6502 OPERATING SYSTEM for the Digital Group 6502 CPU CARD

General Design

This programming system provides five key programs and many supporting subroutines. The user is able to enter his programming, check out his programming, and finally run his programming under the control of these five included programs.

The first program is a cassette reading program, almost completely contained on the Eraseable Read Only Memory (EROM). A frequency shifting data cassette is converted from serial data to parallel data and loaded into memory. The default data rate is 1100 BPS, and the default start and stop addresses are 000 000 and 007 377 respectively.

The next program is a cassette writing program which allows storing the contents of memory on a low-cost audio cassette recorder. The default data rate and addresses are the same as for cassette reading.

A storage dump program uses the CRT readout board and a TV set to display several items necessary to ease programming. The accumulator and two indeces of the 6502 are interpreted and displayed exactly as they were immediately prior to calling the TV storage dump program. The internal 6502 status flags are also dumped and interpreted as are the stack pointer address and return address. The return address is only valid should the TV storage dump occur during a subroutine. The full contents of memory are then displayed, 96 bytes at a time, except for every 3rd display which culminates a page boundary. The initial address for each line is displayed at the left of each line, and six sequential bytes are displayed to the right.

A keyboard programming capability allows entering octal code directly from the system keyboard. The default address is 006 300. Programming may be entered at any available address, but programming below 006 300 runs the risk of destroying key portions of the operating system. Addresses 000 040 - 000 377 are also open for user programming.

The final programming section is an operations monitor. The TV displays a list of up to ten options available to the user. The user then enters the number of the desired operation, and a table lookup selection performs a branch to the desired program.

Using the Digital Group 6502 Operating System

Initial Cassette Read:

After turning on the microprocessor, the message "READ 6502 INITIALIZE Cassette" will appear on the screen. Start the cassette recorder reading the cassette, and when the low tone begins, push the reset button and release. When data begins after the short tone leader, the TV will display the least significant character of the Hex page being currently loaded, byte by byte. Memory is checked byte by

byte, and missing or defective memory addresses are indicated by a "." being printed instead of the page. When the tone stops, the operations monitor assumes control, and the program loops awaiting a keyboard entry of the desired selection.

Storage Dump:

The typical first entry will be a request to view storage to find some free area where some additional user supplied programming may be placed. Pressing a "3" will result in a display of the register, flag, and stack data in Octal. A "5" will produce Hex listings.

Successively pressing the "Space" key will page through memory, 96 bytes at a time. To set storage immediately to a desired page rather than having to successively page up to it, enter an "S" (either upper or lower case is fine on entries) and the three digits (Most Significant, Middle, then Least Significant) which make up the desired page.

Entering a "P" will cause a branch to the keyboard programming routine.

Entering an "R" will Return the control to the operations monitor.

Keyboard Program:

Once available locations in storage have been found, the user can manually enter programming from the keyboard by typing a "4" if in the operations monitor, or a "P" if in a TV dump. A title will be displayed along with the default address in Octal of the tape shipped.

Programming may be entered by merely typing in the desired octal code, MSB through LSB. The results will be displayed on the TV along with some past bytes to insure proper sequencing as well as aid short term entry error detection. A "6" will give the above operation in Hex.

The page (high) and/or byte (low) address may be preset by entering an "H" and MSB through LSB of the octal address and/or an "L" and the MSB through LSB. The current address is displayed on the TV after entry. Memory is changed only following the third entry of the data byte.

Use care when entering code below 006 300 (Octal) or 06C0 (Hex). Since this is system area, any code or operations can result in an inoperative system with no means of recovery other than re-reading the cassette.

Enter an "R" to return to the Operations Monitor.

Type an "S" to go to the Storage Dump directly from programming. Actual programming typically sees considerable "S" and "P" as entries are made, then viewed.

Cassette Write:

Once the desired programming has been entered, the user may wish to save it for later usage. The user is also advised to save all programming on cassette prior to initial execution to avoid potential

programming self-destruction. If self-destruction upon execution occurs, the program may be reloaded and suitable corrections made.

Insert a cassette and start the recorder in record mode. After making sure that the leader on the cassette has passed by the record head, enter a "2" while in the Operations Monitor. The TV will display the message "Cassette being written" until the cassette recording operation is finished about 1/2 minute later, then return to the Operations Monitor. Turn off the recorder, and you have the system and the added programming on the cassette.

Cassette Read:

Cassettes may be read by pressing "1" while in the Operations Monitor, or they can be read when power is applied.

Panic Button:

Pressing the reset button will always return the user to the initial cassette load, or Operations Monitor.

Fine Points of the 6502 Operating System:

Memory Extent:

The 6502 Operating System is designed to occupy the lower 1.5K of the 6502 CPU system. The default read and write high address is preset to 2K. However, the cassettes may be any length up to 64K, but at the read/write speed of 100 bytes per second, the cassette should be no longer than required.

If you have greater than 2K of memory on your system, modify the data at 001 237 (byte) and 001 243 (page) to reflect the memory extent desired on the cassette. Example: You have 10K of 6502 system, and you wish to write 4K worth of programming. Since the octal equivalent of 4K is 017 377, enter 377 at 001 237 and 017 at 001 243. The default address is now set to 017 377. The cassette read programming will be automatically modified by the cassette. Cassettes of varying lengths may be interchangeably read with no operator intervention eg. 2K, 32K, 13K, 20K, etc.

Data Rate:

RAM address 000 013 contains the timing loop constant which controls the resultant cassette baud rate. The normal constant is 056 (Octal), which results in 1100 baud. By making the constant larger, the timing loop is increased, and a baud rate of 300 baud is possible with a constant of 263, for example.

So what? Well, by using these lower data rates, a modem may be attached for inter-hobbyist telephone data transmissions at some standardized rate.

Address 000 013 will have to be preset prior to both Read and Write for proper operation.

Storage Dump:

The initial page of the TV dump which displays and interprets the registers, flags, and stack pointers can be the most useful part of the whole system when faced with a confusing software problem. Insert an unconditional branch to 002 060 in place of the byte following the point in question. This will display and interpret the registers and flags, generally giving a much better picture of what is happening in that "insolvable problem." An unconditional branch is "114," "060," "002."

Interrupts/$\overline{\text{IRQ}}$, $\overline{\text{NMI}}$, BRK

The 6502 has three reset or interrupt addresses at the high end of storage normally occupied by a ROM to give a power on and go capability. The EROM provided in the Digital Group kits vectors the interrupts through the EROM to the beginning of page 000 as shown in the software listings. The user may now vector forward these interrupts as desired, but interrupt level programming is best left to the experts.

Reset

The Reset function on the 650X will force programming to begin at address 377 374, the 6502 restart address. The Reset is used to control the Operations Monitor and the initial cassette read operation. The EROM has control of Reset finally branching it forward to address 005 000 where the Operations Monitor resides.

Operations Monitor:

Page 005 of the 6502 Operating System is dedicated to aiding the user to make his program selections. The title area uses bytes 005 124 through 005 377. Up to 10 (0 - 9) different program start locations may be specified by putting the high and low addresses at the proper place between 005 100 and 005 123.

The user can title his program by inserting the ASCII characters desired in the format required. Here is the secret: A special subroutine called TV Editor controls the messages displayed on the TV screen. This subroutine is entered from the Operations Monitor to put the message on the TV. Address 005 313 - 005 377 can be used to enter a set of titles in a special machine code. "377" = Erase the screen, "376" - "200" are ASCII characters, "177" - "001" are the octal number of spaces, and "000" means the end of the message.

Example: You wish to add "7 Go" to the Operations Monitor message.

Address	Data	Explanation
005 313	267	"7"
005 314	001	1 space
005 315	307	"G"
005 316	357	"o"
005 317	000	End of message.

The program routing portion of the Operations Monitor is located between 005 100 and 005 123 as shown by the listings. The byte portion of the branch address is placed on the even address boundary, and the page portion of the odd address.

Example: You have designed the above program "Go" to execute from address 006 300. Since you also wish to branch to "Go" from a "7" entry when in the Operations Monitor, place a "300" at address 005 116 and an "006" at address 005 117.

Typing a "7" when in the Operations Monitor will now result in execution of "Go".

Subroutines You may wish to call for your own programming:

Subroutine	Address	Operation and Comments
TV	377 322	Prints a character on the TV through the Digital Group CRT readout attached to Port Ø. Load Accumulator with character prior to calling. Accumulator returned cleared to "000".
SPACE	377 320	Prints a space (blank position) on the TV. Accumulator need not be preset. Accumulator will return cleared.
Home Erase	377 261	Prints 512 spaces on the TV, with the cursor set so that the next character entry will appear at the upper left of the screen. Accumulator is cleared at end.
TV Editor	002 000	Previously described during Operations Monitor Operation. Preset 000 026 (low) and 000 027 (high) to the address of the initial byte of the message prior to calling. Accumulator and Index are cleared or changed when subroutine ends.
Keyboard	001 000	This subroutine loops until an MSB keypressed strobe bit goes high. The program does another loop until the MSB returns to low level. The Accumulator will have the input character.

Some suggested practice programs for those new to a 6502 microprocessor:

1. Clear the screen and write an "A".

Address	Data	Explanation
006 300	040	Call the subroutine "Home Erase"
006 301	261	
006 302	377	
006 303	251	Load Accumulator with the ASCII code for "A"
006 304	301	
006 305	040	Print the "A" on the screen
006 306	322	
006 307	377	
006 310	114	Loop around while rejoicing.
006 311	310	
006 312	006	
005 116	300	Modify the Operations Monitor to execute the
005 117	006	above program at 006 300.

   Pushing "Reset" and then typing a "7" should run the program. Push "Reset" to return to the Operations Monitor after execution.

