

Tektronix 4052/4054 Firmware Instructions

Appendix A of Service Manual - updated from the 4052A Assembler program opcode table

Note: opcode name is required syntax used by the 4052A Assembler program

Instruction formats -- from 4052 Assembler program listing

1: immediate

Descriptions are from "General Theory of Operation" pgs 6-7 and 6-8 in 4052/54 & 4052A/54A Tech Data service manual

IMMEDIATE: In immediate addressing, the operand is contained in the second byte or the second and third bytes of the instruction. The operand is data to be used by the RALU (Register Arithmetic Logic Unit) on the ALU Board. These are two or three-byte instructions.

2: direct

DIRECT: In direct addressing, the address of the operand is contained in the second byte of the instruction. Direct addressing accesses the lowest 256 bytes of RAM space or ROM space. Data space is determined by the CCRD bit in the condition code register. These are two-byte instructions.

3: extended

EXTENDED: In extended addressing, the second byte of the instruction is used as the higher eight bits of the operand address. The third byte of the instruction is used as the lower eight bits of the operand address. This address is the absolute address of the operand in RAM space or ROM space. Data space is determined by the CCRD bit in the Condition Code Register. These are three-byte instructions.

4: indexed

INDEXED: In indexed addressing, the address contained in the second byte of the instruction is added to the index register's lower byte. The upper byte added to the index register upper byte is all zeros. The offset is in the range of 0 to 255. These are two-byte instructions.

5: implied

IMPLIED: In the implied addressing mode the instruction indicates the address (i.e., stack pointer, index register). These are one-byte instructions

6: relative

RELATIVE: In relative addressing, the second byte of the instruction is added to the program counter's lower eight bits. If Bit 7 in the second byte is a one, the upper byte added to the program counter is set to all zeros. The offset is in twos complement. These are two-byte instructions.

7: extended immediate

EXTENDED IMMEDIATE: No mention of this in General Theory. Looking at the opcodes below, the 6800 **JMP** opcode is shown with EXTENDED IMMEDIATE addressing and the adjacent **TST** and **INC** instructions show EXTENDED. It appears that with EXTENDED IMMEDIATE addressing, two additional bytes are an address to be used immediately as opposed to an address to access data. Likely the CCRD condition code bit is still used to determine whether the address is in RAM or ROM space. Here are the only opcodes using this mode: SWI FPSH,I JMP CPX,I LDS,I JSR LDX,I LDAG,I WADX ADDG,I SUBG,I JSR LDX,I

NEW

not in 6800

			77 NEW	
4052	4052		Instruction	4052/4054
Hex Code	Opcode	Address Mode	format	INSTRUCTIONS
00	TEST	IMPLIED	5	1
01	NOP	IMPLIED	5	
02	.....		
03	SFA	IMPLIED	5	1
04	LDAG,D	DIRECT	2	1
05	LDAG,X	INDEXED	4	1
06	TAP	IMPLIED	5	
07	TPA	IMPLIED	5	
08	INX	IMPLIED	5	
09	DEX	IMPLIED	5	
0A	CLV	IMPLIED	5	
0B	SEV	IMPLIED	5	
0C	CLC	IMPLIED	5	
0D	SEC	IMPLIED	5	
0E	CLI	IMPLIED	5	
0F	SEI	IMPLIED	5	
10	SBA	IMPLIED	5	
11	CBA	IMPLIED	5	
12	TAPX	IMPLIED	5	1
13	TPAX	IMPLIED	5	1
14	ADX,I	IMMEDIATE	1	1
15	ASPI,I	IMMEDIATE	1	1
16	TAB	IMPLIED	5	
17	TBA	IMPLIED	5	
18	SDA	IMPLIED	5	1
19	DAA	IMPLIED	5	
1A	LDXX	IMPLIED	5	1
1B	ABA	IMPLIED	5	
1C	LDAX	IMPLIED	5	1
1D	LDBX	IMPLIED	5	1
1E	STAX	IMPLIED	5	1

