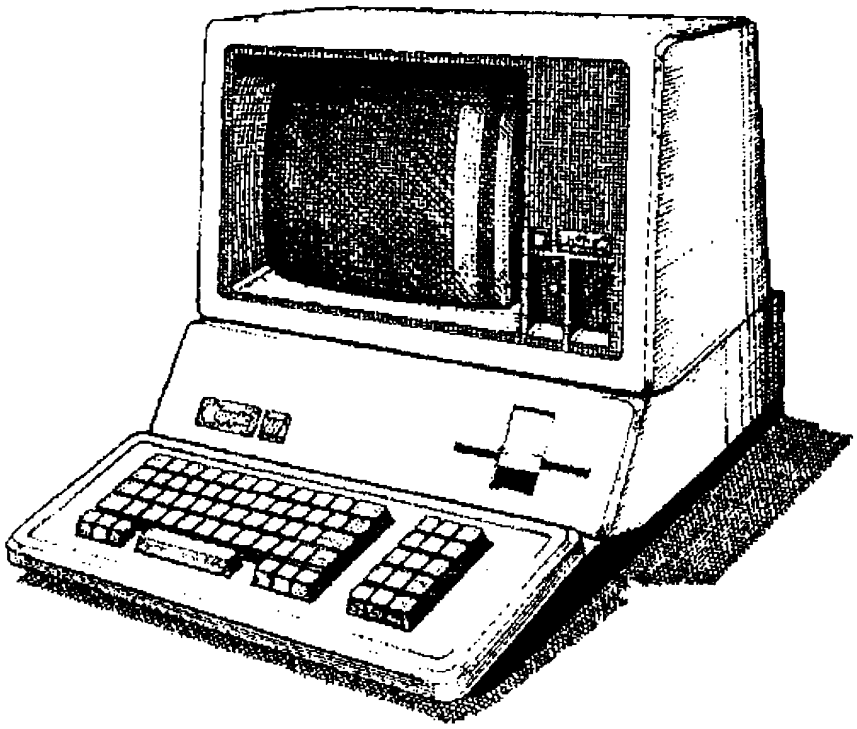
Apple /// Computer Information

Apple /// Service Reference Manual



Section I of II • Theory of Operation

Chapter 8 • The Keyboard

Written by Apple Computer • 1982

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THE KEYBOARD

The Apple /// has a built-in 74 key typewriter-like keyboard which includes full alpha/numerics, four cursor control keys, two special function keys, and a numeric keypad. It has full upper and lower case ASCII code generation capability as well as full incorporation of Apple][functions.

The drawing on the previous page shows the standard keyboard legend and details the keystation number. Note that in addition to the 74 keys there is a recessed Reset key. Every key on the keyboard can be observed individually by the soft- ware. The Control and Shift keys modify the key codes when presented to the system.

The keyboard is electrically connected to the main circuit board by a 26 conductor ribbon cable. The cable plugs into a socket on the keyboard and the main circuit board. The signal assignment is shown on the Pin Signal Assignment table.

