THE KEYBOARD

The keyboard connects to the computer through the jack on the lower right front of the Lisa. Its 80 keys are fully programmable.

The keyboard contains a microprocessor which scans the keys and communicates the occurrence of a key depression or release to the 68000. The keyboard is a true N-key rollover design. An arbitrary number of keys can be depressed without causing phantom key problems. It is the responsibility of the 68000 side of the interface to interpret key up and key down codes to properly handle functions such as shift and auto-repeat. Any key can be programmed to generate an NMI (non-maskable interrupt).

The keyboard's microprocessor contains an eight byte FIFO that buffers keyboard data if the 68000 does not collect it fast enough. Normally, this FIFO keeps keycodes from being lost, but if the keycodes are not read for a long enough time, the buffer will eventually overflow and keycodes will be lost.

KEYCODES

Seven bits of the keycode byte identify the key which moved. The other bit indicates whether the key went up or down. The keycode format is:

drrr nnnn

If the d bit is 0, a key up transition has occurred. If it is 1, a key down transition has occurred.

The rrr and nnnn bits of the keycode have the following meanings:

nnnn \ rrr →	010	011	100	101	110	111
0000	CLEAR		_ -	(9	E	A
0001	/		+ =	) 0	^ 6	@ 2
0010	*			U	& 7	# 3
0011	=			I	* 8	$ 4
0100	7		P	J	% 5	! 1
0101			BACKSPACE	K	R	Q
0110	8			< [	T	S
0111	9			>]	Y	W
1000	-		RETURN	M	RIGHT COMMAND	TAB
1001	4		- 0	L	F	Z
1010	6			: ;	G	X
1011	+			" '	H	D
1100	.		? /	SPACE	V	OPTION
1101	2		1	, ,	C	ALPHA LOCK
1110	3			. .	B	SHIFT
1111	NUMERIC RETURN			0	N	LEFT COMMAND

6.5.3 Parallel Port Operation

Operation of the parallel port is under software control and lies outside the scope of this manual. Refer to software documentation and Chapter 2 of this manual for programming information on this port.

6.5.4 Parallel Port Timing

Timing on the parallel port is programmable and a function of software. It therefore lies outside the scope of this manual. Refer to the data sheet for a discussion of the timing limitations on the 6522.

6.6 The Keyboard/Mouse Controller

The interface to the keyboard and the mouse is implemented by means of a 6522 VIA peripheral port device and a COPS single-chip controller. It is also used to provide software control of the power on-off function and to provide a real-time-clock.

Details on the 6522 can be found in the data sheet. Refer to the COPS user manual for information on the COPS. The logic that comprises the interface controller is shown on sheet 2 of schematic Ø5Ø-4ØØ8 in Appendix C. Programming of the controller is discussed in subsection 2.5.4.

6.6.1 68ØØØ Bus Interface for the Keyboard/Mouse Controller

This interface is implemented with the 6522. The internal I/O board D-bus connects to the DØ-D7 data lines. Selection among the 16 internal register destinations is performed by the A1 through A4 address lines from the system bus.

The device is selected when both the VMA signal on the system bus and the I/O decode output at pin 7 of device U4E are asserted. This indicates that the processor board is performing an access to the keyboard/mouse controller in a 68ØØ compatible cycle.

The address map of the controller as seen by the software is shown in Figure 2-15.

The device is clocked by the E signal and reset by the RESET/ line.

6.6.2 The COPS Processor

The COP421 shown at D-3 on sheet 2 is described in detail in the COPS user manual. As well as controlling data flow from the keyboard and mouse, the COP421 is responsible for maintaining the Time of Day clock. To do that it requires a power supply that is independent of the main supply; one that remains on even when the Lisa is turned off, as described in the next subsection.

The COPS connects to the A port of the 6522, with the CA1 and CA2 control signals of the 6522 being attached to the SO and SI lines of the COPS. In addition, the port PB6 control output signal connects with D3.

The other lines from the COPS are used as follows:

SK is the output to the keyboard. In conjunction with the D2 line, it is used to send a synchronization pulse to the keyboard to initiate data transfer.

GØ and G1 are the multiplexed data inputs from the keyboard and the mouse.

D1 and D2 are the select signals that are used to control the data multiplexer which provides keyboard and mouse data on GØ and G1.

DØ is used to switch the Lisa on and off under control of firmware resident in the COPS.