1F	JMPAX	IMPLIED	5	1
20	BRA	RELATIVE	6	
21	SDB	IMPLIED	5	1
22	BHI	RELATIVE	6	
23	BLS	RELATIVE	6	
24	BCC	RELATIVE	6	
25	BCS	RELATIVE	6	
26	BNE	RELATIVE	6	
27	BEQ	RELATIVE	6	
28	BVC	RELATIVE	6	
29	BVS	RELATIVE	6	
2A	BPL	RELATIVE	6	
2B	BMI	RELATIVE	6	
2C	BGE	RELATIVE	6	
2D	BLT	RELATIVE	6	
2E	BGT	RELATIVE	6	
2F	BLE	RELATIVE	6	
30	TSX	IMPLIED	5	
31	INS	IMPLIED	5	
32	PULA	IMPLIED	5	
33	PULB	IMPLIED	5	
34	DES	IMPLIED	5	
35	TXS	IMPLIED	5	
36	PSHA	IMPLIED	5	
37	PSHB	IMPLIED	5	
38	JMPIN	EXTENDED	3	1
39	RTS	IMPLIED	5	
3A	FPSH,D	DIRECT	2	1
3B	RTI	IMPLIED	5	
3C	FPSH,X	INDEXED	4	1
3D	FPSH	EXTENDED	3	1
3E	WAI	IMPLIED	5	
3F	SWI	EXTENDED IMMEDIATE	7	1
40	NEGA	IMPLIED	5	

41	FPSH,I	EXTENDED IMMEDIATE	7	1
42	FPUL,D	DIRECT	2	1
43	COMA	IMPLIED	5	
44	LSRA	IMPLIED	5	
45	FPUL,X	INDEXED	4	1
46	RORA	IMPLIED	5	
47	ASRA	IMPLIED	5	
48	ASLA	IMPLIED	5	
49	ROLA	IMPLIED	5	
4A	DECA	IMPLIED	5	
4B	FPUL	EXTENDED	3	1
4C	INCA	IMPLIED	5	
4D	TSTA	IMPLIED	5	
4E	FDUP	IMPLIED	5	1
4F	CLRA	IMPLIED	5	
50	NEGB	IMPLIED	5	
51	FSWP	IMPLIED	5	1
52	FADD	IMPLIED	5	1
53	COMB	IMPLIED	5	
54	LSRB	IMPLIED	5	
55	FSUB	IMPLIED	5	1
56	RORB	IMPLIED	5	
57	ASRB	IMPLIED	5	
58	ASLB	IMPLIED	5	
59	ROLB	IMPLIED	5	
5A	DECB	IMPLIED	5	
5B	FMUL	IMPLIED	5	1
5C	INCB	IMPLIED	5	
5D	TSTB	IMPLIED	5	
5E	FDIV	IMPLIED	5	1
5F	CLRB	IMPLIED	5	
60	NEG,X	INDEXED	4	
61	FNORM	IMPLIED	5	1
62	PSHRET	DIRECT	2	1

63	COM,X	INDEXED	4	
64	LSR,X	INDEXED	4	
65	RTRN	DIRECT	2	1
66	ROR,X	INDEXED	4	
67	ASR,X	INDEXED	4	
68	ASL,X	INDEXED	4	
69	ROL,X	INDEXED	4	
6A	DEC,X	INDEXED	4	
6B	PSHX	INDEXED	5	1
6C	INC,X	INDEXED	3	
6D	TST,X	INDEXED	3	
6E	JMP,X	INDEXED	3	
6F	CLR,X	INDEXED	3	
70	NEG	EXTENDED	3	
71	STROKE	IMPLIED	5	1
72	EC	IMPLIED	5	1
73	COM	EXTENDED	3	
74	LSR	EXTENDED	3	
75	PULX	IMPLIED	5	1
76	ROR	EXTENDED	3	
77	ASR	EXTENDED	3	
78	ASL	EXTENDED	3	
79	ROL	EXTENDED	3	
7A	DEC	EXTENDED	3	
7B	STAG,D	DIRECT	2	1
7C	INC	EXTENDED	3	
7D	TST	EXTENDED	3	
7E	JMP	EXTENDED IMMEDIATE	7	
7F	CLR	EXTENDED	3	
80	SUBA,I	IMMEDIATE	1	
81	CMPA,I	IMMEDIATE	1	
82	SBCA,I	IMMEDIATE	1	
83	STAG,X	EXTENDED	4	1
84	ANDA,I	IMMEDIATE	1	