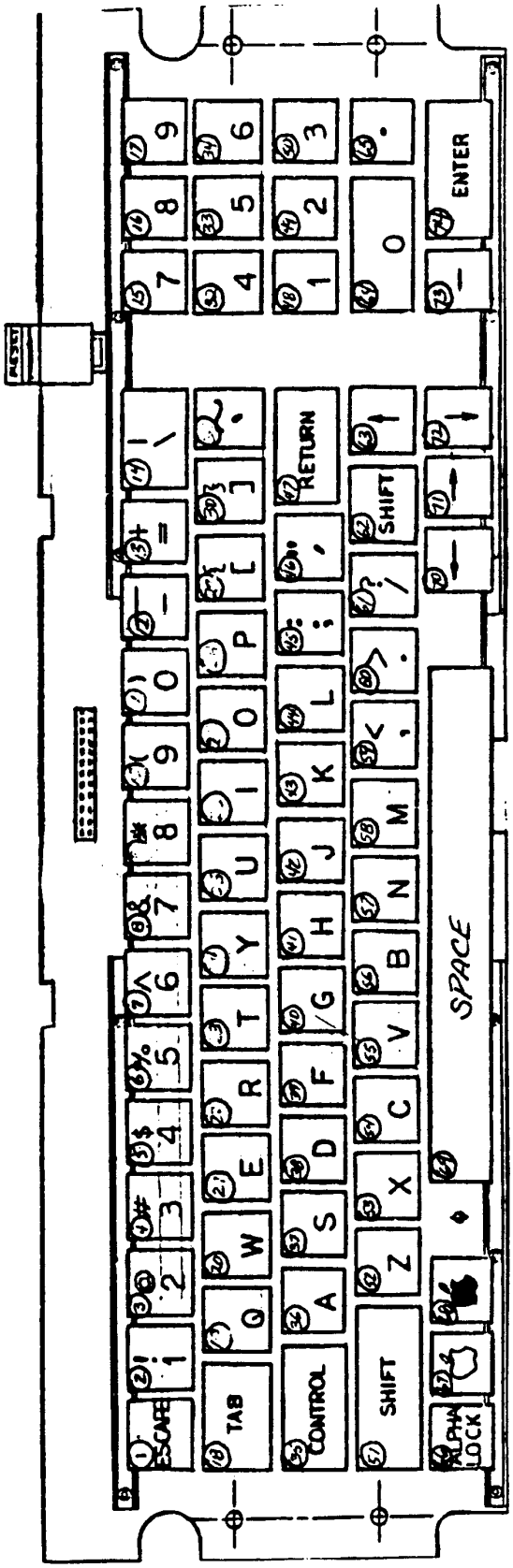
Repeat Functions

Any key held down for more thn 1/2 second is automatically activated to repeat at a 10 CPS rate. A high speed (30 CPS) repeat function is activated by holding down the closed Apple key (Key #68) after depressing and holding the key to be repeated. An idiosyncracy of the Apple /// is that if the closed Apple key is depressed before another key, it is displayed as only one character. If it is depressed after another key, the high speed repeat is activated.

The four cursor control keys (63, 70, 71, 72) are two-contact keys. This means that as the key is partially depressed, it makes its first contact generating a signal code. When it is fully depressed, it will make a second contact, automatically activating a high speed repeat of that key.

READING THE KEYBOARD

The keyboard can be thought of as two hardware ports (busses) that can provide two distinct types of data. The first type is ASCII, which is addressed by Memory Address C000; we will call this the KA port. The KA port always contains the lower 7 bits of the ASCII code and, like the Apple][, uses the MSB as a "keyboard data ready" flag. The second type of data is addressed by Memory Address C008; we call this the KB port. The KB port looks at the "direct connect" keys and at the eighth bit of the key code. A summary of the bit meanings for these two types of data is shown in the table at the top of the following page.