G2 is used to interrupt the processor by means of the NMI/ , non-maskable interrupt, at B-2 on sheet 2, which is presented to the processor board via the system bus, and to detect a power failure via D5 at B-2 on sheet 2.

G3 is used to sense the state of the on-off switch on the lower-left of the Lisa cabinet.

CK1 and CK2 are inputs to the COPS oscillator from timing circuit at D-2. The clock is crystal-controlled to permit the time of day to be kept accurately.

RST is the COPS internal reset input which is used to perform a power-on reset in the COPS should its own power have failed for any reason.

6.6.3 Keyboard/Mouse Interface

Keyboard data are input on the KBD line. This line is pulled low by the COPS generating a SYNC pulse to signal the keyboard to send data if it has any. This is done via the COPS SK output with the D2 output being asserted simultaneously.

The keyboard responds with an ACK pulse on the KBD line, followed by a serial 8-bit byte which indicates the code for a key pressed or released. The keycodes are outlined in Figure 2-14. If no key has changed its state, no ACK pulse is sent.

The mouse interface consists of the LS153 dual 4-to-1 multiplexer at D-2. The selection of data to be input to the COPS is performed by configuring the D1 and D2 outputs from the COPS.

The COPS polls the signal states by reading the signals input to the mulitiplexer. The movement of the mouse is detected by pulse edges on the relevant direction lines. The three inputs SWØ-SW2 reflect the state of up to three switches on the mouse. In the current Lisa only one mouse switch is present and is connected to the SWØ line.

The data presented to the COPS is selected as shown in Figure 6-13. Refer to Chapter 8 for a discussion of the keyboard side of this interface.

Figure 6-13. Keyboard Data Format and Timing

6.6.4 Software On-Off/Reset Logic

The software on-off switch is sensed through the PWRSW/ signal. In addition, pulling the RESET/ signal high when the Lisa is turned off pulls the PWRSW/ signal low and turns the Lisa on. Note that this can be also accomplished by pulling RESET/ to +5STBY with a 1ØØ ohm resistor.

The COPS can turn the Lisa on or off, via the ON line. The COPS may be programmed to turn the Lisa on under control of the real-time-clock (RTC). The RTC is not capable of turning the computer off.

6.6.5 Other Control Lines

The keyboard and mouse controller makes use of the A port of the 6522. The B port is used to provide an interface to the Lisa for several control lines that would otherwise require additional hardware to implement.

The use of the B port lines is as follows:

PBØ is used to reset the keyboard under software control.

