

# Emulator 101

8080 reference 6502 reference

## 6502 Reference

### Ordered by Opcode

Opcode	Instruction	Addressing Mode	Flags
\$00	BRK	Implied	-----
\$01	ORA (\$NN,X)	Indexed Indirect	- Z- --- N
\$05	ORA \$NN	Zero Page	- Z- --- N
\$06	ASL \$NN	Zero Page	CZ- --- N
\$08	PHP	Implied	-----
\$09	ORA #\$NN	Immediate	- Z- --- N
\$0a	ASL A	Accumulator	CZ- --- N
\$0d	ORA \$NNNN	Absolute	- Z- --- N
\$0e	ASL \$NNNN	Absolute	CZ- --- N
\$10	BPL \$NN	Relative	-----
\$11	ORA (\$NN),Y	Indirect Indexed	- Z- --- N
\$15	ORA \$NN,X	Zero Page,X	- Z- --- N
\$16	ASL \$NN,X	Zero Page,X	CZ- --- N
\$18	CLC	Implied	C- -----
\$19	ORA \$NNNN,Y	Absolute,Y	- Z- --- N
\$1d	ORA \$NNNN,X	Absolute,X	- Z- --- N
\$1e	ASL \$NNNN,X	Absolute,X	CZ- --- N
\$20	JSR \$NNNN	Absolute	-----
\$21	AND (\$NN,X)	Indexed Indirect	- Z- --- N
\$24	BIT \$NN	Zero Page	- Z- --- VN
\$25	AND \$NN	Zero Page	- Z- --- N
\$26	ROL \$NN	Zero Page	CZ- --- N
\$28	PLP	Implied	CZIDBVN
\$29	AND #\$NN	Immediate	- Z- --- N
\$2a	ROL A	Accumulator	CZ- --- N
\$2c	BIT \$NNNN	Absolute	- Z- --- VN
\$2d	AND \$NNNN	Absolute	- Z- --- N
\$2e	ROL \$NNNN	Absolute	CZ- --- N
\$30	BMI \$NN	Relative	-----
\$31	AND (\$NN),Y	Indirect Indexed	- Z- --- N
\$35	AND \$NN,X	Zero Page,X	- Z- --- N
\$36	ROL \$NN,X	Zero Page,X	CZ- --- N
\$38	SEC	Implied	C- -----
\$39	AND \$NNNN,Y	Absolute,Y	- Z- --- N
\$3d	AND \$NNNN,X	Absolute,X	- Z- --- N

\$3e	ROL \$NNNN,X	Absolute,X	CZ- - - - N
\$40	RTI	Implied	- - - - -
\$41	EOR (\$NN,X)	Indexed Indirect	- Z- - - - N
\$45	EOR \$NN	Zero Page	- Z- - - - N
\$46	LSR \$NN	Zero Page	CZ- - - - N
\$48	PHA	Implied	- - - - -
\$49	EOR #\$NN	Immediate	- Z- - - - N
\$4a	LSR A	Accumulator	CZ- - - - N
\$4c	JMP \$NNNN	Absolute	- - - - -
\$4d	EOR \$NNNN	Absolute	- Z- - - - N
\$4e	LSR \$NNNN	Absolute	CZ- - - - N
\$50	BVC \$NN	Relative	- - - - -
\$51	EOR (\$NN),Y	Indirect Indexed	- Z- - - - N
\$55	EOR \$NN,X	Zero Page,X	- Z- - - - N
\$56	LSR \$NN,X	Zero Page,X	CZ- - - - N
\$58	CLI	Implied	- - I- - - -
\$59	EOR \$NNNN,Y	Absolute,Y	- Z- - - - N
\$5d	EOR \$NNNN,X	Absolute,X	- Z- - - - N
\$5e	LSR \$NNNN,X	Absolute,X	CZ- - - - N
\$60	RTS	Implied	- - - - -
\$61	ADC (\$NN,X)	Indexed Indirect	CZ- - - VN
\$65	ADC \$NN	Zero Page	CZ- - - VN
\$66	ROR \$NN	Zero Page	CZ- - - - N
\$68	PLA	Implied	- Z- - - - N
\$69	ADC #\$NN	Immediate	CZ- - - VN
\$6a	ROR A	Accumulator	CZ- - - - N
\$6c	JMP \$NN	Indirect	- - - - -
\$6d	ADC \$NNNN	Absolute	CZ- - - VN
\$6e	ROR \$NNNN,X	Absolute,X	CZ- - - - N
\$70	BVS \$NN	Relative	- - - - -
\$71	ADC (\$NN),Y	Indirect Indexed	CZ- - - VN
\$75	ADC \$NN,X	Zero Page,X	CZ- - - VN
\$76	ROR \$NN,X	Zero Page,X	CZ- - - - N
\$78	SEI	Implied	- - I- - - -
\$79	ADC \$NNNN,Y	Absolute,Y	CZ- - - VN
\$7d	ADC \$NNNN,X	Absolute,X	CZ- - - VN
\$7e	ROR \$NNNN	Absolute	CZ- - - - N
\$81	STA (\$NN,X)	Indexed Indirect	- - - - -
\$84	STY \$NN	Zero Page	- - - - -
\$85	STA \$NN	Zero Page	- - - - -
\$86	STX \$NN	Zero Page	- - - - -
\$88	DEY	Implied	- Z- - - - N
\$8a	TXA	Implied	- Z- - - - N