ESCAPE
TAB
CONTROL
SHIFT
ALPHA LOCK
SHIFT
SPACE
RETURN
ENTER

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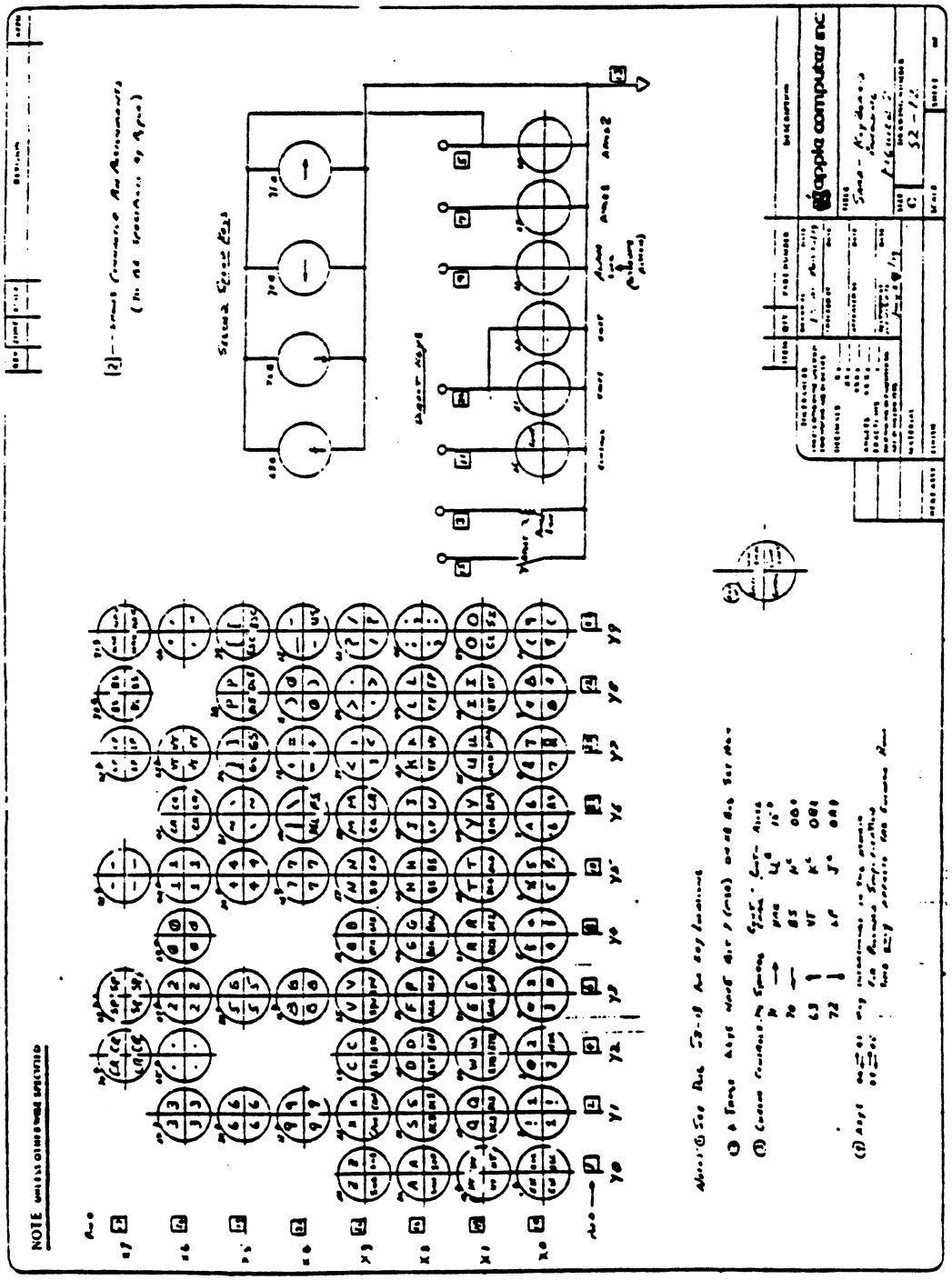

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KEYBOARD ENCODER MATRIX

	KEYBOARD VERTICAL Y								KEY PAD
Y0	A	Z	ESC	TAB					NONE
Y1	1	Q	S	X					9 6 3
Y2	2	W	D	C					. ENTER
Y3	3	E	F	V	SPACE				8 5 2
Y4	4	R	H	B					Ø
Y5	5	T	G	N					7 4 1 -
Y6	6	| \	Y	~ ^	J	M	RETURN		NONE
Y7	7	+ =	U	}]	K	<,	↑		NONE
Y8	8	Ø	I	P	;:	←	> .		NONE
Y9		9	§[	O	" '	L	?/		NONE

	KEYBOARD HORIZONTAL X										KEY PAD
X0	ESC	1	2	3	4	5	6	7	8	9	NONE
X1	TAB	Q	W	E	R	T	Y	U	I	O	NONE
X2	A	S	D	F	G	H	J	K	L	: ;	NONE
X3	Z	X	C	V	B	N	M	<,	>.	? /	NONE
X4	Ø	_ -	+ =	| \							7 8 9
X5	P	{ [	}]	~ ^							4 5 6
X6	" '	RETURN	↑								1 2 3 . Ø
X7	SPACE	←	→	↓							- ENTER

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MEMORY ADDRESS REFERENCE

****

KA PORT (C000)			KA PORT (C008)	
Bit 0	ASCII Bit 0	*	Bit 0	"1"="any key down"
Bit 1	ASCII Bit 1	*	Bit 1	"0"="shift depressed"
Bit 2	ASCII Bit 2	*	Bit 2	"0"="control depressed"
Bit 3	ASCII Bit 3	*	Bit 3	"0"="alpha lock set"
Bit 4	ASCII Bit 4	*	Bit 4	"0"="Apple 1 switch depressed"
Bit 5	ASCII Bit 5	*	Bit 5	"0"="Apple 2 switch depressed"
Bit 6	ASCII Bit 6	*	Bit 6	"1"="start up uncommitted mode"
Bit 7	"1"="data ready flag"	*	Bit 7	ASCII Bit 7

****

The KA data is used exactly like that in the Apple][keyboard. The KB data is provided for function expansion. The KB ports 1 to 5 are direct mechanical connections to defined function switches. Bit 0 is an output from the encoder circuity and bit 7 is the eighth bit of the key code. Bit 6 is a special bit, a flag used during turn-on to show that the operational mode (Apple /// or Apple][) has not yet been determined..