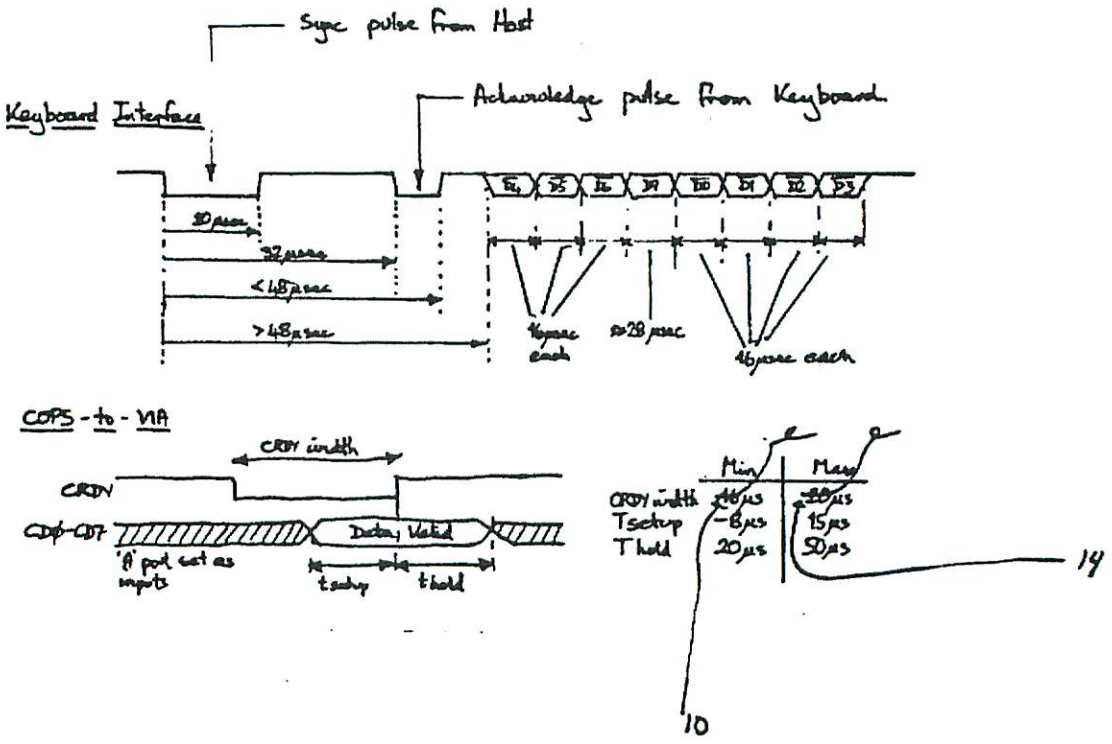


Figure 6-13. Keyboard Data Format and Timing

PB1-PB3 are used for output of a digital value to control the speaker volume.

PB4 is used to input the floppy-disk interrupt (FDIR) status, which has been latched by the floppy-disk processor in the LS259 at B-1 on sheet 4.

PB5 is used to sense the PRES/ reset, derived from the CRES/ bus signal at C-3. The CRES/ signal is pulled low by RESET/ to reset the parallel device. PB5 can be used to reset a parity error on the parallel interface at D-3 on sheet 3.

PB6 is used for the COPS handshake as described above.

PB7 is used to output the CRES/ reset signal to the parallel port interface at pin 117 of the J1 connector.

6.7 Miscellaneous Logic

The I/O board contains several blocks of logic, which have been located there for optimal use of board space within the Lisa.

This section describes the hardware implementation of the following functions:

* Speaker volume control
* Battery power control
* Video contrast latch.

6.7.1 Speaker Volume Control

The Lisa is equipped with a speaker; its volume can be controlled by the software. The value of the volume is presented by the PB1-PB3 lines of the Keyboard 6522, and these are input to the D-to-A ladder network shown at C-4 on sheet 5.

The resulting analog value is presented as a voltage to pin 1Ø of device U1ØA. This operates as a voltage follower to present a high input impedance to the D-to-A ladder network.

The resulting output defines the speaker level, while the TONE output from the 6522 defines the frequency. The output signal is presented to pin 13 of A1Ø, which drives the power transistors Q3 and Q4

Keyboard 6522 PA Port 7654 321Ø	Function
ØØØØ ØØØØ	Turn I/O port on
ØØØØ ØØØ1	Turn I/O port off
ØØØØ ØØ1Ø	Read Clock Data
ØØØ1 nnnn	Write nnnn to clock
ØØ1Ø spmm	Set Clock Modes, where: s=enable (1) or disable (Ø) clock set mode p=power on (1) or off (Ø) mm = ØØ Clock/Timer Disable Ø1 Timer Disable 1Ø Timer Underflow Interrupt 11 Timer Underflow Power-On
Ø1Ø1 nnnn	Set NMI character high nibble to nnnn
Ø11Ø nnnn	Set NMI character low nibble to nnnn
1xxx xxxx	No operation

Figure 2-14. Keyboard COPS Commands

Note that, in addition to the keyboard and mouse, several other peripherals are interfaced to the Lisa via the keyboard 6522. These are:

* Two parallel-port lines
* Three volume-control lines
* Speaker tone line
* Floppy-disk interrupt.

The COPS receives power from the backup supply. This voltage is available at all times, whether the Lisa is powered down or even unplugged. The only time the COPS ceases functioning is if the battery is allowed to run down by having the Lisa unplugged over a long period.

This means that the COPS is always operational. It keeps the time of day and provides software control of the power on and off functions.

Keyboard

The keyboard on the Lisa is a true N-key rollover design. An arbitrary number of keys can be depressed without causing phantom key problems. The key codes returned by the interface are in the form:

drrr@2 nnnn@2

where "d" indicates direction of keystroke (down=1, up=Ø), and "rrr" and "nnnn" are given in Figure 2-15.