2. Modify the above program to print an "a".

3. Print your name.

4. Print your name in the middle of the screen using "TV Editor".

5. Print only the 128 possible characters on the screen and stop, using less than 20 bytes. (Hint - Load Accum, Save, Print, Restore and Modify, Loop not end.)

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Score:   Over 100 bytes = HA!
         Over  30 bytes = Fair
            20-25 bytes = Good
         Under 20 bytes = Giant
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PROGRAM: 6502 EROM

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
Sys	377 000	170		Disable Interrupt
Initialize	377 001	370		Clear Decimal Mode
	377 002	242		Load X Index with 377
	377 003	377		
	377 004	232		Load Stack Pointer with X Index
Cassette	377 005	245		Load Accum with "ZØ"
Init?	377 006	000		(Constant area)
	377 007	311		Compare Accum with "123"
	377 010	123		
	377 011	320		Branch not equal (1)
	377 012	007		
	377 013	305		Compare Accum with "Z1"
	377 014	001		(Does next position also have a 123?)
	377 015	320		Branch not equal (1)
	377 016	003		
	377 017	114		Branch Uncondx
	377 020	000		(Operations Monitor)
	377 021	005		
Display	377 022	040		Call (Home Erase)
Message	377 023	261		
	377 024	377		
	377 025	240		Load Y index with 333
	377 026	333		(Starting byte of message)
	377 027	251		Load Accum with 000
	377 030	000		(Offset to message byte)
	377 031	205		Load "Reg Z26" with Accum
	377 032	026		
	377 033	251		Load Accum with 377
	377 034	377		(Page address of message)
	377 035	205		Load "Reg Z27" with Accum
	377 036	027		
	377 037	261		Load Accum with Memory Indexed Indirect
	377 040	026		(Z26 + Y index = L; Z27 = H address)
	377 041	040		Call (TV)
	377 042	322		
	377 043	377		
	377 044	310		Increment Y index
	377 045	300		Compare Y index with 370
	377 046	370		(End of message area?)
	377 047	320		Branch not equal
	377 050	366		(Read & Output another character)
Cassette Init-	377 051	251		Load Accum with
ialize con-	377 052	056		(Read Speed Constant)
stants	377 053	205		Load "Z13"
	377 054	013		
	377 055	251		Load Accum with 000
	377 056	000		(Cassette Start Low & High Addr)
	377 057	205		Load "Z14"

PROGRAM: 6502 EROM

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	377 060	014		
	377 061	205		Load "Z15"
	377 062	015		
	377 063	251		Load Accum with 377
	377 064	377		(Cassette Stop Low Addr)
	377 065	205		Load "Z16"
	377 066	016		
	377 067	251		Load Accum with 007
	377 070	007		(Cassette Stop High Addr)
	377 071	205		Load "Z17"
	377 072	017		
Cassette	377 073	240		Clear Y index
Read	377 074	000		
Byte Read	377 075	251		Load Accum with 010
	377 076	010		(Bit Counter)
	377 077	205		Load "Z26" with Accum
	377 100	026		
Clear Start	377 101	255		In 1
Bit	377 102	001		
	377 103	376		
	377 104	051		And Accum with 001
	377 105	001		
	377 106	320		Branch not zero
	377 107	371		(Looking for stop bit)
	377 110	242		Load X index with 003
	377 111	003		(Delay to middle of 1st bit)
	377 112	040		Call (Delay Loop)
	377 113	245		
	377 114	377		
Bits	377 115	251		Load Accum with 000
	377 116	000		
	377 117	205		Load "Z27" with Accum
	377 120	027		(Clear for temp byte storage)
Bit Read	377 121	242		Load X index with 002
	377 122	002		
	377 123	255		In 1
	377 124	001		
	377 125	376		
	377 126	051		AND Accum with 001
	377 127	001		
	377 130	005		OR "Z27" with Accum
	377 131	027		
	377 132	205		Load "Z27" with Accum
	377 133	027		
	377 134	040		Call (Delay Loop)
	377 135	245		
	377 136	377		
	377 137	306		Decrement "Z26"

PROGRAM: 6502 EROM

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	377 140	026		
	377 141	360		Branch if zero
	377 142	005		(Byte end--load memory)
	377 143	006		Shift "Z27" left
	377 144	027		
	377 145	114		Branch Uncondx
	377 146	121		(Bit Read)
	377 147	377		
Load Byte	377 150	245		Load Accum with "Z27"
	377 151	027		
	377 152	221		Load Mem with Accum Indexed Indirect
	377 153	014		(Z14 + Y index = L; Z15 = H address)
	377 154	261		Load Accum with Mem indexed Indirect
	377 155	014		(Z14 + Y index = L; Z15 = H address)
	377 156	305		Compare Accum with "Z27"
	377 157	027		
	377 160	360		Branch if equal (3)
	377 161	005		
Memory Error	377 162	251		Load Accum with "."
	377 163	256		
	377 164	114		Branch Uncondx (5)
	377 165	211		(Write Error Character)
	377 166	377		
(-, TV dis-	377 167	245		Load Accum with Z15
play	377 170	015		
	377 171	051		AND Accum with 017
	377 172	017		
	377 173	311		Compare Accum with 012
	377 174	012		(Hex alpha or #?)
	377 175	060		Branch if less (4)
	377 176	010		(#)
Alpha	377 177	070		Set Carry
	377 200	351		Subtract 011 with Borrow
	377 201	011		
	377 202	011		OR Accum with 300
	377 203	300		(Convert to ASCII alpha Char)
	377 204	114		Jump Uncondx (5)
	377 205	211		(Write Char)
	377 206	377		
(4) #	377 207	011		OR Accum with 260
	377 210	260		(Convert to ASCII number)
(5) TV record	377 211	040		Call (TV)
	377 212	322		
	377 213	377		
	377 214	245		Load Accum with "Z17"
	377 215	017		
	377 216	305		Compare Accum with "Z15"
	377 217	015		

PROGRAM: 6502 EROM

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	377 220	320		Jump not equal (6)
	377 221	011		
	377 222	245		Load Accum with "Z16"
	377 223	016		
	377 224	305		Compare Accum with "Z14"
	377 225	014		
	377 226	320		Jump not equal (6)
	377 227	003		
	377 230	114		Jump Uncondx
	377 231	000		(Operations monitor)
	377 232	005		--Cassette Reading finished--
(6) Next	377 233	346		Increment "Z14"
byte	377 234	014		
	377 235	320		Branch not zero (7)
	377 236	002		
(7)	377 237	346		Increment "Z15"
	377 240	015		
	377 241	114		Branch Uncondx
	377 242	075		(Byte Read)
	377 243	377		
	377 244	000		(Unused)
(8) Delay	377 245	245		Load Accum with Z13
Loop	377 246	013		
	377 247	205		Load Z30 with Accum
	377 250	030		
(7)	377 251	306		Decrement Z30
	377 252	030		
	377 253	320		Jump not zero (7)
	377 254	374		
	377 255	312		Decrement X
	377 256	320		Jump not zero (8)
	377 257	365		
	377 260	140		Return
Home Erase	377 261	251		Load Accum with 377
	377 262	377		("Home" command)
	377 263	040		Call (TV)
	377 264	322		
	377 265	377		
	377 266	251		Load Accum with 002
	377 267	002		(2 times through)
	377 270	205		Load "Reg Z24" with Accum
	377 271	024		
	377 272	251		Load Accum with 000
	377 273	000		(256 blanks)
	377 274	205		Load "Reg Z25" with Accum
	377 275	025		
	377 276	040		Call (Spacer)
	377 277	307		

PROGRAM: 6502 EROM

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	377 300	377		
	377 301	306		Decrement "Z24" counter
	377 302	024		
	377 303	320		Branch not zero
	377 304	371		
	377 305	140		Return
	377 306	000		(Unused)
Spacer	377 307	040		Call (a Space)
	377 310	320		
	377 311	377		
	377 312	306		Decrement "Z25" contents
	377 313	025		
	377 314	320		Branch not zero
	377 315	371		
	377 316	140		Return
	377 317	000		(Unused)
A Space	377 320	251		Load Accum with "Space"
	377 321	240		
TV	377 322	215		Out Ø
	377 323	000		
	377 324	376		
	377 325	251		Clear Accum
	377 326	000		
	377 327	215		Out Ø
	377 330	000		
	377 331	376		
	377 332	140		Return
	377 333	322		R
	377 334	345		e
	377 335	341		a
	377 336	344		d
	377 337	240		
	377 340	266		6
	377 341	265		5
	377 342	260		0
	377 343	262		2
	377 344	240		
	377 345	311		I
	377 346	316		N
	377 347	311		I
	377 350	324		T
	377 351	311		I
	377 352	301		A
	377 353	314		L
	377 354	311		I
	377 355	332		Z
	377 356	305		E
	377 357	240		

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PROGRAM: 6502 EROM

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	377 360	303		C
	377 361	341		a
	377 362	363		s
	377 363	363		s
	377 364	345		e
	377 365	364		t
	377 366	364		t
	377 367	345		e
	377 370	000		(Unused)
	377 371	000		(Unused)
	377 372	005		(NMI) - low address
	377 373	000		(NMI) - high address
	377 374	000		(RESET) - low address
	377 375	377		(RESET) - high address
	377 376	002		(IRQ + BRK vector) - low
	377 377	000		(IRQ + BRK vector) - high