\$8c	STY \$NNNN	Absolute	-----
\$8d	STA \$NNNN	Absolute	-----
\$8e	STX \$NNNN	Absolute	-----
\$90	BCC \$NN	Relative	-----
\$91	STA (\$NN),Y	Indirect Indexed	-----
\$94	STY \$NN,X	Zero Page,X	-----
\$95	STA \$NN,X	Zero Page,X	-----
\$96	STX \$NN,Y	Zero Page,Y	-----
\$98	TYA	Implied	- Z- - - - N
\$99	STA \$NNNN,Y	Absolute,Y	-----
\$9a	TXS	Implied	-----
\$9d	STA \$NNNN,X	Absolute,X	-----
\$a0	LDY #\$NN	Immediate	- Z- - - - N
\$a1	LDA (\$NN,X)	Indexed Indirect	- Z- - - - N
\$a2	LDX #\$NN	Immediate	- Z- - - - N
\$a4	LDY \$NN	Zero Page	- Z- - - - N
\$a5	LDA \$NN	Zero Page	- Z- - - - N
\$a6	LDX \$NN	Zero Page	- Z- - - - N
\$a8	TAY	Implied	- Z- - - - N
\$a9	LDA #\$NN	Immediate	- Z- - - - N
\$aa	TAX	Implied	- Z- - - - N
\$ac	LDY \$NNNN	Absolute	- Z- - - - N
\$ad	LDA \$NNNN	Absolute	- Z- - - - N
\$ae	LDX \$NNNN	Absolute	- Z- - - - N
\$b0	BCS \$NN	Relative	-----
\$b1	LDA (\$NN),Y	Indirect Indexed	- Z- - - - N
\$b4	LDY \$NN,X	Zero Page,X	- Z- - - - N
\$b5	LDA \$NN,X	Zero Page,X	- Z- - - - N
\$b6	LDX \$NN,Y	Zero Page,Y	- Z- - - - N
\$b8	CLV	Implied	----- V-
\$b9	LDA \$NNNN,Y	Absolute,Y	- Z- - - - N
\$ba	TSX	Implied	- Z- - - - N
\$bc	LDY \$NNNN,X	Absolute,X	- Z- - - - N
\$bd	LDA \$NNNN,X	Absolute,X	- Z- - - - N
\$be	LDX \$NNNN,Y	Absolute,Y	- Z- - - - N
\$c0	CPY #\$NN	Immediate	CZ- - - - N
\$c1	CMP (\$NN,X)	Indexed Indirect	CZ- - - - N
\$c4	CPY \$NN	Zero Page	CZ- - - - N
\$c5	CMP \$NN	Zero Page	CZ- - - - N
\$c6	DEC \$NN	Zero Page	- Z- - - - N
\$c8	INY	Implied	- Z- - - - N
\$c9	CMP #\$NN	Immediate	CZ- - - - N
\$ca	DEX	Implied	- Z- - - - N