Figure 2-15. Lisa Keyboard Codes

Replaces fig 2-15 on p. 2-30

Keycodes

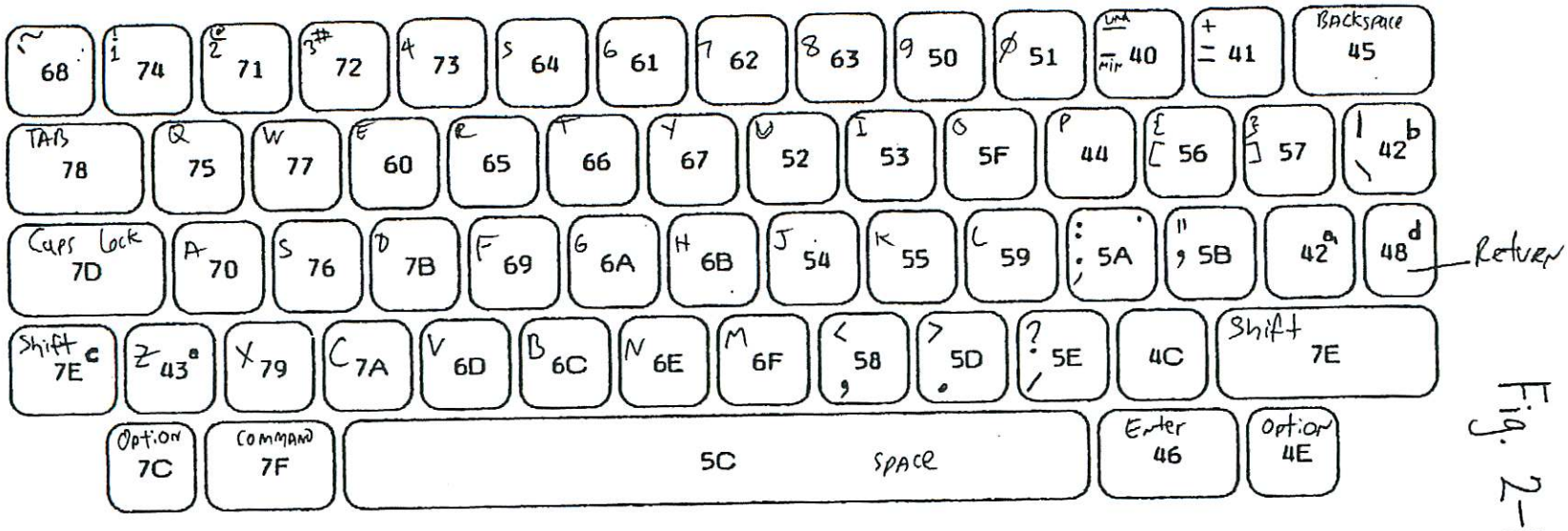
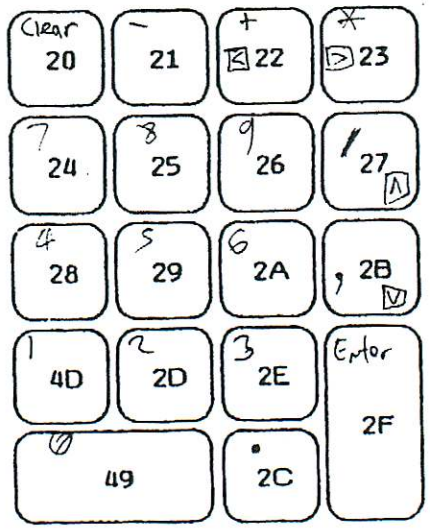


Fig. 2-15 : Keyboard Codes

All keycodes are in hexadecimal, with the following format in binary:

drrr nnnn

d=0, upcode
d=1, downcode
rrrnnnn=above keynumber



Notes:

a. Not on US layout

b. Not on European layout

c. Key 7E is shaped to fill the hole of the unused keys 43 on US layout.

d. Key 48 is shaped to fill the hole of the unused key 42.

Software must interpret such functions as shift and auto-repeat. Any key can be programmed to generate a non-maskable interrupt.

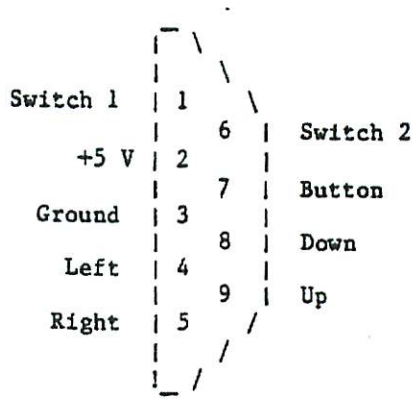
In addition to key information, a number of two-byte sequences that are known as reset codes are produced. Each sequence consists of a reset character, 8Ø@16, followed by a code number. The significance of the code numbers is shown in Figure 2-16.

