6502 MICROPROCESSOR
INSTRUCTION SET SUMMARY

INSTRUCTIONS		IMMEDIATE			ABSOLUTE			ZERO PAGE			ACCUM.			IMPLIED			(IND,X)			(IND),Y			Z.PAGE,X			ABS,X			ABS,Y			RELATIVE			INDIRECT			Z.PAGE,Y			CONDITION CODES					
MNEMONIC	OPERATION	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	N	Z	C	I	D	V
A D C	A + M + C → A (4)(1)	69	2	2	6D	4	3	65	3	2							61	6	2	71	5	2	75	4	2	7D	4	3	79	4	3										✓	✓	✓	-	-	✓
A N D	A ^ M → A (1)	29	2	2	2D	4	3	25	3	2							21	6	2	31	5	2	35	4	2	3D	4	3	39	4	3										✓	✓	-	-	-	-
A S L	C ← 7·····0 ← 0				0E	6	3	06	5	2	0A	2	1										16	6	2	1E	7	3													✓	✓	✓	-	-	-
B C C	BRANCH ON C=0 (2)																															90	2	2												
B C S	BRANCH ON C=1 (2)																															B0	2	2							-	-	-	-	-	-
B E Q	BRANCH ON Z=1 (2)																															F0	2	2							-	-	-	-	-	-
B I T	A ^ M				2C	4	3	24	3	2																															M_7	✓	-	-	-	M_6
B M I	BRANCH ON N=1 (2)																															30	2	2							-	-	-	-	-	-
B N E	BRANCH ON Z=0 (2)																															D0	2	2							-	-	-	-	-	-
B P L	BRANCH ON N=0 (2)																															10	2	2							-	-	-	-	-	-
B R K	(See Fig 1)													00	7	1																									-	-	-	✓	-	-
B V C	BRANCH ON V=0 (2)																															50	2	2							-	-	-	-	-	-
B V S	BRANCH ON V=1 (2)																															70	2	2							-	-	-	-	-	-
C L C	0 → C													18	2	1																									-	-	0	-	-	-
C L D	0 → D													D8	2	1																									-	-	-	-	0	-
C L I	0 → I													58	2	1																									-	-	-	0	-	-
C L V	0 → V													B8	2	1																									-	-	-	-	-	0
C M P	A - M (1)	C9	2	2	CD	4	3	C5	3	2							C1	6	2	D1	5	2	D5	4	2	DD	4	3	D9	4	3										✓	✓	✓	-	-	-
C P X	X - M	E0	2	2	EC	4	3	E4	3	2																															✓	✓	✓	-	-	-
C P Y	Y - M	C0	2	2	CC	4	3	C4	3	2																															✓	✓	✓	-	-	-
D E C	M - 1 → M				CE	6	3	C6	5	2													D6	6	2	DE	7	3													✓	✓	-	-	-	-
D E X	X - 1 → X													CA	2	1																									✓	✓	-	-	-	-
D E Y	Y - 1 → Y													88	2	1																									✓	✓	-	-	-	-
E O R	A ◊ M → A (1)	49	2	2	4D	4	3	45	3	2							41	6	2	51	5	2	55	4	2	5D	4	3	59	4	3										✓	✓	-	-	-	-
I N C	M + 1 → M				EE	6	3	E6	5	2													F6	6	2	FE	7	3													✓	✓	-	-	-	-
I N X	X + 1 → X													E8	2	1																									✓	✓	-	-	-	-
I N Y	Y + 1 → Y													C8	2	1																									✓	✓	-	-	-	-
J M P	JUMP TO NEW LOCATION				4C	3	3																													6C	5	3				-	-	-	-	-	-
J S R	JUMP INTO SUBROUTINE				20	6	3																																			-	-	-	-	-	-
L D A	M →A (1)	A9	2	2	AD	4	3	A5	3	2							A1	6	2	B1	5	2	B5	4	2	BD	4	3	B9	4	3										✓	✓	-	-	-	-