It should be noted that the Reset key cannot act on its own but has to be depressed with another key. This is a safety feature to prevent blowing away a good night's programming effort. Now isn't that nifty!? A CONTROL- RESET will give a true system reset. However, it cannot be used for recovery from Apple][mode. The CONTROL-RESET will also give the system an NMI (Non-Maskable Interrupt). This provides Apple /// with two levels of "reset."

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KEYBOARD CODES

A complete list of the codes generated by the encoder circuitry is presented is the following table:

Table: Apple /// KEYBOARD CODES (HEX)

Key #	Key Name	US	SH	CT	SU-CT	Key #	Key Name	US	SH	CT	SU-CT
1*	ESCAPE	9B	9B	9B	9B	39	F	46	46	04	04
2	1	31	21	31	31	40	G	47	47	07	07
3	2	32	40	32	00	41	H	48	48	08	08
4	3	33	23	33	23	42	J	4A	4A	0A	0A
5	4	34	24	34	24	43	K	4B	4B	0B	0B
6	5	35	25	35	25	44	L	4C	4C	0C	0C
7	6	36	5E	36	53	45	;	3B	3A	3B	3A
8	7	37	26	37	26	46	'	27	22	27	22
9	8	38	2A	38	2A	47	RETURN	0D	0D	0D	0D
10	9	39	28	39	28	48*	1	B1	B1	B1	B1
11	0	30	29	30	29	49*	2	B2	B2	B2	B2
12	-	2D	5F	2D	1F	50*	3	B3	B3	B3	B3
13	=	3D	2B	3D	2B	51	SHIFT	-----KB-1------			
14	BACKLASH	5C	7C	7F	1C	52	Z	5A	5A	1A	1A
15*	7	B7	B7	B7	B7	53	X	58	58	18	18
16*	8	B8	B8	B8	B8	54	C	43	43	03	03
17*	9	B9	B9	B9	B9	55	V	56	56	16	16
18*	TAB	89	89	89	89	56	B	42	42	02	02
19	Q	51	51	11	11	57	N	4E	4E	0E	0E
20	W	57	57	17	17	58	M	4D	4D	0D	0D
21	E	45	45	05	05	59	,	2C	3C	2C	3C
22	R	52	52	12	12	60	.	2E	3E	2E	3E
23	T	54	54	14	14	61	/	2F	3F	2F	3F
24	Y	59	59	19	19	62	SHIFT	-----KB-1-------			
25	U	55	55	15	15	63*	UP-CURSOR	8B	8B	8B	8B
26	I	49	49	09	09	64*	0	B0	B0	B0	B0
27	O	4F	4F	0F	0F	65*	.	AE	AE	AE	AE
28	P	50	50	10	10	66	ALPHA-LK	-----KB-3------			
29	RT-BRACK	5B	7B	1B	1B	67	APPLE 1	-----KB-4------			
30	LT-BRACK	5D	7D	1D	1D	68	APPLE 2	-----KB-5------			
31	LT-BRACK	60	7E	60	7E	69*	SPACE	A0	A0	A0	A0
32*	4	B4	B4	B4	B4	70*	LT-CURSOR	8B	8B	8B	8B
33*	5	B5	B5	B5	B5	71*	RT-CURSOR	95	95	95	95
34*	6	B6	B6	B6	B6	72*	DN-CURSOR	8A	8A	8A	8A
35	CONTROL	-----KB-2------				73*	-	AD	AD	AD	AD
36	A	41	41	01	01	74*	ENTER	8D	8D	8D	8D
37	S	53	53	13	13						
38	D	44	44	04	04						

* Bit 7 (MSB) on these keys appears on bit 7 of KB port, on the KA port.

Note: the keys on the numeric keypad have only one code. Shift and Control

have no effect on these keys.

THE APPLE II EMULATION MODE

In this mode the Apple /// special functions are locked out, making the keyboard look exactly like the Apple][. Thus, the Apple][software does not look at the KB port and must get all the Apple][codes for the KA port. This is the reason for coding and bit arrangements. However, the Apple /// functions are not really locked out and could be read by an enterprising programmer, if desired.