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	000 000	123		Cassette Initialized Constants
	000 001	123		
	000 002	114		
	000 003	*L		User Defined Address for IRQ servicing
	000 004	*H		
	000 005	114		
	000 006	*L		User Defined Address for NMI servicing
	000 007	*H		
	000 010			
	000 011			
	000 012			
	000 013	*056		Read Speed Constant
	000 014	*000		Cassette Start Address
	000 015	*000		
	000 016	*377		Cassette Stop Address
	000 017	*007		
	000 020			
	000 021			Reserved for Cassette Title Writer
	000 022			
	000 023			
	000 024		"Z24"	
	000 025		"Z25"	
	000 026		"Z26"	
	000 027		"Z27"	
	000 030		"Z30"	
	000 031		"Z31"	Reserved for Pseudo Registers
	000 032		"Z32"	of Op System
	000 033		"Z33"	
	000 034		"Z34"	
	000 035		"Z35"	
	000 036		"Z36"	
	000 037		"Z37"	
	000 040			
	000 041			
	000 042			
	000 043			
	000 044			
	000 045			
	000 046			
	000 047			Reserved for Pseudo Registers
	000 050			at User's option
	000 051			
	000 052			
	000 053			
	000 054			
	000 055			
	000 056			
	000 057			

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	000 060			
	000 061			
	000 062			
	000 063			
	000 064			
	000 065			Area open to User's
	000 066			"Zero Page" programming
	000 067			
	000 070			
	•			
	to			
	000 377			
Keyboard	001 000	255	In Ø	Get the keyboard input from
	001 001	000		Input Port Ø
	001 002	376		
	001 003	020		Loop until a key pressed
	001 004	373		strobe arrives
	001 005	205		Save Data in "Reg Z30"
	001 006	030		
	001 007	255	In Ø	Get the keyboard input again
	001 010	000		
	001 011	376		
	001 012	060		Loop until the key pressed
	001 013	373		strobe stops
	001 014	245		Restore the data from "Z30"
	001 015	030		back in the accumulator
	001 016	140		Return
100 µs (2)	001 017	251		Load Accum with 015
timer	001 020	015		
	001 021	205		Transfer Accum to "Z24"
	001 022	024		
(1)	001 023	306		Decrement "Z24"
	001 024	024		
	001 025	320		Loop not zero (1)
	001 026	374		
	001 027	306		Decrement "Z25"
	001 030	025		
	001 031	320		Loop not zero (2)
	001 032	364		
	001 033	140		Return
10 ms (3)	001 034	251		Load Accum with 144
timer	001 035	144		
	001 036	205		Transfer Accum to "Z25"
	001 037	025		

General Comments: Call the appropriate delay timer after 1st presetting the timeout desired. Z25 used as "100's of µs timer."

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	001 040	040		Call (μstimer)
	001 041	017		
	001 042	001		
	001 043	306		Decrement "Z26"
	001 044	026		
	001 045	320		Loop not zero (3)
	001 046	365		
	001 047	140		Return
Seconds (4)	001 050	251		Load Accum with 144
timer	001 051	144		"1000 ms"
	001 052	205		Transfer Accum to "Z26"
	001 053	026		
	001 054	040		Call (ms timer)
	001 055	034		
	001 056	001		
	001 056	306		Decrement "Z27"
	001 060	027		
	001 061	320		Loop not zero (4)
	001 062	365		
	001 063	140		Return
Minutes (5)	001 064	251		Load Accum with 074
timer	001 065	074		"60 seconds"
	001 066	205		Transfer Accum to "Z27"
	001 067	027		
	001 070	040		Call (seconds)
	001 071	050		
	001 072	001		
	001 073	306		Decrement "Z30"
	001 074	030		
	001 075	320		Loop not zero (5)
	001 076	365		
	001 077	140		Return
Write	001 100	170		Disable Interrupts
Cassette	001 101	242		Load the X index with 377
	001 102	377		
	001 103	232		Transfer the X index to the stack pointer
	001 104	251		Load Accum with 001
	001 105	001		
Tone Leader	001 106	215		Out 1 - Put out the "Mark"
	001 107	001		tone leader
	001 110	376		
	001 111	251		Load Accum with 005
	001 112	005		(Set up a 5 second delay)
	001 113	205		Transfer Accum to "Z27"
	001 114	027		
	001 115	040		Call (Seconds Timer)
	001 116	050		
	001 117	001		

General Comments:
Z26 used as "10's of ms timer"
Z27 used as "Seconds Timer"
Z30 used as "Minutes timer"

PROGRAM: 6502 Operating System

LABEL	OCTAL	OCTAL	MNEMONIC	COMMENTS
Start	001 120	240		Clear Y index
	001 121	000		
Byte (5)	001 122	251		Load Accum with 011
Write	001 123	011		
	001 124	205		Transfer Accum to "Z24"
	001 125	024		
	001 126	012		Clear Carry by shifting Accum left
	001 127	261		Load Accum indexed indirect
	001 130	014		(Z14 + Y index=L; Z15 = H Address)
(2)	001 131	052		Rotate Accum left
	001 132	215		Out 1
	001 133	001		(Send Start bit, then 8 data bits)
	001 134	376		
	001 135	205		Transfer Accum to "Z25"
	001 136	025		(Temp. save Accum)
	001 137	242		Load X index with 002
	001 140	002		
	001 141	040		Call (EROM delay loop)
	001 142	245		
	001 143	377		
Read timing	001 144	242		Load X index with 004
equalizer	001 145	004		
(1)	001 146	312		Decrement X
	001 147	320		Branch not zero (1)
	001 150	375		
	001 151	245		Transfer "Z25" back to Accum
	001 152	025		(Restore Accum)
	001 153	306		Decrement "Z24"
	001 154	024		
	001 155	320		Branch not zero (2)
	001 156	352		
Stop Bit	001 157	251		Load Accum with 001
	001 160	001		
	001 161	215		Out 1
	001 162	001		(Stop Bit)
	001 163	376		
	001 164	242		Load X index with 004
	001 165	004		
	001 166	040		Call (EROM delay loop)
	001 167	245		
	001 170	377		
End of	001 171	245		Transfer "Z14" to Accum
Write?	001 172	014		(Preset L Address)
	001 173	305		Compare Accum with "Z16"
	001 174	016		(Stop L address)
	001 175	320		Jump not equal (3)
	001 176	006		
	001 177	245		Transfer "Z15" to Accum

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	001 200	015		(Preset H Address)
	001 201	305		Compare Accum with "Z17"
	001 202	017		(Stop H Address)
	001 203	360		Branch if equal (4)
	001 204	011		(End of Cassette)
Another (3)	001 205	346		Increment "Z14"
Byte	001 206	014		
	001 207	320		Branch not zero (5)
	001 210	311		(Byte Write)
	001 211	346		Increment "Z15"
	001 212	015		
	001 213	114		Branch Uncondx
	001 214	122		(Byte Write)
	001 215	001		
End Tone	001 216	251		Load Accum with 005
	001 217	005		(Set up a 5 sec delay)
	001 220	205		Transfer Accum to "Z27"
	001 221	027		
	001 222	040		Call (Seconds timer)
	001 223	050		
	001 224	001		
	001 225	114		Branch Uncondx
	001 226	000		(Operations Monitor)
	001 227	005		
2K Write	001 230	251		Load Accum with 000
	001 231	000		
	001 232	205		Transfer Accum to "Z14"
	001 233	014		
	001 234	205		Transfer Accum to "Z15"
	001 235	015		
	001 236	251		Load Accum with 377
	001 237	377		
	001 240	205		Transfer Accum to "Z16"
	001 241	016		
	001 242	251		Load Accum with 007
	001 243	007		
	001 244	205		Transfer Accum to "Z17"
	001 245	017		
Write mes-	001 246	251		Load Accum with 264
sage	001 247	264		
	001 250	205		Transfer Accum to "Z26"
	001 251	026		
	001 252	251		Load Accum with 001
	001 253	001		
	001 254	205		Transfer Accum to "Z27"
	001 255	027		
	001 256	040		Call (TV Editor)
	001 257	000		

General Comments: Enter the Highest address to be written at 1243 if using > 2K.

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	001 260	002		
	001 261	114		Branch Uncondx
	001 262	100		(Write Cassette)
	001 263	001		
Edit Message	001 264	377		(Home Erase)
	001 265	144		(Spaces)
	001 266	303		C
	001 267	341		a
	001 270	363		s
	001 271	363		s
	001 272	345		e
	001 273	364		t
	001 274	364		t
	001 275	345		e
	001 276	240		
	001 277	342		b
	001 300	345		e
	001 301	351		i
	001 302	356		n
	001 303	347		g
	001 304	240		
	001 305	367		w
	001 306	362		r
	001 307	351		i
	001 310	364		t
	001 311	364		t
	001 312	345		e
	001 313	356		n
	001 314	000		(Return)
	001 315			
	001 316			
	001 317			
	001 320			
	001 321			
	001 322			
	001 323			
	001 324			
	001 325			
	001 326			(Unused)
	001 327			
	001 330			
	001 331			
	001 332			
	001 333			
	001 334			
	001 335			
	001 336			
	001 337			

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	001 340			
	001 341			
	001 342			
	001 343			
	001 344			
	001 345			
	001 346			
	001 347			
	001 350			
	001 351			
	001 352			
	001 353			
	001 354			
	001 355			
	001 356			
	001 357			Reserved for Stack
	001 360			
	001 361			
	001 362			
	001 363			
	001 364			
	001 365			
	001 366			
	001 367			
	001 370			
	001 371			
	001 372			
	001 373			
	001 374			
	001 375			
	001 376			
	001 377			
TV Editor	002 000	240		Load Y index with 000
	002 001	000		
TV Ed. (1)	002 002	261		Load Accumulator indexed indirect
Cont.	002 003	026		(Z26 + Y=L; Z27=H Address)
	002 004	311		Compare Accum with 377
	002 005	377		(Home Erase Command?)
	002 006	320		Branch not equal (2)
	002 007	006		
	002 010	040		Call (Home Erase)
	002 011	261		
	002 012	377		
	002 013	114		Branch Uncondx (3)
	002 014	041		
	002 015	002		
	002 016	051		AND Accum with 377
	002 017	377		(Character to be printed?)