INSTRUCTIONS		IMMEDIATE			ABSOLUTE			ZERO PAGE			ACCUM.			IMPLIED			(IND,X)			(IND),Y			Z.PAGE,X			ABS,X			ABS,Y			RELATIVE			INDIRECT			Z.PAGE,Y			CONDITION CODES					
MNEMONIC	OPERATION	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	OP	N	#	N	Z	C	I	D	V
L D X	M → X (1)	A2	2	2	AE	4	3	A6	3	2																			BE	4	3									B6	4	2	✓	✓	-	-	-	-
L D Y	M → Y (1)	A0	2	2	AC	4	3	A4	3	2													B4	4	2	BC	4	3													✓	✓	-	-	-	-
L S R	0 → 7·····0 → C				4E	6	3	46	5	2	4A	2	1										56	6	2	5E	7	3													0	✓	✓	-	-	-
N O P	NO OPERATION													EA	2	1																									-	-	-	-	-	-
O R A	A v M → A	09	2	2	0D	4	3	05	3	2							01	6	2	11	5	2	15	4	2	1D	4	3	19	4	3										✓	✓	-	-	-	-
P H A	A → Ms, S - 1 → S													48	3	1																									-	-	-	-	-	-
P H P	P → Ms, S - 1 → S													08	3	1																									-	-	-	-	-	-
P L A	S + 1 → S, Ms → A													68	4	1																									✓	✓	-	-	-	-
P L P	S + 1 → S, Ms → P													28	4	1																									RESTORED					
R O L	C ← 7·····0 ← C				2E	6	3	26	5	2	2A	2	1										36	6	2	3E	7	3													✓	✓	✓	-	-	-
R O R	C → 7·····0 → C				6E	6	3	66	5	2	6A	2	1										76	6	2	7E	7	3													✓	✓	✓	-	-	-
R T I	RETURN FROM INTERRUPT													40	6	1																									RESTORED					
R T S	RETURN FROM SUBROUTINE													60	6	1																									-	-	-	-	-	-
S B C	A - M - C̲ →A (1)(3)	E9	2	2	ED	4	3	E5	3	2							E1	6	2	F1	5	2	F5	4	2	FD	4	3													✓	✓	(3)	-	-	✓
S E C	1 → C													38	2	1																									-	-	1	-	-	-
S E D	1 → D													F8	2	1																									-	-	-	-	1	-
S E I	1 → I																																								-	-	-	1	-	-
S T A	A → M				8D	4	3	85	3	2							81	6	2	91	6	2	95	4	2	9D	5	3	99	5	3										-	-	-	-	-	-
S T X	X → M				8E	4	3	86	3	2																															96	4	2	-	-	-	-	-	-
S T Y	Y → M				8C	4	3	84	3	2													94	4	2																	-	-	-	-	-	-
T A X	A → X													AA	2	1																									✓	✓	-	-	-	-
T A Y	A → Y													AB	2	1																									✓	✓	-	-	-	-
T S X	S → X													BA	2	1																									✓	✓	-	-	-	-
T X A	X → A													8A	2	1																									✓	✓	-	-	-	-
T X S	X → S													9A	2	1																									-	-	-	-	-	-
T Y A	Y → A													98	2	1																									✓	✓	-	-	-	-

(1) ADD 1 TO "N" IF PAGE BOUNDARY IS CORSSED
(2) ADD 1 TO "N" IF BRANCH OCCURS TO SAME PAGE
ADD 2 TO "N" IF BRANCH OCCURS TO DIFFERENT PAGE
(3) C̲ = CARRY NOT = BORROW
(4) IF IN DECIMAL MODE, Z FLAG IS INVALID
ACCUMULATOR MUST BE CHECKED FOR ZERO RESULT

X = X REGISTER
Y = Y REGISTER
A = ACCUMULATOR
S = STACK POINTER
M = MEMORY PER EFFECTIVE ADDRESS
Ms = MEMORY PER STACK POINTER