Some of the keyboard codings which should be noted because of the Apple II emulation mode are:

1. "NUL" is a control-@ (Control-Shift-2). With the Apple][, the "NUL" is a Control-Shift-p.

2. "RS", record separator, is a control-Shift-6, which corresponds to control-Shift-n in the Apple][.

3. The Shift-m, for a left square bracket in the japple][, is not available in the emulation mode since the character is represented on the keyboard. The "GS", group separator, is a Control-left bracket rather than the Control-Shift-m.

4. "BS", backspace, has been retained for the left arrow and "NAK", negative acknowledgment, for the right arrow for both the Apple][and Apple /// modes.

5. "VT", vertical tab, and "LF, line feed, were chosen for the up and down cursor keys. In the Apple][mode these will not give a cursor movement (unless the operating system is changed) but will give the Control-k and Control-j codes. This could cause some slight confusion for those Apple][programs that use those codes (...now he tells me!).

6. The autorepeat and high speed repeat functions will work for the Apple][just like they do in the Apple /// mode. Nice!

ELECTRONIC CIRCUIT DESCRIPTION

Please refer to sheet 9 of 10 of the Schematic (Drawing Number 050-0039) for the following Keyboard Logic circuit description.

The Apple /// keyboard is simply an 8 by 10 X,Y matrix which is scanned by the encoder circuit [keyboard encoder rom H14] on the main logic board. All keys are scanned with the exception of five keys [shift, control, capslock, Applel, Apple2] that are direct connected. The second contacts of the cursor keys (high speed repeat function are OR'd wired into the Apple2 switch line on KB-5.

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On the main board the encoder scans the keyboard matrix and provides the correct code outputs plus a strobe and an "any key down" signal. A diagram for the key matrix shows the key locations, and their ASCII character representations are shown on the following page. The special function keys can be detected separately from the standard control keys by observing that the MSB of the KB port is set high.

The A3 signal to the Tri-state data selectors (LS257's) selects whether the output of the LS257 will be a KA or KB port. If A3 is high, selected by memory address C008, the KB port is selected. The KBD line enable the reading of data off the keyboard.

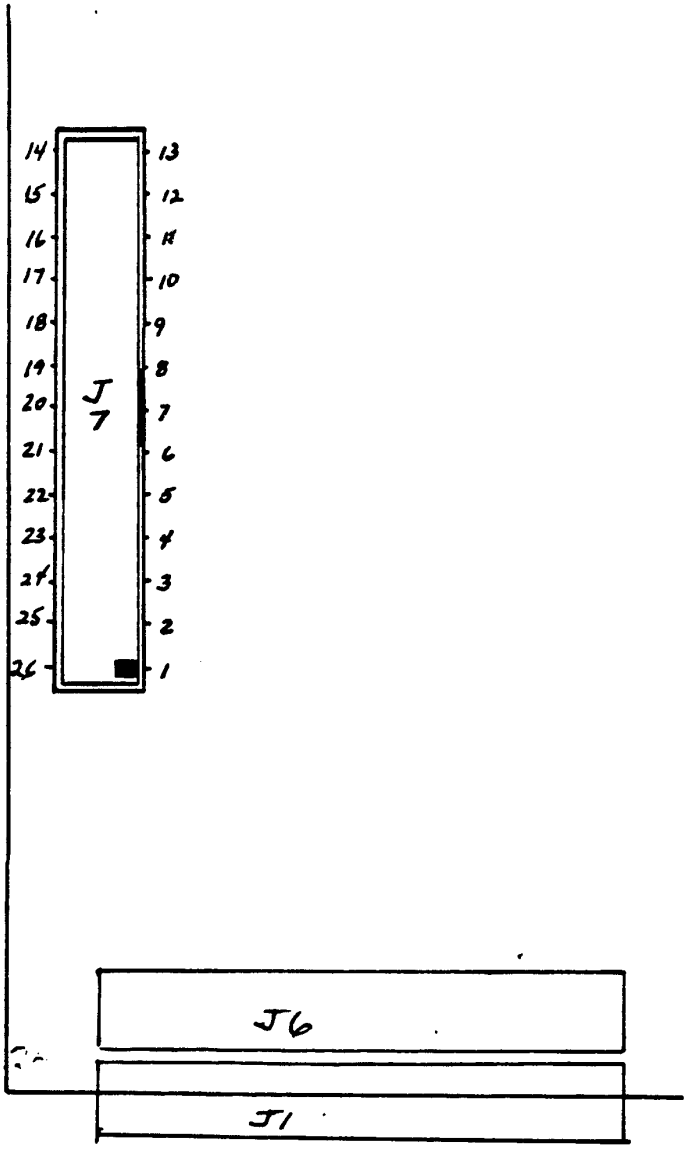
The Repeat Function: The normal repeat function (10 cps) that occurs when a key is held down is the result of clocking and resetting the flip-flop H11 (feeding into H12). This is accomplished by the AK (any key) and DTRDY (data ready) setting, H11 then having CLRSTB (clear strobe) resetting the flip-flop. The Apple2 key, when depressed after a character key, engages the high-speed repeat function. The combination of the Apple2 key signal clocking the edge triggered flip-flop (H11), and pulse change to the inputs of the 556 (L10) dual timers speeds up the timing.