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	002 020	020		Branch if plus (4)
	002 021	006		
	002 022	040		Call (EROM TV)
	002 023	322		
	002 024	377		
	002 025	114		Branch Uncondx (3)
	002 026	041		
	002 027	002		
(4)	002 030	311		Compare A with 000
	002 031	000		(End of Edit?)
	002 032	360		Branch if equal (5)
	002 033	011		
	002 034	205		Transfer Accum to "Z25"
	002 035	025		
	002 036	040		Call (Spacer)
	002 037	307		
	002 040	377		
	002 041	310		Increment Y Index
	002 042	114		Branch Uncondx (1)
	002 043	002		(Next Edit Character)
	002 044	002		
	002 045	140		Return
	002 046			(Unused)
	002 047			(Unused)
	002 050	*		Accum
	002 051	*		X Index
	002 052	*		Y Index
	002 053	*	(Reserved	Status
	002 054	*	for TV dump)	Stack Pointer
	002 055	*		L Return Address
	002 056	*		H Return Address
	002 057	*		Hex/Octal characters to be used
TV Dump	002 060	110		Put Accum on Stack
	002 061	010		Put Status on Stack
	002 062	150		Load Accum from Stack (Status)
	002 063	215		Load Mem with Accum
	002 064	053		(Store Status)
	002 065	002		
	002 066	150		Load Accum from Stack (Accum)
	002 067	215		Load Mem with Accum
	002 070	050		(Store Accum)
	002 071	002		
	002 072	216		Load Mem with X Index
	002 073	051		
	002 074	002		
	002 075	214		Load Mem with Y Index
	002 076	052		
	002 077	002		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCATL CODE	MNEMONIC	COMMENTS
	002 100	272		Transfer Stack Pointer to X Index
	002 101	216		Load Mem with X Index
	002 102	054		(Stack Pointer)
	002 103	002		
	002 104	150		Load Accum from Stack (L Return)
	002 105	215		Load Mem with Accum
	002 106	055		
	002 107	002		
	002 110	150		Load Accum from Stack (H Return)
	002 111	215		Load Mem with Accum
	002 112	056		
	002 113	002		
Restore	002 114	110		Put Accum on Stack
Stack	002 115	255		Load Accum with Mem
	002 116	055		
	002 117	002		
	002 120	110		Put Accum on Stack
	002 121	251		Load Accum with 000
	002 122	000		
	002 123	205		Transfer Accum to "Z26"
	002 124	026		
	002 125	251		Load Accum with 003
	002 126	003		
	002 127	205		Transfer Accum to "Z27"
	002 130	027		
	002 131	040		Call (TV Editor)
	002 132	000		(Prints Title, A,X & Y)
	002 133	002		
	002 134	255		Load Accum with Mem
	002 135	050		(Accum)
	002 136	002		
	002 137	040		Call (Dump Out)
	002 140	266		
	002 141	002		
	002 142	251		Load Accum with 010
	002 143	010		
	002 144	205		Transfer Accum to "Z25"
	002 145	025		
	002 146	040		Call (Spacer)
	002 147	307		
	002 150	377		
	002 151	255		Load Accum with Mem
	002 152	051		(X Index)
	002 153	002		
	002 154	040		Call (Dump Out)
	002 155	266		
	002 156	002		
	002 157	251		Load Accum with 011

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	002 160	011		
	002 161	205		Transfer Accum to "Z25"
	002 162	025		
	002 163	040		Call (Spacer)
	002 164	307		
	002 165	377		
	002 166	255		Load Accum with Mem
	002 167	052		(Y Index)
	002 170	002		
	002 171	040		Call (Dump Out)
	002 172	266		
	002 173	002		
	002 174	310		Increment Y Index
	002 175	352		NOP
	002 176	040		Call (TV Editor Continue)
	002 177	002		(Print four flag titles)
	002 200	002		
	002 201	040		Call (4 Flags)
	002 202	230		(Print a 1 or Ø for Neg, OV,
	002 203	003		(), & Brk)
	002 204	310		Increment Y Index
	002 205	352		NOP
	002 206	040		Call (TV Editor Continue)
	002 207	002		(Print four more flag titles)
	002 210	002		
	002 211	040		Call (4 Flags)
	002 212	230		(Print a 1 or Ø for Dec, Int,
	002 213	003		zero, & Carry)
	002 214	310		Increment Y Index
	002 215	352		NOP
	002 216	040		Call (TV Editor Continue)
	002 217	002		(Print Stack & Return Titles)
	002 220	002		
	002 221	251		Load Accum with 001
	002 222	001		(High Stack Address)
	002 223	040		Call (Dump)
	002 224	266		
	002 225	002		
	002 226	255		Load Accum with Mem
	002 227	054		(Stack Address)
	002 230	002		
	002 231	040		Call (Dump)
	002 232	266		
	002 233	002		
	002 234	251		Load Accum with 014
	002 235	014		
	002 236	205		Transfer Accum to "Z25"
	002 237	025		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	002 240	040		Call (Spacer)
	002 241	307		
	002 242	377		
	002 243	255		Load Accum with Mem
	002 244	056		(H Return Address)
	002 245	002		
	002 246	040		Call (Dump)
	002 247	266		
	002 250	002		
	002 251	255		Load Accum with Mem
	002 252	055		(L Return Address)
	002 253	002		
	002 254	040		all (Dump)
	002 255	266		
	002 256	002		
Storage	002 257	242		Load X Index with 377
	002 260	377		
	002 261	232		Load Stack Pointer with X Index
	002 262	114		Branch Uncondx
	002 263	264		
	002 264	003		
	002 265			(Unused)
Dump	002 266	256		Load X Index with Mem
	002 267	057		(Octal/Hex Select Code)
	002 270	002		
	002 271	340		Compare X index with "H"
	002 272	310		
	002 273	360		Branch if equal (5)
	002 274	037		(Hex)
Octal	002 275	252		Load X index with Accum (Save A)
	002 276	052		Rotate Accum left
	002 277	052		Rotate Accum left
	002 300	052		Rotate Accum left
	002 301	051		AND Accum with 003
	002 302	003		(Strip off 6 lower bits)
	002 303	011		OR Accum with 260
	002 304	260		(Convert to ASCII number)
	002 305	040		Call (TV Out)
	002 306	322		
	002 307	377		
	002 310	212		Load Accum with X index (Restore A)
	002 311	112		Shift Right
	002 312	112		Shift Right
	002 313	112		Shift Right
	002 314	051		AND Accum with 007
	002 315	007		(Strip off upper 2 & lower 3 bits)
	002 316	011		OR A with 260
	002 317	260		(Convert to ASCII number)

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	002 320	040		Call (TV Output)
	002 321	322		
	002 322	377		
	002 323	212		Load Accum with X index (Restore A)
	002 324	051		AND Accum with 007
	002 325	007		(Strip off upper 5 bits)
	002 326	011		OR A with 260
	002 327	260		(Convert to ASCII number)
	002 330	040		Call (TV Output)
	002 331	322		
	002 332	377		
	002 333	140		Return
Hex (5)	002 334	252		Load X Index with Accum (Save A)
	002 335	112		Shift Right
	002 336	112		Shift Right
	002 337	112		Shift Right
	002 340	112		Shift Right
	002 341	040		Call (Hex Out)
	002 342	354		
	002 343	002		
	002 344	212		Load Accum with X (Restore A)
	002 345	040		Call (Hex Out)
	002 346	354		
	002 347	002		
	002 350	040		Call (Space)
	002 351	320		
	002 352	377		
	002 353	140		Return
Hex Out	002 354	051		AND Accum with 017
	002 355	017		(Strip Off upper 4 bits)
	002 356	311		Compare Accum with 012
	002 357	012		
	002 360	060		Branch if less (6)
	002 361	010		(Not Alpha Hex)
	002 362	351		Subtract 011 from Accum
	002 363	011		
	002 364	011		OR Accum with 300
	002 365	300		(Convert to Alpha ASCII)
	002 366	040		Call (TV Out)
	002 367	322		
	002 370	377		
	002 371	140		Return
	002 372	011		OR Accum with 260
	002 373	260		(Convert to numeric ASCII)
	002 374	040		Call (TV Out)
	002 375	322		
	002 376	377		
	002 377	140		Return

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
TV Edit	003 000	377		(Home Erase)
	003 001	010		(Spaces)
	003 002	324	T	
	003 003	326	V	
	003 004	240		
	003 005	323	S	
	003 006	324	T	
	003 007	317	O	
	003 010	322	R	
	003 011	301	A	
	003 012	307	G	
	003 013	305	E	
	003 014	240		
	003 015	304	D	
	003 016	325	U	
	003 017	315	M	
	003 020	320	P	
	003 021	051		(Spaces)
	003 022	301	A	
	003 023	343	c	
	003 024	343	c	
	003 025	365	u	
	003 026	355	m	
	003 027	365	u	
	003 030	354	l	
	003 031	341	a	
	003 032	364	t	
	003 033	357	o	
	003 034	362	r	
	003 035	002		(Spaces)
	003 036	330	X	
	003 037	240		
	003 040	311	I	
	003 041	356	n	
	003 042	344	d	
	003 043	345	e	
	003 044	370	x	
	003 045	005		(Spaces)
	003 046	331	Y	
	003 047	240		
	003 050	311	I	
	003 051	356	n	
	003 052	344	d	
	003 053	345	e	
	003 054	370	x	
	003 055	004		(Spaces)
	003 056	000		(Return)
	003 057	102		(Spaces)