+ ADD
- SUBTRACT
^ AND
v OR
◊ EXCLUSIVE OR
✓ MODIFIED

- NOT MODIFIED
M_7 MEMORY BIT 7
M_6 MEMORY BIT 6
N NUMBER OF CYCLES
NUMBER OF BYTES

6502 MICROPROCESSOR

INSTRUCTION SET OP CODE MATRIX

MSD \ LSD	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	MSD
0	**BRK** Implied 1 7	**ORA** (IND, X) 2 6				**ORA** ZP 2 3	**ASL** ZP 2 5		**PHP** Implied 1 3	**ORA** IMM 2 2	**ASL** Accum 1 2			**ORA** ABS 3 4	**ASL** ABS 3 6		0
1	**BPL** Relative 2 2**	**ORA** (IND), Y 2 5*				**ORA** ZP, X 2 4	**ASL** ZP, X 2 6		**CLC** Implied 1 2	**ORA** ABS, Y 3 4*				**ORA** ABS, X 3 4*	**ASL** ABS, X 3 7		1
2	**JSR** ABS 2 3	**AND** (IND, X) 2 6			**BIT** ZP 2 3	**AND** ZP 2 3	**ROL** ZP 2 5		**PLP** Implied 1 4	**AND** IMM 2 2	**ROL** Accum 1 2		**BIT** ABS 3 4	**AND** ABS 3 4	**ROL** ABS 3 6		2
3	**BMI** Relative 2 2**	**AND** (IND), Y 2 5*				**AND** ZP, X 2 4	**ROL** ZP, X 2 6		**SEC** Implied 1 2	**AND** ABS, Y 3 4*				**AND** ABS, X 3 4*	**ROL** ABS, X 3 7		3
4	**RTI** Implied 1 6	**EOR** (IND, X) 2 6				**EOR** ZP 2 3	**LSR** ZP 2 5		**PHA** Implied 1 3	**EOR** IMM 2 2	**LSR** Accum 1 2		**JMP** ABS 3 3	**EOR** ABS 3 4	**LSR** ABS 3 6		4
5	**BVC** Relative 2 2**	**EOR** (IND), Y 2 5*				**EOR** ZP, X 2 4	**LSR** ZP, X 2 6		**CLI** Implied 1 2	**EOR** ABS, Y 3 4*				**EOR** ABS, X 3 4*	**LSR** ABS, X 3 7		5
6	**RTS** Implied 1 6	**ADC** (IND, X) 2 6$				**ADC** ZP 2 3$	**ROR** ZP 2 5		**PLA** Implied 1 4	**ADC** IMM 2 2$	**ROR** Accum 1 2		**JMP** (ABS) 3 6	**ADC** ABS 3 4$	**ROR** ABS 3 6		6
7	**BVS** Relative 2 2**	**ADC** (IND), Y 2 5*$				**ADC** ZP, X 2 4$	**ROR** ZP, X 2 6		**SEI** Implied 1 2	**ADC** ABS, Y 3 4*$				**ADC** ABS, X 3 4*$	**ROR** ABS, X 3 7		7
8		**STA** (IND, X) 2 6			**STY** ZP 2 3	**STA** ZP 2 3	**STX** ZP 2 3		**DEY** Implied 1 2		**TXA** Implied 1 2		**STY** ABS 3 4	**STA** ABS 3 4	**STX** ABS 3 4		8
9	**BCC** Relative 2 2**	**STA** (IND), Y 2 6			**STY** ZP, X 2 4	**STA** ZP, X 2 4	**STX** ZP, Y 2 4		**TYA** Implied 1 2	**STA** ABS, Y 3 5	**TXS** Implied 1 2			**STA** ABS, X 3 5			9
A	**LDY** IMM 2 2	**LDA** (IND, X) 2 6	**LDX** IMM 2 2		**LDY** ZP 2 3	**LDA** ZP 2 3	**LDX** ZP 2 3		**TAY** Implied 1 2	**LDA** IMM 2 2	**TAX** Implied 1 2		**LDY** ABS 3 4	**LDA** ABS 3 4	**LDX** ABS 3 4		A
B	**BCS** Relative 2 2**	**LDA** (IND), Y 2 5*			**LDY** ZP, X 2 4	**LDA** ZP, X 2 4	**LDX** ZP, Y 2 4		**CLV** Implied 1 2	**LDA** ABS, Y 3 4*	**TSX** Implied 1 2		**LDY** ABS, X 3 4*	**LDA** ABS, X 3 4*	**LDX** ABS, Y 3 4*		B
C	**CPY** IMM 2 2	**CMP** (IND, X) 2 6			**CPY** ZP 2 3	**CMP** ZP 2 3	**DEC** ZP 2 3		**INY** Implied 1 2	**CMP** IMM 2 2	**DEX** Implied 1 2		**CPY** ABS 3 4	**CMP** ABS 3 4	**DEC** ABS 3 6		C
D	**BNE** Relative 2 2**	**CMP** (IND), Y 2 5*				**CMP** ZP, X 2 4	**DEC** ZP, X 2 6		**CLD** Implied 1 2	**CMP** ABS, Y 3 4*				**CMP** ABS, X 3 4*	**DEC** ABS, X 3 7		D
E	**CPX** IMM 2 2	**SBC** (IND, X) 2 6$			**CPX** ZP 2 3	**SBC** ZP 2 3$	**INC** ZP 2 5		**INX** Implied 1 2	**SBC** IMM 2 2$	**NOP** Implied 1 2		**CPX** ABS 3 4	**SBC** ABS 3 4$	**INC** ABS 3 6		E
F	**BEQ** Relative 2 2**	**SBC** (IND), Y 2 5*$				**SBC** ZP, X 2 4$	**INC** ZP, X 2 6		**SED** Implied 1 2	**SBC** ABS, Y 3 4*$				**SBC** ABS, X 3 4*$	**INC** ABS, X 3 7		F
MSD \ LSD	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	MSD

BRK Implied 1 7	->	OP Code Addressing Mode Instruction Bytes, N = Machine Cycles

$	Add 1 to N if in decimal mode
*	Add 1 to N if page boundary is crossed
**	Add 1 to N if branch occurs to different page Add 2 to N if branch occurs to same page