85	BITA,I	IMMEDIATE	1	
86	LDAA,I	IMMEDIATE	1	
87	ADDG,D	DIRECT	2	1
88	EORA,I	IMMEDIATE	1	
89	ADCA,I	IMMEDIATE	1	
8A	ORAA,I	IMMEDIATE	1	
8B	ADDA,I	IMMEDIATE	1	
8C	CPX,I	EXTENDED IMMEDIATE	7	
8D	BSR	RELATIVE	6	
8E	LDS,I	EXTENDED IMMEDIATE	7	
8F	ADDG,X	DIRECT	2	1
90	SUBA,D	DIRECT	2	
91	CMPA,D	DIRECT	2	
92	SBCA,D	DIRECT	2	
93	SUBG,D	DIRECT	2	1
94	ANDA,D	DIRECT	2	
95	BITA,D	DIRECT	2	
96	LDAA,D	DIRECT	2	
97	STAA,D	DIRECT	2	
98	EORA,D	DIRECT	2	
99	ADCA,D	DIRECT	2	
9A	ORAA,D	DIRECT	2	
9B	ADDA,D	DIRECT	2	
9C	CPX,D	DIRECT	2	
9D	SUBG,X	EXTENDED	4	
9E	LDS,D	DIRECT	2	
9F	STS,D	DIRECT	2	
A0	SUBA,X	INDEXED	4	
A1	CMPA,X	INDEXED	4	
A2	SBCA,X	INDEXED	4	
A3	INXSTX	DIRECT	2	1
A4	ANDA,X	INDEXED	4	
A5	BITA,X	INDEXED	4	
A6	LDAA,X	INDEXED	4	

A7	STAA,X	INDEXED	4	
A8	EORA,X	INDEXED	4	
A9	ADCA,X	INDEXED	4	
AA	ORAA,X	INDEXED	4	
AB	ADDA,X	INDEXED	4	
AC	CPX,X	INDEXED	4	
AD	JSR,X	INDEXED	4	
AE	LDS,X	INDEXED	4	
AF	STS,X	INDEXED	4	
B0	SUBA	EXTENDED	3	
B1	CMPA	EXTENDED	3	
B2	SBCA	EXTENDED	3	
B3	LDAG	EXTENDED	3	
B4	ANDA	EXTENDED	3	
B5	BITA	EXTENDED	3	
B6	LDAA	EXTENDED	3	
B7	STAA	EXTENDED	3	
B8	EORA	EXTENDED	3	
B9	ADCA	EXTENDED	3	
BA	ORAA	EXTENDED	3	
BB	ADDA	EXTENDED	3	
BC	CPX	EXTENDED	3	
BD	JSR	EXTENDED IMMEDIATE	7	
BE	LDS	EXTENDED	3	
BF	STS	EXTENDED	3	
C0	SUBB,I	IMMEDIATE	1	
C1	CMPB,I	IMMEDIATE	1	
C2	SBCB,I	IMMEDIATE	1	
C3	STAG	EXTENDED	3	1
C4	ANDB,I	IMMEDIATE	1	
C5	BITB,I	IMMEDIATE	1	
C6	LDAB,I	IMMEDIATE	1	
C7	ESC????	C7 OPCODE FOLLOWS		1
C8	EORB,I	IMMEDIATE	1	