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	003 060	306	F	
	003 061	354	l	
	003 062	341	a	
	003 063	347	g	
	003 064	363	s	
	003 065	272	:	
	003 066	032		(Spaces)
	003 067	316	N	
	003 070	345	e	
	003 071	347	g	
	003 072	341	a	
	003 073	364	t	
	003 074	351	i	
	003 075	366	v	
	003 076	345	e	
	003 077	240		
	003 100	317	O	
	003 101	366	v	
	003 102	345	e	
	003 103	362	r	
	003 104	346	f	
	003 105	354	l	
	003 106	357	o	
	003 107	367	w	
	003 110	240		
	003 111	250	(	
	003 112	365	u	
	003 113	356	n	
	003 114	365	u	
	003 115	363	s	
	003 116	345	e	
	003 117	344	d	
	003 120	251	)	
	003 121	240		
	003 122	302	B	
	003 123	362	r	
	003 124	345	e	
	003 125	341	a	
	003 126	353	k	
	003 127	004		(Spaces)
	003 130	000		(Return)
	003 131	034		(Spaces)
	003 132	304	D	
	003 133	345	e	
	003 134	343	c	
	003 135	351	l	
	003 136	355	m	
	003 137	341	a	

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	003 140	354	l	
	003 141	001		(Spaces)
	003 142	311	I	
	003 143	356	n	
	003 144	364	t	
	003 145	345	e	
	003 146	362	r	
	003 147	362	r	
	003 150	365	u	
	003 151	360	p	
	003 152	364	t	
	003 153	002		(Spaces)
	003 154	332	Z	
	003 155	345	e	
	003 156	362	r	
	003 157	357	o	
	003 160	003		(Spaces)
	003 161	303	C	
	003 162	341	a	
	003 163	362	r	
	003 164	362	r	
	003 165	371	y	
	003 166	005		(Spaces)
	003 167	000		(Return)
	003 170	074		(Spaces)
	003 171	323	S	
	003 172	364	t	
	003 173	341	a	
	003 174	343	c	
	003 175	353	k	
	003 176	240		
	003 177	320	P	
	003 200	357	o	
	003 201	351	i	
	003 202	356	n	
	003 203	364	t	
	003 204	345	e	
	003 205	362	r	
	003 206	004		(Spaces)
	003 207	322	R	
	003 210	345	e	
	003 211	364	t	
	003 212	365	u	
	003 213	362	r	
	003 214	356	n	
	003 215	240		
	003 216	301	A	
	003 217	344	d	

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	003 220	344	d	
	003 221	362	r	
	003 222	345	e	
	003 223	363	s	
	003 224	363	s	
	003 225	277	?	
	003 226	003		(Spaces)
	003 227	000		(Return)
4 flags	003 230	242		Load X Index with 004
	003 231	004		
	003 232	056		Rotate Mem Left
	003 233	053		(Status)
	003 234	002		
	003 235	260		Branch on Carry
	003 236	005		(1)
ø	003 237	251		Load Accum with ASCII "ø"
	003 240	260		
	003 241	114		Branch Uncondx
	003 242	246		
	003 243	003		
1	003 244	251		Load Accum with ASCII "1"
	003 245	261		
	003 246	040		Call (EROM TV)
	003 247	322		
	003 250	377		
	003 251	251		Load Accum with 007
	003 252	007		
	003 253	205		Transfer Accum to "Z25"
	003 254	025		
	003 255	040		Call (Spacer)
	003 256	307		
	003 257	377		
	003 260	312		Decrement X Index
	003 261	320		Branch not zero
	003 262	347		
	003 263	140		Return
Dump Address	003 264	240		Load Y index with 000
	003 265	000		(Starting Offset Address)
	003 266	251		Load Accum with 000
	003 267	000		
	003 270	205		Transfer Accum to "Z31"
	003 271	031		
	003 272	205		Transfer Accum to "Z32"
	003 273	032		
TV Keyboard	003 274	040		Call (Keyboard)
	003 275	000		
	003 276	001		
	003 277	051		AND Accum with 337

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	003 300	337		(Convert lower case ASCII to upper)
	003 301	311		Compare Accum with 200
	003 302	200		(Space bar)
	003 303	320		Branch not equal
	003 304	003		
	003 305	114		Branch Uncondx
	003 306	362		
	003 307	003		
	003 310	311		Compare Accum with "S"
	003 311	323		(set Storage Address)
	003 312	320		Branch not equal
	003 313	003		
	003 314	114		Branch Uncondx
	003 315	335		
	003 316	003		
	003 317	311		Compare Accum with "P"
	003 320	320		(Program)
	003 321	320		Branch not equal
	003 322	003		
	003 323	114		Branch Uncondx
	003 324	255		
	003 325	004		
	003 326	311		Compare Accum with "R"
	003 327	322		(Restart)
	003 330	320		Branch not equal
	003 331	342		(not valid entry)
	003 332	114		Branch Uncondx
	003 333	000		
	003 334	005		
Set Address	003 335	040		Call (Home Erase)
	003 336	261		
	003 337	377		
	003 340	251		Load Accum with 056
	003 341	056		"L"
	003 342	205		Transfer Accum to "Z26"
	003 343	026		
	003 344	251		Load Accum with 004
	003 345	004		"H"
	003 346	205		Transfer Accum to "Z27"
	003 347	027		
	003 350	040		Call (TV Editor)
	003 351	000		
	003 352	002		
	003 353	040		Call (ASCII)
	003 354	102		
	003 355	004		
	003 356	205		Transfer Accum to "Z32"
	003 357	032		(Set H Address)

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	003 360	240		Clear X Index
	003 361	000		(000 L Address)
Pages	003 362	040		Call (Home Erase)
	003 363	261		
	003 364	377		
H&L Print	003 365	245		Transfer "Z32" to Accum
	003 366	032		
	003 367	040		Call (Dump)
	003 370	266		(Print H Address)
	003 371	002		
	003 372	230		Transfer Y index to Accum
	003 373	040		Call (Dump)
	003 374	266		(Print L Address)
	003 375	002		
	003 376	040		Call (Space)
	003 377	320		
	004 000	377		Call (Space)
	004 001	040		
	004 002	320		
	004 003	377		
	004 004	251		Load Accum with 006
	004 005	006		(# of Characters in each line)
	004 006	205		Transfer Accum to Z33
	004 007	033		
	004 010	040		Call (Line Writer)
	004 011	034		
	004 012	004		
	004 013	300		Compare Y Index with 140
	004 014	140		(Check for end of 1st page)
	004 015	360		Branch if equal
	004 016	255		(TV Keyboard)
	004 017	300		Compare Y Index with 300
	004 020	300		(Check for end of 2nd page)
	004 021	360		Branch if equal
	004 022	251		(TV Keyboard)
	004 023	300		Compare Y Index with 002
	004 024	002		(Check for end of 3rd page)
	004 025	320		Branch not equal
	004 026	336		(H&L Address print)
	004 027	240		Clear Y Index
	004 030	000		
	004 031	114		Branch Uncondx
	004 032	274		(New Page)
	004 033	003		
Line Writer	004 034	040		Call (Space)
	004 035	320		
	004 036	377		
	004 037	261		Load Accum with Mem, Indexed Indirect

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	004 040	031		(Z31 + Y=L; Z32=H Address)
	004 041	040		Call (Dump)
	004 042	266		
	004 043	002		
	004 044	310		Increment Y Index
	004 045	320		Branch not zero
	004 046	002		
	004 047	346		Increment "Z32"
	004 050	032		(H Address)
	004 051	306		Decrement "Z33"
	004 052	033		(Another Address printed)
	004 053	320		Branch not zero
	004 054	357		
	004 055	140		Return
Page Edit	004 056	305	E	
	004 057	356	n	
	004 060	364	t	
	004 061	345	e	
	004 062	362	r	
	004 063	240		
	004 064	360	p	
	004 065	341	a	
	004 066	347	g	
	004 067	345	e	
	004 070	240		
	004 071	341	a	
	004 072	344	d	
	004 073	344	d	
	004 074	362	r	
	004 075	345	e	
	004 076	363	s	
	004 077	363	s	
	004 100	002		(Spaces)
	004 101	000		(Return)
ASCII-long	004 102	040		Call (Keyboard)
	004 103	000		
	004 104	001		
ASCII-short	004 105	256		Load X Index with Mem
	004 106	057		(Octal/Hex select code)
	004 107	002		
	004 110	340		Compare X Index with "H"
	004 111	310		
	004 112	360		Branch if equal
	004 113	055		(Ascii Hex)
ASCII-octal	004 114	252		Transfer Accum to X (Save A)
	004 115	040		Call (TV Ascii)
	004 116	175		
	004 117	006		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	004 120	212		Transfer X to Accum (Restore A)
	004 121	012		Shift Left
	004 122	012		Shift Left
	004 123	012		Shift Left
	004 124	012		Shift Left
	004 125	012		Shift Left
	004 126	012		Shift Left
	004 127	205		Transfer Accum to "Z34"
	004 130	034		
	004 131	040		Call (Keyboard)
	004 132	000		
	004 133	001		
	004 134	252		Transfer Accum to X (Save A)
	004 135	040		Call (TV Ascii)
	004 136	175		
	004 137	006		
	004 140	212		Transfer X to Accum (Restore A)
	004 141	012		Shift Left
	004 142	012		Shift Left
	004 143	012		Shift Left
	004 144	051		AND Accum with 070
	004 145	070		
	004 146	005		OR Accum with "Z34"
	004 147	034		
	004 150	205		Transfer Accum to "Z34"
	004 151	034		
	004 152	040		Call (Keyboard)
	004 153	000		
	004 154	001		
	004 155	252		Transfer Accum to X (Save A)
	004 156	040		Call (TV Ascii)
	004 157	175		
	004 160	006		
	004 161	212		Transfer X to Accum (Restore A)
	004 162	051		AND Accum with 007
	004 163	007		
	004 164	005		OR Accum with "Z34"
	004 165	034		
	004 166	114		Branch Uncondx
	004 167	223		(Video Delay)
	004 170	006		
	004 171	040		Call (Hexer-short)
	004 172	224		
	004 173	004		
	004 174	012		Shift Left
	004 175	012		Shift Left
	004 176	012		Shift Left
	004 177	012		Shift Left