Reset Code (hexadecimal)	Significance
FF	Keyboard COPS failure detected
FE	I/O Board COPS failure detected
FD	Keyboard unplugged. The reset code of the keyboard identification follows when the keyboard is plugged back in.
FC	Clock timer interrupt
FB	"Soft power off" switch has been depressed
FA) .) .) .) FØ)	Reserved for future use
Ey	Clock data follows. Five bytes are transferred after this. "y" is the year, coded in the reset byte. The other bytes have the format: (8Ø Ey) dd dh hm ms st where ddd is the day, hh the hour, mm the minute, ss the second and t the tenths of a second.
DF) .) .) .) ØØ)	Keyboard ID number. This code is produced whenever the keyboard COPS is reset. At present, the valid codes are:

Single nibble allows a 16 year span: Ø to 15 $Ø to $F

HEX		LAYOUT
KEYTRONICS	APD	
$AD	$2D	French
$AE	$2E	German
$AF	$2F	UK
$BF	$2F	US

Figure 2-16. Keyboard COPS Reset Codes



Note: Switch 2 is connected to CHK on the parallel port.

Figure 3-9. Mouse Interface Pin Assignment

3.5.4 The Keyboard Interface

The keyboard interface consists of a 1/4 inch stereo phone jack connector. It is defined as follows:

Ring	Data
Shield	Ground
Tip	+5 V

3.5.5 Composite Video Interface

This interface consists of a phone jack at the back of the cabinet. It is available to drive an external CRT monitor.

The signal levels conform to RS17Ø. The horizontal sweep rate is 22,4ØØ Hz and the vertical refresh rate is 6Ø Hz.

CHAPTER 8. USER INTERFACES

The Lisa uses the CRT and a speaker to communicate with the user. The user can communicate with the Lisa by using the mouse and keyboard. In addition, there is a video jack available on the motherboard at the back of the Lisa that supplies a composite video signal and can be used to drive a secondary CRT.

8.1 The CRT

The CRT is controlled by a combination of Lisa software and hardware elements on both the processor and video boards. Refer to section 4.5 and to Chapter 7 for a discussion of the hardware.

8.2 The Keyboard

The 76-key Lisa keyboard is a detachable assembly that contains a full key-set and function keys. It is connected to the Lisa by a standard 1/4 inch stereo phone jack, located above the on-off button on the front of the cabinet. The standard keyboard layout, North American, is shown in Figure 8-1. Appendix H contains all available Lisa keyboard layouts.

8.2.1 Keyboard Logic

The keyboard logic is shown in schematic Ø5Ø-4ØØ1 in Appendix E. It operates under control of the COPS device shown on the schematic at C-1.

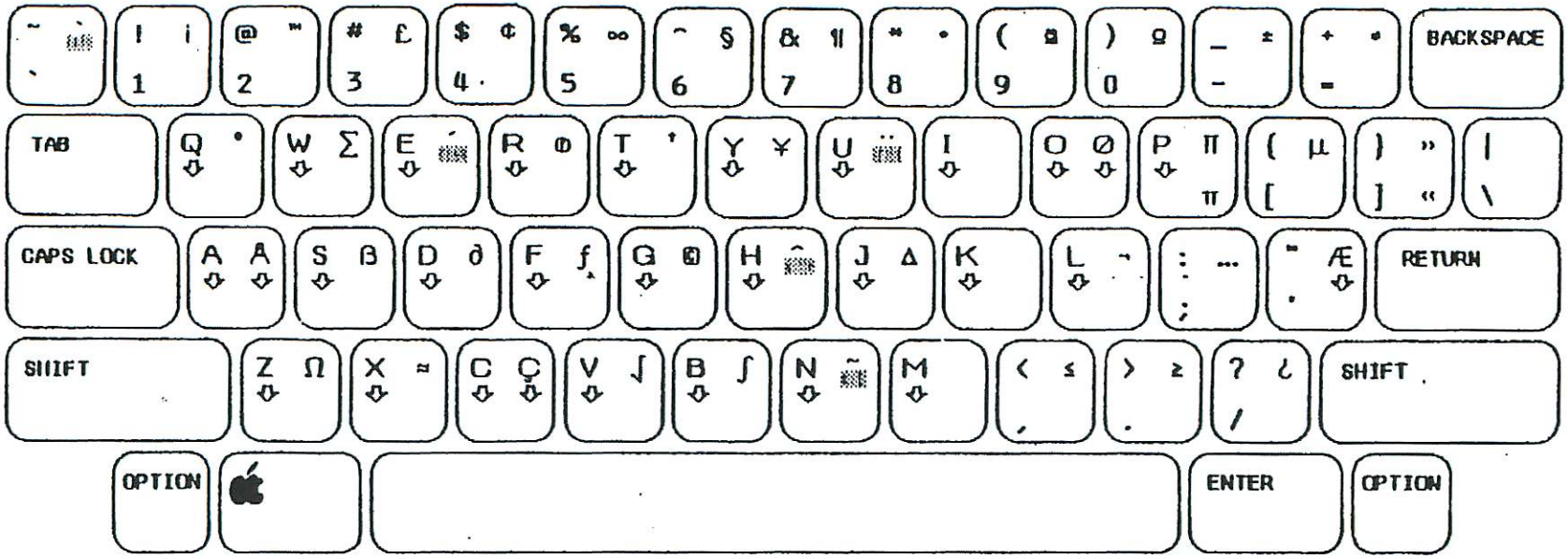
The COPS is identical to that found in the keyboard control logic on the I/O board. Refer to section 6.5 for details of this. The same routines are present in both devices. Only the routines that apply to the location of the device are used.