The Reset Function: The power on reset is provided by the one shot (A5). Depressing the reset key results in a soft reset. This causes the KRESET line to go low and enable the LS139 (J11). If the Control key and the Reset key are both depressed, a hard reset results. This hard reset can be foiled through sophisticated programming. The RESETLK (reset lock signal) provided from the Environmental Register [6522 - B6], can disable the Reset and NMI. (Try it!)

Keyboard Light: The keyboard light indicates the VCC is provided to the keyboard. If no light is observed, check Q9 [MPV 51].

PIN SIGNAL ASSIGNMENT

Pin #	Description
1	Y0
2	Y1
3	Power Light
4	Y2
5	Apple 2 (high speed repeat)
6	Y3
7	Apple 1
8	Y4
9	Alpha Lock (alternate action)
10	Y5
11	Control
12	Y8
13	Signal Ground
14	X0
15	Reset
16	X2
17	X7
18	X2
19	X5
20	X3
21	X4
22	Y9
23	Y6
24	Shift (both keys)
25	Y7
26	X6

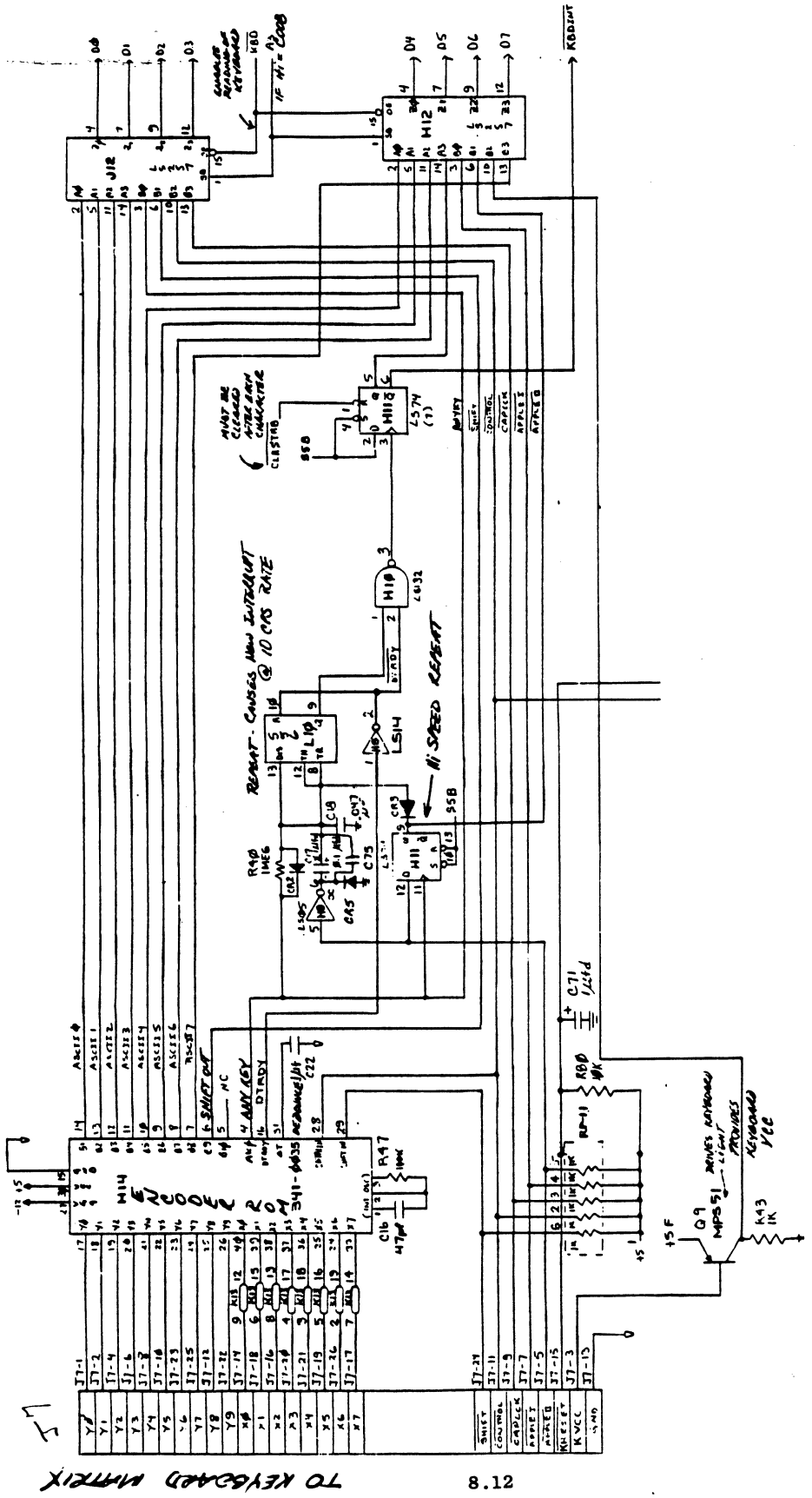


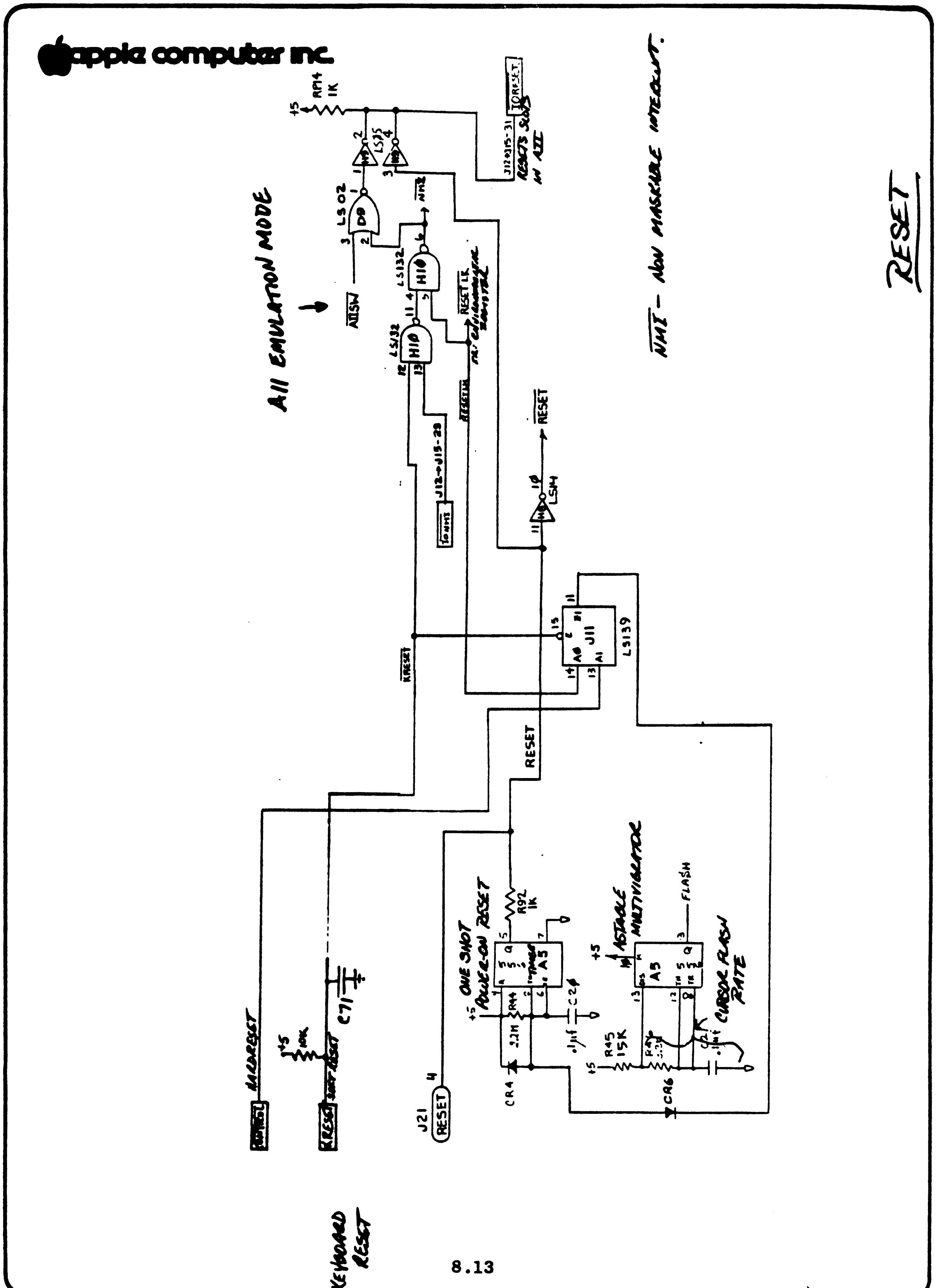
$ = REPRESENTS HEXADECIMAL

Table 2: Keys and their Associated ASCII Codes (Bit 7 always set)

Key	Alone	CONTROL	SHIFT	Both
<space>	$A0	$A0	$A0	$A0
ESCAPE	$9B	$9B	$9B	$9B
1!	$B1	$B1	$A1	$A1
2@	$B2	$B2	$C0	$80
3#	$B3	$B3	$A3	$A3
4$	$B4	$B4	$A4	$A4
5%	$B5	$B5	$A5	$A5
6^	$B6	$B6	$DE	$9E
7&	$B7	$B7	$A6	$A6
8*	$B8	$B8	$AA	$AA
9(	$B9	$B9	$A8	$A8
0)	$B0	$B0	$A9	$A9
-_	$AD	$AD	$DF	$9F
=+	$BD	$BD	$AB	$AB
\\|	$DC	$9C	$FC	$FF
TAB	$89	$89	$89	$89
[{	$DB	$9B	$FB	$9B
]}	$DD	$9D	$FD	$9D
'"	$A7	$A7	$A2	$A2
RETURN	$8D	$8D	$8D	$8D
,<	$AC	$AC	$BC	$BC
.>	$AE	$AE	$BE	$BE
/?	$AF	$AF	$BF	$BF
<left arrow>	$88	$88	$88	$88
<right arrow>	$95	$95	$95	$95
<up arrow>	$8B	$8B	$8B	$8B
<down arrow>	$8A	$8A	$8A	$8A
.	$AE	$AE	$AE	$AE