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	004 200	205		Transfer Accum to "Z34"
	004 201	034		
	004 202	040		Call (Hexer)
	004 203	221		
	004 204	004		
	004 205	005		OR Accum with "Z34"
	004 206	034		
Video Delay	004 207	252		Transfer Accum to X (Save A)
	004 210	040		Call (Space)
	004 211	320		
	004 212	377		
	004 213	040		Call (Video Delay Short)
	004 214	224		
	004 215	006		
	004 216	140		Return
	004 217	000		
	004 220	000		
Hexer	004 221	040		Call (Keyboard)
	004 222	000		
	004 223	001		
Hexer-short	004 224	311		Compare Accum with 272
	004 225	272		(Check for > "9")
	004 226	020		Branch if not less
	004 227	010		(alpha)
Number	004 230	252		Transfer Accum to X
	004 231	040		Call (TV Ascii)
	004 232	175		
	004 233	006		
	004 234	212		Transfer X to Accum
	004 235	051		AND Accum with 017
	004 236	017		(Drop 4 MSB's)
	004 237	140		Return
Alpha	004 240	051		AND Accum with 337
	004 241	337		(Convert to Upper Case)
	004 242	252		Transfer Accum to X
	004 243	040		Call (TV Ascii)
	004 244	175		
	004 245	006		
	004 246	212		Transfer X to Accum
	004 247	030		Clear Carry bit
	004 250	151		ADD 011 to Accum
	004 251	011		
	004 252	051		AND 017 with Accum
	004 253	017		
	004 254	140		Return
Program	004 255	130		Enable Interrupts
	004 256	242		Load X Index with 377
	004 257	377		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	004 260	232		Load Stack Pointer with X Index
	004 261	251		Load Accum with 240
	004 262	240		
	004 263	205		Transfer Accum to "Z26"
	004 264	026		
	004 265	251		Load Accum with 006
	004 266	006		
	004 267	205		Transfer Accum to "Z27"
	004 270	027		
	004 271	040		Call (TV Editor)
	004 272	000		
	004 273	002		
	004 274	240		Load Y Index with 300
	004 275	300		
	004 276	251		Load Accum with 000
	004 277	000		
	004 300	205		Transfer Accum to "Z31"
	004 301	031		
	004 302	251		Load Accum with 006
	004 303	006		
	004 304	205		Transfer Accum to "Z32"
	004 305	032		
H&L Display	004 306	245		Transfer Z32 to Accum
	004 307	032		
	004 310	040		Call (Dump)
	004 311	266		
	004 312	002		
	004 313	230		Transfer Y Index to Accum
	004 314	040		Call (Dump)
	004 315	266		
	004 316	002		
Key	004 317	040		Call (Keyboard)
	004 320	000		
	004 321	001		
	004 322	051		AND Accum with 337
	004 323	337		(Convert lower case to upper case)
	004 324	252		Transfer Accum to X (Save A)
	004 325	040		Call (Home Erase)
	004 326	261		
	004 327	377		
	004 330	212		Transfer X to Accum (restore A)
	004 331	311		Compare Accum with "H"
	004 332	310		(Set High Address?)
	004 333	320		Branch not equal
	004 334	013		
	004 335	040		Call (TV)
	004 336	322		
	004 337	377		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	004 340	040		Call (ASCII)
	004 341	102		
	004 342	004		
	004 343	205		Transfer Accum to Z32
	004 344	032		
	004 345	114		Branch Uncondx
	004 346	215		
	004 347	006		
	004 350	311		Compare Accum with "L"
	004 351	314		(Set Low Address?)
	004 352	320		Branch Not Equal
	004 353	012		
	004 354	040		Call (TV)
	004 355	322		
	004 356	377		
	004 357	040		Call (ASCII)
	004 360	102		
	004 361	004		
	004 362	250		Transfer Accum to Y Index
	004 363	114		Branch Uncondx
	004 364	215		
	004 365	006		
	004 366	311		Compare Accum with "S"
	004 367	323		(Go to Storage Dump?)
	004 370	320		Branch not equal
	004 371	003		
	004 372	114		Branch Uncondx
	004 373	060		
	004 374	002		
	004 375	114		Branch Uncondx
	004 376	000		
	004 377	006		
Operations	005 000	130		Enable Interrupts
Monitor	005 001	330		Clear Decimal Mode
	005 002	242		Load X Index with 377
	005 003	377		
	005 004	232		Transfer X Index to Stack Pointer
	005 005	251		Load Accum with 124
	005 006	124		(Low Address of Edit)
	005 007	205		Transfer Accum to "Z26"
	005 010	026		
	005 011	251		Load Accum with 005
	005 012	005		
	005 013	205		Transfer Accum to "Z27"
	005 014	027		
	005 015	040		Call (TV Editor)
	005 016	000		
	005 017	002		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	005 020	040		Call (Keyboard)
	005 021	000		
	005 022	001		
	005 023	311		Compare accum with 272
	005 024	272		
	005 025	020		Branch if not less
	005 026	371		
	005 027	311		Compare Accum with 260
	005 030	260		
	005 031	060		Branch if less
	005 032	365		
	005 033	252		Transfer Accum to X Index (Save A)
	005 034	040		Call (Home Erase)
	005 035	261		
	005 036	377		
	005 037	212		Transfer X Index to Accum (Restore A)
	005 040	012		Shift Left
	005 041	051		AND Accum with 136
	005 042	136		
	005 043	215		Load Memory with Accum
	005 044	050		(5050)
	005 045	005		
	005 046	252		Transfer Accum to X Index
	005 047	255		Load Accum with Memory
	005 050	*		
	005 051	005		
	005 052	215		Load Memory with Accum
	005 053	070		(5070)
	005 054	005		
	005 055	350		Increment X
	005 056	216		Load Memory with X
	005 057	062		(5062)
	005 060	005		
	005 061	255		Load Accum with Memory
	005 062	*		
	005 063	005		
	005 064	215		Load Memory with Accum
	005 065	071		(5071)
	005 066	005		
	005 067	114		Branch Uncondx
	005 070	*		
	005 071	*		
	005 072			
	005 073			
	005 074			
	005 075			(Unused)
	005 076			
	005 077			

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	005 100	*		Ø (User's Option)
	005 101	*		
	005 102	051		1 Read Cassette (2K default)
	005 103	377		
	005 104	230		2 Write Cassette (2K default)
	005 105	001		
	005 106	334		3 Octal Dump
	005 107	005		
	005 110	342		4 Octal Program
	005 111	005		
	005 112	350		5 Hex Dump
	005 113	005		
	005 114	356		6 Hex Program
	005 115	005		
	005 116	*		7
	005 117	*		
	005 120	*		8 (User's Option)
	005 121	*		
	005 122	*		9
	005 123	*		
	005 124	377		(Home Erase)
	005 125	011		(Spaces)
	005 126	266	6	
	005 127	265	5	
	005 130	260	0	
	005 131	262	2	
	005 132	240		
	005 133	317	O	
	005 134	320	P	
	005 135	240		
	005 136	323	S	
	005 137	331	Y	
	005 140	323	S	
	005 141	324	T	
	005 142	305	E	
	005 143	315	M	
	005 144	011		(Spaces)
	005 145	323	s	
	005 146	345	e	
	005 147	354	l	
	005 150	345	e	
	005 151	343	c	
	005 152	364	t	
	005 153	240		
	005 154	317	O	
	005 155	360	p	
	005 156	364	t	
	005 157	351	i	

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	005 160	357	o	
	005 161	356	n	
	005 162	272	:	
	005 163	062		(Spaces)
	005 164	261	1	
	005 165	240		
	005 166	322	R	
	005 167	305	E	
	005 170	301	A	
	005 171	304	D	
	005 172	240		
	005 173	303	C	
	005 174	341	a	
	005 175	363	s	
	005 176	363	s	
	005 177	345	e	
	005 200	364	t	
	005 201	364	t	
	005 202	345	e	
	005 203	021		(Spaces)
	005 204	262	2	
	005 205	240		
	005 206	327	W	
	005 207	322	R	
	005 210	311	I	
	005 211	324	T	
	005 212	305	E	
	005 213	240		
	005 214	303	C	
	005 215	341	a	
	005 216	363	s	
	005 217	363	s	
	005 220	345	e	
	005 221	364	t	
	005 222	364	t	
	005 223	345	e	
	005 224	020		(Spaces)
	005 225	263	3	
	005 226	240		
	005 227	317	O	
	005 230	303	C	
	005 231	324	T	
	005 232	301	A	
	005 233	314	L	
	005 234	240		
	005 235	304	D	
	005 236	365	u	
	005 237	355	m	