Figure 8-1. Standard Keyboard Layout

The keys interface to five 4Ø67 16-to-1 multiplexer devices. The COPS polls these in an upper and lower bank by means of the SK signal and the LSØ3 gate at C-2. The configuration of the COPS DØ-D3 outputs defines which of the sixteen switches attached to each device is being selected.

US NEW Keyboard Layout

TN / 8 NOV, 82



LEGEND

- Left
- Right
- Up
- Down
- Dead key, no character is generated until next key is pressed.
- Character has lower case and is affected by Caps Lock.

OPTION Selects Alternate Keyboard

Left: Primary keyboard | Right: Alternate keyboard

Upper: Shifted

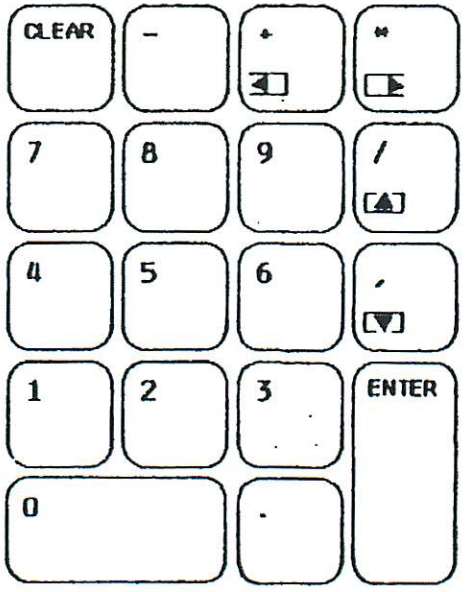
Lower: Unshifted

Boldface indicates that the character is printed on the keytop.

When no character is shown in the lower area of the keytop, one of the following is true:

a. If the symbol ⇩ is shown, the lower character is the lower case equivalent of the upper character.

b. If the symbol ⇩ is not shown, the lower character is the same as the upper character.



The state of the switches in the bank of 4Ø67 devices is presented to the COPS on the three lines G1-G3. The lower bank uses all three but the upper bank uses only G2 and G3.

Key data are passed to the Lisa in serial form from the SØ output of the COPS via the LSØ3 gates at B-1 and pin 1 of the Molex connector. Synchronization pulses from the Lisa are also input to the keyboard on pin 1 and passed to the GØ input of the COPS via the final LSØ3 gate at B-1.

8.2.2 Keyboard Timing

Transfer of data from the keyboard to the Lisa is performed when the keyboard controller initiates it. This is shown in Figure 6-13. The keycodes are discussed in section 2.4.5.

Data transfer is initiated when the keyboard-data line is pulled low by the Lisa for approximately 2Ø microseconds. The keyboard COPS senses the leading and trailing edges of this SYNC pulse and transmits an ACK pulse to indicate to the keyboard controller that data are about to be transferred.

A data byte that specifies the key is transferred in a lower and upper nibble as shown in Figure 8-2. The byte is interpreted as a key and a polarity, up or down, by the keyboard controller.