\$cc	CPY \$NNNN	Absolute	CZ- - - - N
\$cd	CMP \$NNNN	Absolute	CZ- - - - N
\$ce	DEC \$NNNN	Absolute	- Z- - - - N
\$d0	BNE \$NN	Relative	- - - - -
\$d1	CMP (\$NN),Y	Indirect Indexed	CZ- - - - N
\$d5	CMP \$NN,X	Zero Page,X	CZ- - - - N
\$d6	DEC \$NN,X	Zero Page,X	- Z- - - - N
\$d8	CLD	Implied	- - - D- - -
\$d9	CMP \$NNNN,Y	Absolute,Y	CZ- - - - N
\$dd	CMP \$NNNN,X	Absolute,X	CZ- - - - N
\$de	DEC \$NNNN,X	Absolute,X	- Z- - - - N
\$e0	CPX #\$NN	Immediate	CZ- - - - N
\$e1	SBC (\$NN,X)	Indexed Indirect	CZ- - - VN
\$e4	CPX \$NN	Zero Page	CZ- - - - N
\$e5	SBC \$NN	Zero Page	CZ- - - VN
\$e6	INC \$NN	Zero Page	- Z- - - - N
\$e8	INX	Implied	- Z- - - - N
\$e9	SBC #\$NN	Immediate	CZ- - - VN
\$ea	NOP	Implied	- - - - -
\$ec	CPX \$NNNN	Absolute	CZ- - - - N
\$ed	SBC \$NNNN	Absolute	CZ- - - VN
\$ee	INC \$NNNN	Absolute	- Z- - - - N
\$f0	BEQ \$NN	Relative	- - - - -
\$f1	SBC (\$NN),Y	Indirect Indexed	CZ- - - VN
\$f5	SBC \$NN,X	Zero Page,X	CZ- - - VN
\$f6	INC \$NN,X	Zero Page,X	- Z- - - - N
\$f8	SED	Implied	- - - D- - -
\$f9	SBC \$NNNN,Y	Absolute,Y	CZ- - - VN
\$fd	SBC \$NNNN,X	Absolute,X	CZ- - - VN
\$fe	INC \$NNNN,X	Absolute,X	- Z- - - - N

**Ordered by Nemonic**

Instruction	Addressing Mode	Opcode	Flags
ADC #\$NN	Immediate	\$69	CZ- - - VN
ADC \$NNNN	Absolute	\$6d	CZ- - - VN
ADC \$NNNN,X	Absolute,X	\$7d	CZ- - - VN
ADC \$NNNN,Y	Absolute,Y	\$79	CZ- - - VN
ADC \$NN	Zero Page	\$65	CZ- - - VN
ADC \$NN,X	Zero Page,X	\$75	CZ- - - VN
ADC (\$NN,X)	Indexed Indirect	\$61	CZ- - - VN
ADC (\$NN),Y	Indirect Indexed	\$71	CZ- - - VN
AND #\$NN	Immediate	\$29	- Z- - - - N
AND \$NNNN	Absolute	\$2d	- Z- - - - N
AND \$NNNN,X	Absolute,X	\$3d	- Z- - - - N
AND \$NNNN,Y	Absolute,Y	\$39	- Z- - - - N
AND \$NN	Zero Page	\$25	- Z- - - - N
AND \$NN,X	Zero Page,X	\$35	- Z- - - - N
AND (\$NN,X)	Indexed Indirect	\$21	- Z- - - - N
AND (\$NN),Y	Indirect Indexed	\$31	- Z- - - - N
ASL A	Accumulator	\$0a	CZ- - - - N
ASL \$NNNN	Absolute	\$0e	CZ- - - - N
ASL \$NNNN,X	Absolute,X	\$1e	CZ- - - - N
ASL \$NN	Zero Page	\$06	CZ- - - - N
ASL \$NN,X	Zero Page,X	\$16	CZ- - - - N
BCC \$NN	Relative	\$90	- - - - -
BCS \$NN	Relative	\$b0	- - - - -
BEQ \$NN	Relative	\$f0	- - - - -
BIT \$NNNN	Absolute	\$2c	- Z- - - VN
BIT \$NN	Zero Page	\$24	- Z- - - VN
BMI \$NN	Relative	\$30	- - - - -
BNE \$NN	Relative	\$d0	- - - - -
BPL \$NN	Relative	\$10	- - - - -
BRK	Implied	\$00	- - - - -
BVC \$NN	Relative	\$50	- - - - -
BVS \$NN	Relative	\$70	- - - - -
CLC	Implied	\$18	C- - - - -
CLD	Implied	\$d8	- - - D- - -
CLI	Implied	\$58	- - I- - - -
CLV	Implied	\$b8	- - - - - V-
CMP #\$NN	Immediate	\$c9	CZ- - - - N
CMP \$NNNN	Absolute	\$cd	CZ- - - - N
CMP \$NNNN,X	Absolute,X	\$dd	CZ- - - - N
CMP \$NNNN,Y	Absolute,Y	\$d9	CZ- - - - N
CMP \$NN	Zero Page	\$c5	CZ- - - - N
CMP \$NN,X	Zero Page,X	\$d5	CZ- - - - N