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	005 240	360	p	
	005 241	024		(Spaces)
	005 242	364	4	
	005 243	240		
	005 244	317	O	
	005 245	303	C	
	005 246	324	T	
	005 247	301	A	
	005 250	314	L	
	005 251	240		
	005 252	320	P	
	005 253	362	r	
	005 254	357	o	
	005 255	347	g	
	005 256	362	r	
	005 257	341	a	
	005 260	355	m	
	005 261	021		(Spaces)
	005 262	265	5	
	005 263	240		
	005 264	310	H	
	005 265	305	E	
	005 266	330	X	
	005 267	240		
	005 270	304	D	
	005 271	365	u	
	005 272	355	m	
	005 273	360	p	
	005 274	026		(Spaces)
	005 275	266	6	
	005 276	240		
	005 277	310	H	
	005 300	305	E	
	005 301	330	X	
	005 302	240		
	005 303	320	P	
	005 304	362	r	
	005 305	357	o	
	005 306	347	g	
	005 307	362	r	
	005 310	341	a	
	005 311	355	m	
	005 312	023		(Spaces)
	005 313	241	!	(Next Edit supplied by user)
	005 314	000		Return
	005 315			
	005 316			
	005 317			

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	005 320			
	005 321			
	005 322			
	005 323			
	005 324			
	005 325			
	005 326			
	005 327			
	005 330			
	005 331			
	005 332			
	005 333			
Octal Dump	005 334	040		Call (Octal Set)
	005 335	364		
	005 336	005		
	005 337	114		Branch Uncondx
	005 340	060		
	005 341	002		
Octal Pro-	005 342	040		Call (Octal Set)
gram	005 343	364		
	005 344	005		
	005 345	114		Branch Uncondx
	005 346	255		
	005 347	004		
Hex Dump	005 350	040		Call (Hex Set)
	005 351	372		
	005 352	005		
	005 353	114		Branch Uncondx
	005 354	060		
	005 355	002		
Hex Program	005 356	040		Call (Hex Set)
	005 357	372		
	005 360	005		
	005 361	114		Branch Uncondx
	005 362	255		
	005 363	004		
Octal Set	005 364	251		Clear Accum
	005 365	000		
	005 366	215		Load Mem with Accum
	005 367	057		
	005 370	002		
	005 371	140		Return
Hex Set	005 372	251		Load Accum with "H"
	005 373	310		
	005 374	215		Load Mem with Accum
	005 375	057		
	005 376	002		
	005 377	140		Return

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LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	006 000	311		Compare Accum with "R"
	006 001	322		
	006 002	320		Branch not equal
	006 003	003		
	006 004	114		Branch Uncondx
	006 005	000		
	006 006	005		
	006 007	205		Transfer Accum to "Z34" (Save A)
	006 010	034		
	006 011	251		Load Accum with 010
	006 012	010		
	006 013	205		Transfer Accum to Z33
	006 014	033		
	006 015	210		Decrement Y Index
	006 016	300		Compare Y with 377
	006 017	377		(Rollover page boundary)
	006 020	320		Branch not equal
	006 021	002		
	006 022	306		Decrement Z32
	006 023	032		
	006 024	306		Decrement Z33
	006 025	033		
	006 026	320		Branch not zero
	006 027	365		
	006 030	040		Call (Home Erase)
	006 031	261		
	006 032	377		
	006 033	251		Load Accum with 010
	006 034	010		(Print 8 past locations)
	006 035	205		Transfer Accum to Z33
	006 036	033		
	006 037	245		Transfer Z32 to Accum
	006 040	032		(H Address)
	006 041	040		Call (Dump)
	006 042	266		
	006 043	002		
	006 044	230		Transfer Y to Accum
	006 045	040		Call (Dump)
	006 046	266		
	006 047	002		
	006 050	040		Call (Space)
	006 051	320		
	006 052	377		
	006 053	040		Call (Space)
	006 054	320		
	006 055	377		
	006 056	261		Load Accum with Mem.Indirect index
	006 057	031		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	006 060	040		Call (Dump)
	006 061	266		
	006 062	002		
	006 063	251		Load Accum with 025
	006 064	025		
	006 065	205		Transfer Accum to Z25
	006 066	025		
	006 067	040		Call (Spacer)
	006 070	307		(Single address & Data per line)
	006 071	377		
	006 072	310		Increment Y
	006 073	320		Branch not zero
	006 074	002		
	006 075	346		Increment "Z32"
	006 076	032		
	006 077	306		Decrement "Z33"
	006 100	033		
	006 101	320		Branch not zero
	006 102	334		(Print another address)
	006 103	245		Transfer "Z32" to Accum
	006 104	032		
	006 105	040		Call (Dump)
	006 106	266		
	006 107	002		
	006 110	230		Transfer Y to Accum
	006 111	040		Call (Dump)
	006 112	266		
	006 113	002		
	006 114	040		Call (Space)
	006 115	320		
	006 116	377		
	006 117	040		Call (Space)
	006 120	320		
	006 121	377		
	006 122	245		Transfer "Z34" to Accum (Restore A)
	006 123	034		
	006 124	040		Call (Ascii-short)
	006 125	105		
	006 126	004		
	006 127	221		Load Mem with Accum,Indirect & indexes
	006 130	031		
	006 131	251		Load Accum with 025
	006 132	025		
	006 133	205		Transfer Accum to Z25
	006 134	025		
	006 135	040		Call (Spacer)
	006 136	307		
	006 137	377		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	006 140	310		Increment Y
	006 141	320		Branch not zero
	006 142	002		
	006 143	346		Increment "Z32"
	006 144	032		
	006 145	245		Transfer "Z32" to Accum
	006 146	032		
	006 147	040		Call (Dump)
	006 150	266		
	006 151	002		
	006 152	230		Transfer Y to Accum
	006 153	040		Call (Dump)
	006 154	266		
	006 155	002		
	006 156	251		Load Accum with 003
	006 157	003		
	006 160	205		Transfer Accum to "Z25"
	006 161	025		
	006 162	040		Call (Spacer)
	006 163	307		
	006 164	377		
	006 165	251		Load Accum with "?"
	006 166	277		
	006 167	040		Call (TV)
	006 170	322		
	006 171	377		
	006 172	114		Branch Uncondx
	006 173	317		(Key)
	006 174	004		
TV Ascii	006 175	311		Compare Accum with 300
	006 176	300		
	006 177	060		Branch if less
	006 200	006		(Number)
Alpha TV	006 201	051		AND Accum with 337
	006 202	337		
	006 203	040		Call (TV)
	006 204	322		
	006 205	377		
	006 206	140		Return
Number TV	006 207	011		OR Accum with 040
	006 210	040		
	006 211	040		Call (TV)
	006 212	322		
	006 213	377		
	006 214	140		Return
Erase & Display	006 215	040		Call (Home Erase)
	006 216	261		
	006 217	377		

PROGRAM: 6502 Operating System

LABEL	OCTAL ADDRESS	OCTAL CODE	MNEMONIC	COMMENTS
	006 220	114		Branch Uncondx
	006 221	306		
	006 222	004		
Video Delay	006 223	252		Transfer Accum to X (Save A)
	006 224	251		Load Accum with 031
	006 225	031		(¼second)
	006 226	205		Transfer Accum to "Z26"
	006 227	026		
	006 230	040		Call (MS timer)
	006 231	034		
	006 232	001		
	006 233	212		Transfer X to Accum (Restore A)
	006 234	140		Return
	006 235			
	006 236			
	006 237			
	006 240	377		(Home Erase)
	006 241	046		(Spaces)
	006 242	313	K	
	006 243	305	E	
	006 244	331	Y	
	006 245	302	B	
	006 246	317	0	
	006 247	301	A	
	006 250	322	R	
	006 251	304	D	
	006 252	240		
	006 253	320	P	
	006 254	322	R	
	006 255	317	O	
	006 256	307	G	
	006 257	322	R	
	006 260	301	A	
	006 261	315	M	
	006 262	315	M	
	006 263	305	E	
	006 264	322	R	
	006 265	147		(Spaces)
	006 266	301	A	
	006 267	344	D	
	006 270	344	D	
	006 271	362	R	
	006 272	345	E	
	006 273	363	S	
	006 274	363	S	
	006 275	272	:	
	006 276	002		(Spaces)
	006 277	000		(Return)

Load Operations	Mnemonic	Octal	Hex	Status
Load Accum Immediate	LDA xxx	251 xxx	A9 xx	NZ
from Absolute	LDA hhhlll	255 lllhhh	AD llhh	NZ
from Zero Page	LDA lll	245 lll	A5 ll	NZ
Load Mem Absolute with Accum	STA hhhlll	215 lllhhh	8D llhh	
Zero Page with Accum	STA lll	205 lll	85 ll	

Logic & Arithmetic Operations

Add to Accum Immediate	ADC xxx	151 xxx	69 xx	NZC	V
from Absolute	ADC hhhlll	155 lllhhh	6D llhh	NZC	V
from Zero Page	ADC lll	145 lll	65 ll	NZC	V
Subtract from Accum Immediate	SBC xxx	351 xxx	E9 xx	NZC	V
Absolute	SBC hhhlll	355 lllhhh	ED llhh	NZC	V
Zero Page	SBC lll	345 lll	E5 ll	NZC	V
AND with Accum Immediate	AND xxx	051 xxx	29 xx	NZ	
Absolute	AND hhhlll	055 lllhhh	2D llhh	NZ	
Zero Page	AND lll	045 lll	25 ll	NZ	
XOR with Accum Immediate	EOR xxx	111 xxx	49 xx	NZ	
Absolute	EOR hhhlll	115 lllhhh	4D llhh	NZ	
Zero Page	EOR lll	105 lll	45 ll	NZ	
OR with Accum Immediate	ORA xxx	011 xxx	09 xx	NZ	
Absolute	ORA hhhlll	015 lllhhh	0D llhh	NZ	
Zero Page	ORA hhhlll	005 ll	05 ll	NZ	
Compare with Accum Immediate	CMP xxx	311 xxx	C9 xx	NZC	
Absolute	CMP hhhlll	315 lllhhh	CD llhh	NZC	
Zero Page	CMP lll	305 lll	C5 ll	NZC	
Test Bits with Acc Absolute	BIT hhhlll	054 lllhhh	2C llhh	NZ	V
Zero Page	BIT lll	044 lll	24 ll	NZ	V
Decrement Memory Absolute	DEC hhhlll	316 lllhhh	CE llhh	NZ	
Zero Page	DEC lll	306 lll	C6 ll	NZ	
Increment Memory Absolute	INC hhhlll	356 lllhhh	EE llhh	NZ	
Zero Page	INC lll	346 lll	E6 ll	NZ	
No Operation	NOP	352	EA		