-	$AD	$AD	$AD	$AD
ENTER	$8D	$8D	$8D	$8D
A	$C1	$81	$C1	$81
B	$C2	$82	$C2	$82
C	$C3	$83	$C3	$83
D	$C4	$84	$C4	$84
E	$C5	$85	$C5	$85
F	$C6	$86	$C6	$86
G	$C7	$87	$C7	$87
H	$C8	$88	$C8	$88
I	$C9	$89	$C9	$89
J	$CA	$8A	$CA	$8A
K	$CB	$8B	$CB	$8B
L	$CC	$8C	$CC	$8C
M	$CD	$8D	$CD	$8D
N	$CE	$8E	$CE	$8E
O	$CF	$8F	$CF	$8F
P	$D0	$90	$D0	$90
Q	$D1	$91	$D1	$91
R	$D2	$92	$D2	$92
S	$D3	$93	$D3	$93
T	$D4	$94	$D4	$94

U	$D5	$95	$D5	$95
V	$D6	$96	$D6	$96
W	$D7	$97	$D7	$97
X	$D8	$98	$D8	$98
Y	$D9	$99	$D9	$99
Z	$DA	$9A	$DA	$9A


TO KEYBOARD MATRIX
8.12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RESET
A II EMULATION MODE
NMI - NON MASKABLE INTERRUPT
ONE SHOT POWER-ON RESET
ASTABLE MULTIVIBRATOR
CURSOR FLASH RATE
FLASH
KEYBOARD RESET
LS02
LS132
LS139
LS05
LS04
RP14 1K
R92 1K
R45 15K
C71
CR4
CR6
J21

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