CMP (\$NN,X)	Indexed Indirect	\$c1	CZ- - - - N
CMP (\$NN),Y	Indirect Indexed	\$d1	CZ- - - - N
CPX #\$NN	Immediate	\$e0	CZ- - - - N
CPX \$NNNN	Absolute	\$ec	CZ- - - - N
CPX \$NN	Zero Page	\$e4	CZ- - - - N
CPY #\$NN	Immediate	\$c0	CZ- - - - N
CPY \$NNNN	Absolute	\$cc	CZ- - - - N
CPY \$NN	Zero Page	\$c4	CZ- - - - N
DEC \$NNNN	Absolute	\$ce	- Z- - - - N
DEC \$NNNN,X	Absolute,X	\$de	- Z- - - - N
DEC \$NN	Zero Page	\$c6	- Z- - - - N
DEC \$NN,X	Zero Page,X	\$d6	- Z- - - - N
DEX	Implied	\$ca	- Z- - - - N
DEY	Implied	\$88	- Z- - - - N
EOR #\$NN	Immediate	\$49	- Z- - - - N
EOR \$NNNN	Absolute	\$4d	- Z- - - - N
EOR \$NNNN,X	Absolute,X	\$5d	- Z- - - - N
EOR \$NNNN,Y	Absolute,Y	\$59	- Z- - - - N
EOR \$NN	Zero Page	\$45	- Z- - - - N
EOR \$NN,X	Zero Page,X	\$55	- Z- - - - N
EOR (\$NN,X)	Indexed Indirect	\$41	- Z- - - - N
EOR (\$NN),Y	Indirect Indexed	\$51	- Z- - - - N
INC \$NNNN	Absolute	\$ee	- Z- - - - N
INC \$NNNN,X	Absolute,X	\$fe	- Z- - - - N
INC \$NN	Zero Page	\$e6	- Z- - - - N
INC \$NN,X	Zero Page,X	\$f6	- Z- - - - N
INX	Implied	\$e8	- Z- - - - N
INY	Implied	\$c8	- Z- - - - N
JMP \$NNNN	Absolute	\$4c	- - - - -
JMP \$NN	Indirect	\$6c	- - - - -
JSR \$NNNN	Absolute	\$20	- - - - -
LDA #\$NN	Immediate	\$a9	- Z- - - - N
LDA \$NNNN	Absolute	\$ad	- Z- - - - N
LDA \$NNNN,X	Absolute,X	\$bd	- Z- - - - N
LDA \$NNNN,Y	Absolute,Y	\$b9	- Z- - - - N
LDA \$NN	Zero Page	\$a5	- Z- - - - N
LDA \$NN,X	Zero Page,X	\$b5	- Z- - - - N
LDA (\$NN,X)	Indexed Indirect	\$a1	- Z- - - - N
LDA (\$NN),Y	Indirect Indexed	\$b1	- Z- - - - N
LDX #\$NN	Immediate	\$a2	- Z- - - - N
LDX \$NNNN	Absolute	\$ae	- Z- - - - N
LDX \$NNNN,Y	Absolute,Y	\$be	- Z- - - - N
LDX \$NN	Zero Page	\$a6	- Z- - - - N