6502 Programming

Branching Operations	Mnemonic	Octal	Hex	Status
Branch on Carry	BCS rrr	260 rrr	B0 rr	
Zero or Equal	BEQ rrr	360 rrr	F0 rr	
Less or Minus	BMI rrr	060 rrr	30 rr	
Overflow	BVS rrr	160 rrr	70 rr	
Branch if no Carry	BCC rrr	220 rrr	90 rr	
not Zero or Equal	BNE rrr	320 rrr	D0 rr	
not Less (is Plus)	BPL rrr	020 rrr	10 rr	
no Overflow	BVC rrr	120 rrr	50 rr	
Branch Unconditionally	JMP hhhlll	114 lllhhh	4C llhh	
Uncondx,Indirect	JMP hhhlll	154 lllhhh	6C llhh	
Call Subroutine Unconditional	JSR hhhlll	040 lllhhh	20 llhh	
Return from Subroutine	RTS	140	60	
Interrupt	BRK	000	00	I
Return from Interrupt	RTI	100	40	

Stack Operations				
Push Accum on Stack	PHA	110	48	
Status on Stack	PHP	010	08	
Pop Accum from Stack	PLA	150	68	NZ
Status from Stack	PLP	050	28	NZCIDV
Load Stack Pointer with X	TXS	232	9A	
X with Stack Pointer	TSX	272	BA	NZ

Shift/Rotate Operations				
Shift Left Accum	ASL A	012	0A	NZC
Absolute	ASL hhhlll	016 lllhhh	0E llhh	NZC
Zero Page	ASL lll	006 lll	06 ll	NZC
Right Accum	LSR A	112	4A	NZC
Absolute	LSR hhhlll	116 lllhhh	4E llhh	NZC
Zero Page	LSR lll	106	46 ll	NZC
Rotate Left Accum	ROL A	052	2A	NZC
Absolute	ROL hhhlll	056 lllhhh	2E llhh	NZC
Zero Page	ROL lll	046 lll	26 ll	NZC

SET/CLEAR Status Bit				
Set Carry Bit	SEC	070	38	C
Decimal Mode	SED	370	F8	D
Clear Carry Bit	CLC	030	18	C
Decimal Mode	CLD	330	D8	D
Overflow	CLV	270	B8	V
Enable Interrupts	CLI	130	58	I
Prevent Interrupts	SEI	170	78	I

X Index Operations	Mnemonic	Octal	Hex	Status
Load X Immediate	LDX xxx	242 xxx	A2 xx	NZ
from Absolute	LDX hhhlll	256 lllhhh	AE llhh	NZ
from Zero Page	LDX lll	246 lll	A6 ll	NZ
Load Mem Absolute with X	STX hhhlll	216 lllhhh	8E llhh	
Zero Page with X	STX lll	206 lll	86 ll	
Load X Index with Accum	TAX	252	AA	NZ
Accum with X index	TXA	212	8A	NZ
Compare with X Immediate	CPX xxx	340 xxx	E0 xx	NZC
Absolute	CPX hhhlll	354 lllhhh	EC llhh	NZC
Zero Page	CPX lll	344 lll	E4 ll	NZC
Decrement X	DEX	312	CA	NZ
Increment X	INX	350	E8	NZ

Y Index Operations				
Load Y Immediate	LDY xxx	240 xxx	A0 xx	NZ
from Absolute	LDY hhhlll	254 lllhhh	AC llhh	NZ
from Zero Page	LDY lll	244 lll	A4 ll	NZ
Load Mem Absolute with Y	STY hhhlll	214 lllhhh	8C llhh	
Zero Page with Y	STY lll	204 lll	84 ll	
Load Y Index with Accum	TAY	250	A8	NZ
Accum with Y Index	TYA	230	98	NZ
Compare with Y Immediate	CPY xxx	300 xxx	C0 xx	NZC
Absolute	CPY hhhlll	314 lllhhh	CC llhh	NZC
Zero Page	CPY lll	304 lll	C4	NZC
Decrement Y	DEY	210	88	NZ
Increment Y	INY	310	C8	NZ

Operations Indexed by X				
Load Accum from Absolute,X	LDA hhhlll,X	275 lllhhh	BD llhh	NZ
Zero Page,X	LDA lll,X	265 lll	B5 ll	NZ
Indirect,X	LDA xxx,X	241 xxx	A1 xx	NZ
Load Mem Absolute,X with A	STA hhhlll,X	235 lllhhh	9D llhh	
Zero Page,X	STA lll,X	225 lll	95 ll	
Indirect,X	STA xxx,X	201 xxx	81 xx	
Load Y with Mem Absolute,X	LDY hhhlll,X	274 lllhhh	BC llhh	NZ
Zero Page,X	LDY lll,X	264 lll	B4 ll	NZ
Load Mem with Y Zero Page,X	STY hhhlll,X	224 lllhhh	94 llhh	

Operations Indexed by X(cont)	Mnemonic	Octal	Hex	Status
ADD to Accum Absolute,X	ADC hhhlll,X	175 lllhhh	7D llhh	NZC V
Zero Page,X	ADC lll,X	165 lll	75 ll	NZC V
Indirect,X	ADC xxx,X	141 xxx	61 xx	NZC V
SUBTRACT from A Absolute,X	SBC hhhlll,X	375 lllhhh	FD llhh	NZC V
Zero Page,X	SBC lll,X	365 lll	F5 ll	NZC V
Indirect,X	SBC xxx,X	341 xxx	E1 xx	NZC V
AND with Accum Absolute,X	AND hhhlll,X	075 lllhhh	3D llhh	NZ
Zero Page,X	AND lll,X	065 lll	35 ll	NZ
Indirect,X	AND xxx,X	041 xxx	21 xx	NZ
XOR with Accum Absolute,X	EOR hhhlll,X	135 lllhhh	5D llhh	NZ
Zero Page,X	EOR lll,X	125 lll	55 ll	NZ
Indirect,X	EOR xxx,X	101 xxx	41 xx	NZ
OR with Accum Absolute,X	ORA hhhlll,X	035 lllhhh	1D llhh	NZ
Zero Page,X	ORA lll,X	025 lll	15 ll	NZ
Indirect,X	ORA xxx,X	001 xxx	01 xx	NZ
COMPARE with A Absolute,X	CMP hhhlll,X	335 lllhhh	DD llhh	NZC
Zero Page,X	CMP lll,X	325 lll	D5 ll	NZC
Indirect,X	CMP xxx,X	301 xxx	C1 xx	NZC
Decrement Memory Absolute,X	DEC hhhlll,X	336 lllhhh	DE llhh	NZ
Zero Page,X	DEC lll,X	326 lll	D6 ll	NZ
Increment Memory Absolute,X	INC hhhlll,X	376 lllhhh	FE llhh	NZ
Zero Page,X	INC lll,X	366 lll	F6 ll	NZ
Shift Mem Left Absolute,X	ASL hhhlll,X	036 lllhhh	1E llhh	NZC
Zero Page,X	ASL lll,X	026 lll	16 ll	NZC
Right Absolute,X	LSR hhhlll,X	136 lllhhh	5E llhh	NZC
Zero Page,X	LSR lll,X	126 lll	56 ll	NZC
Rotate Mem Left Absolute,X	ROL hhhlll,X	076 lllhhh	3E llhh	NZC
Zero Page,X	ROL lll,X	066 lll	36 ll	NZC

Operations Indexed by Y				
Load Accum from Absolute,Y	LDA hhhlll,Y	271 lllhhh	B9 llhh	NZ
Indirect,Y	LDA lll,Y	261 lll	B1 ll	NZ
Load Mem Absolute,Y with A	STA hhhlll,Y	231 lllhhh	99 llhh	
Indirect,Y	STA lll,Y	221 lll	91 ll	
Load X with Mem Absolute,Y	LDX hhhlll,Y	276 lllhhh	BE llhh	NZ
Zero Page,Y	LDX lll,Y	266 lll	B6 ll	NZ
Load Mem Zero Page,Y with X	STX lll,Y	226 lll	96 ll	
ADD to Accum Absolute,Y	ADC hhhlll,Y	171 lllhhh	79 llhh	NZC V
Indirect,Y	ADC lll,Y	161 lll	71 ll	NZC V
SUBTRACT from A Absolute,Y	SBC hhhlll,Y	371 lllhhh	F9 llhh	NZC V
Indirect,Y	SBC lll,Y	361 lll	F1 ll	NZC V
AND with Accum Absolute,Y	AND hhhlll,Y	071 lllhhh	39 llhh	NZ
Indirect,Y	AND lll,Y	061 lll	31 ll	NZ
XOR with Accum Absolute,Y	EOR hhhlll,Y	131 lllhhh	59 llhh	NZ
Indirect,Y	EOR lll,Y	121 lll	51 ll	NZ
OR with Accum Absolute,Y	ORA hhhlll,Y	031 lllhhh	19 llhh	NZ
Indirect,Y	ORA lll,Y	021 lll	11 ll	NZ
COMPARE with A Absolute,Y	CMP hhhlll,Y	331 lllhhh	D9 llhh	NZC
Indirect,Y	CMP lll,Y	321 lll	D1 ll	NZC