If no data are present in the keyboard COPS, no ACK pulse is sent. The interface becomes quiescent until the next SYNC pulse.

8.2.3 Keyboard Interface

The keyboard interface to the Lisa consists of a 3-wire shielded cable which is terminated by a 3-pin Molex connector attached to the keyboard PCB at one end and a standard 1/4 inch stereo phone jack plug at the other. This arrangement is shown in Figure 8-2.

Figure 8-2. Keyboard Interface

8.3 The Mouse

The mouse is an electromechanical device that provides communication with the Lisa software in addition to the keyboard. It consists of a rolling ball arrangement on the under side and a plastic cover with a button on the top. A cable connects the mouse with the 9-pin DB connector in the center of the motherboard at the back of the Lisa.

The specific functions of the mouse depend on the software currently running. However, the two controls on the mouse provide the same general function in all cases:

* Rolling the mouse around a flat surface moves a cursor around the screen, and

* Pressing the button on top of the mouse selects the item or software function at the cursor location.

8.3.1 Internal Components

The internal components of the mouse consist basically of a switch and two directional wheels. One directional wheel detects motion forward and

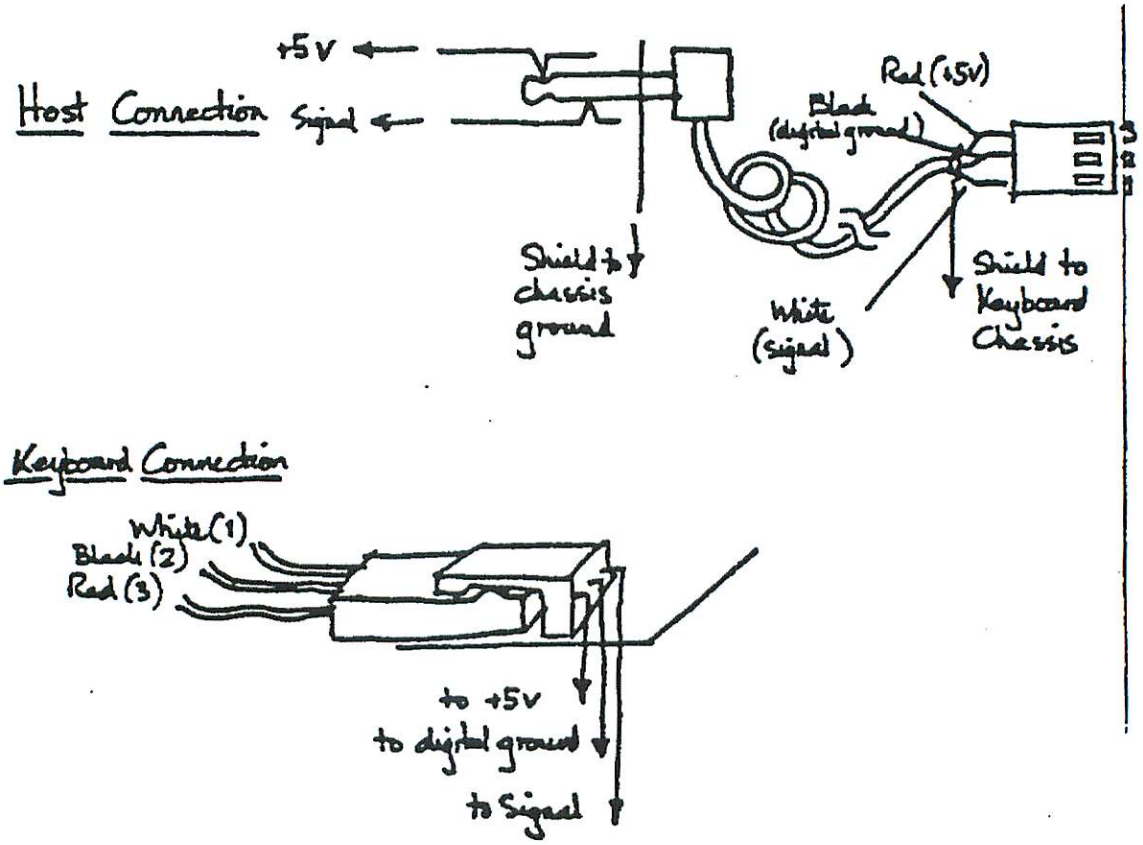


Figure 8-2. Keyboard Interface