C9	ADCB,I	IMMEDIATE	1	
CA	ORAB,I	IMMEDIATE	1	
CB	ADDB,I	IMMEDIATE	1	
CC	ADAX	IMPLIED	5	1
CD	WADAX	IMPLIED	5	1
CE	LDX,I	EXTENDED IMMEDIATE	7	
CF	.....		
D0	SUBB,D	DIRECT	2	
D1	CMPB,D	DIRECT	2	
D2	SBCB,D	DIRECT	2	
D3	LDAG,I	EXTENDED IMMEDIATE	7	1
D4	ANDB,D	DIRECT	2	
D5	BITB,D	DIRECT	2	
D6	LDAB,D	DIRECT	2	
D7	STAB,D	DIRECT	2	
D8	EORB,D	DIRECT	2	
D9	ADCB,D	DIRECT	2	
DA	ORAB,D	DIRECT	2	
DB	ADDB,D	DIRECT	2	
DC	SBUG	IMPLIED	5	1
DD	CBUG	IMPLIED	5	1
DE	LDX,D	DIRECT	2	
DF	STX,D	DIRECT	2	
EO	SUBB,X	INDEXED	4	
E1	CMPB,X	INDEXED	4	
E2	SBCB,X	INDEXED	4	
E3	MVLR	IMPLIED	5	1
E4	ANDB,X	INDEXED	4	
E5	BITB,X	INDEXED	4	
E6	LDAB,X	INDEXED	4	
E7	STAB,X	INDEXED	4	
E8	EORB,X	INDEXED	4	
E9	ADCB,X	INDEXED	4	
EA	ORAB,X	INDEXED	4	

EB	ADDB,X	INDEXED	4	
EC	MVRL	IMPLIED	5	1
ED	WADX	EXTENDED	7	1
EE	LDX	INDEXED	4	
EF	STXX	INDEXED	4	
F0	SUBB	EXTENDED	3	
F1	CMPB	EXTENDED	3	
F2	SBCB	EXTENDED	3	
F3	CMPH	IMMEDIATE	1	1
F4	ANDB	EXTENDED	3	
F5	BITB	EXTENDED	3	
F6	LDAB	EXTENDED	3	
F7	STAB	EXTENDED	3	
F8	EORB	EXTENDED	3	
F9	ADCB	EXTENDED	3	
FA	ORAB	EXTENDED	3	
FB	ADDB	EXTENDED	3	
FC	ESC???	FC OPCODE FOLLOWS		1
FD	PCH	IMMEDIATE	1	1
FE	LDX	EXTENDED	3	
FF	STX	EXTENDED	3	
C700	TGX	IMPLIED	5	1
C701	TXG	IMPLIED	5	1
C702	CLRGH	IMPLIED	5	1
C703	IFLOAT	IMPLIED	5	1
C704	FIXRND	IMPLIED	5	1
C705	TMULT	IMPLIED	5	1
C706	BUFIN	IMPLIED	5	1
C707	BUFOUT	IMPLIED	5	1
C708	SEABNK	IMPLIED	5	1
C709	DEVIN	IMPLIED	5	1
C70A	DEVOUT	IMPLIED	5	1
C70B	.....		

C70C	.....		
C70D	.....		
C70E	.....		
C70F	.....		
FC00	PSHG	IMPLIED	5	1
FC01	PULG	IMPLIED	5	1
FC02	ADDG,I	EXTENDED IMMEDIATE	7	1
FC03	ADDG	IMPLIED	3	1
FC04	SUBG,I	EXTENDED IMMEDIATE	7	1
FC05	SUBG	IMPLIED	3	1
FC06	CMPGX	IMPLIED	5	1
FC07	CMPSYM	IMPLIED	5	1
FC08	LDAGX	IMPLIED	5	1
FC09	STAGX	IMPLIED	5	1
FC0A	.....		
FC0B	.....		
FC0C	.....		
FC0D	.....		
FC0E	.....		
FC0F	.....		

6800 OPCODES=	198
New 1-BYTE OPCODES	56
NEW 2-BYTE OPCODES	21
TOTAL new opcodes	77
PERCENTAGE new	39%