LDX \$NN,Y	Zero Page,Y	\$b6	- Z- - - - N
LDY #\$NN	Immediate	\$a0	- Z- - - - N
LDY \$NNNN	Absolute	\$ac	- Z- - - - N
LDY \$NNNN,X	Absolute,X	\$bc	- Z- - - - N
LDY \$NN	Zero Page	\$a4	- Z- - - - N
LDY \$NN,X	Zero Page,X	\$b4	- Z- - - - N
LSR A	Accumulator	\$4a	CZ- - - - N
LSR \$NNNN	Absolute	\$4e	CZ- - - - N
LSR \$NNNN,X	Absolute,X	\$5e	CZ- - - - N
LSR \$NN	Zero Page	\$46	CZ- - - - N
LSR \$NN,X	Zero Page,X	\$56	CZ- - - - N
NOP	Implied	\$ea	- - - - -
ORA #\$NN	Immediate	\$09	- Z- - - - N
ORA \$NNNN	Absolute	\$0d	- Z- - - - N
ORA \$NNNN,X	Absolute,X	\$1d	- Z- - - - N
ORA \$NNNN,Y	Absolute,Y	\$19	- Z- - - - N
ORA \$NN	Zero Page	\$05	- Z- - - - N
ORA \$NN,X	Zero Page,X	\$15	- Z- - - - N
ORA (\$NN,X)	Indexed Indirect	\$01	- Z- - - - N
ORA (\$NN),Y	Indirect Indexed	\$11	- Z- - - - N
PHA	Implied	\$48	- - - - -
PHP	Implied	\$08	- - - - -
PLA	Implied	\$68	- Z- - - - N
PLP	Implied	\$28	CZIDBVN
ROL A	Accumulator	\$2a	CZ- - - - N
ROL \$NNNN	Absolute	\$2e	CZ- - - - N
ROL \$NNNN,X	Absolute,X	\$3e	CZ- - - - N
ROL \$NN	Zero Page	\$26	CZ- - - - N
ROL \$NN,X	Zero Page,X	\$36	CZ- - - - N
ROR A	Accumulator	\$6a	CZ- - - - N
ROR \$NNNN	Absolute	\$7e	CZ- - - - N
ROR \$NNNN,X	Absolute,X	\$6e	CZ- - - - N
ROR \$NN	Zero Page	\$66	CZ- - - - N
ROR \$NN,X	Zero Page,X	\$76	CZ- - - - N
RTI	Implied	\$40	- - - - -
RTS	Implied	\$60	- - - - -
SBC #\$NN	Immediate	\$e9	CZ- - - VN
SBC \$NNNN	Absolute	\$ed	CZ- - - VN
SBC \$NNNN,X	Absolute,X	\$fd	CZ- - - VN
SBC \$NNNN,Y	Absolute,Y	\$f9	CZ- - - VN
SBC \$NN	Zero Page	\$e5	CZ- - - VN
SBC \$NN,X	Zero Page,X	\$f5	CZ- - - VN
SBC (\$NN,X)	Indexed Indirect	\$e1	CZ- - - VN

SBC (\$NN),Y	Indirect Indexed	\$f1	CZ- - - VN
SEC	Implied	\$38	C- - - - -
SED	Implied	\$f8	- - - D- - -
SEI	Implied	\$78	- - I- - - -
STA \$NNNN	Absolute	\$8d	- - - - -
STA \$NNNN,X	Absolute,X	\$9d	- - - - -
STA \$NNNN,Y	Absolute,Y	\$99	- - - - -
STA \$NN	Zero Page	\$85	- - - - -
STA \$NN,X	Zero Page,X	\$95	- - - - -
STA (\$NN,X)	Indexed Indirect	\$81	- - - - -
STA (\$NN),Y	Indirect Indexed	\$91	- - - - -
STX \$NNNN	Absolute	\$8e	- - - - -
STX \$NN	Zero Page	\$86	- - - - -
STX \$NN,Y	Zero Page,Y	\$96	- - - - -
STY \$NNNN	Absolute	\$8c	- - - - -
STY \$NN	Zero Page	\$84	- - - - -
STY \$NN,X	Zero Page,X	\$94	- - - - -
TAX	Implied	\$aa	- Z- - - - N
TAY	Implied	\$a8	- Z- - - - N
TSX	Implied	\$ba	- Z- - - - N
TXA	Implied	\$8a	- Z- - - - N
TXS	Implied	\$9a	- - - - -
TYA	Implied	\$98	- Z- - - - N

Post questions or comments on Twitter [@realemulator101](#), or if you find issues in the code, file them on the github repository.