEA p reg reg lit lit	XX1011011011100	641
587	DSET reg reg reg p	XX100001001101010	642
588	DSET reg reg const p	XX000001001001010	643
589	DSET reg reg lit p	XX0001001001100	644
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592			647
593			648
594			649
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