B.1   GENERAL DESCRIPTION

The LK201 keyboard has 105 concave-surfaced keys that are divided
into   four   groups: typing   keys,   numeric keypad for data entry,
screen/cursor   control   keys for editing, and special programmable
command/function keys supported by an enclosed printed circuit
board.   Four   LEDs   indicate   when   a   specific   function   is   in
operation.   A 1.9 m (6 ft) coiled cable connects the keyboard to a
dedicated   4-pin   MICRO-DIN connector on the monitor's rear panel.
Figure B-1 shows the LK201 keyboard.

The   keyboard   is   the   user   interface   to the system. It detects
keystrokes,   encodes   them,   and   transmits the information to the
central processor. The keyboard also receives information from the
central processor.

Communication   between   the   keyboard and the central processor in
the   BA23   or BA123 enclosure is full-duplex, serial asynchronous,
at   a   speed   of 4800 baud. The communication lines conform to EIA
Standard RS-423, which applies to unbalanced voltage interfaces.

B.2   PHYSICAL DESCRIPTION

The   keyboard   used   with   the   MicroVAX   workstation has 105 keys
arranged in the following four groups. (See Figure B-1.)

- Main keypad (57 keys)
- Numeric keypad (18 keys)
- Special function keypad (20 keys)
- Editing keypad (10 keys)

The   keycaps can be installed manually, but require a special tool
for removal.

The   keyboard circuitry is contained in a low-profile cabinet with
a nominal height of 30 mm (1.2 in) from table top to home row. The
keyboard   case is made of two plastic shells that can be separated
with   a   screwdriver.   Nonslip   plastic   strips   along   the bottom
prevent   the keyboard from sliding on a table top. Two feet can be
manually   inserted   into   holes   to   raise   the   back   edge   of   the
keyboard.

SPECIAL
FUNCTION
KEYPAD

WINDOW

NUMERIC
KEYPAD

EDITING
KEYPAD

LEDS

MAIN
KEYPAD

TOP VIEW

J4

CABLE
SLOT

BOTTOM VIEW
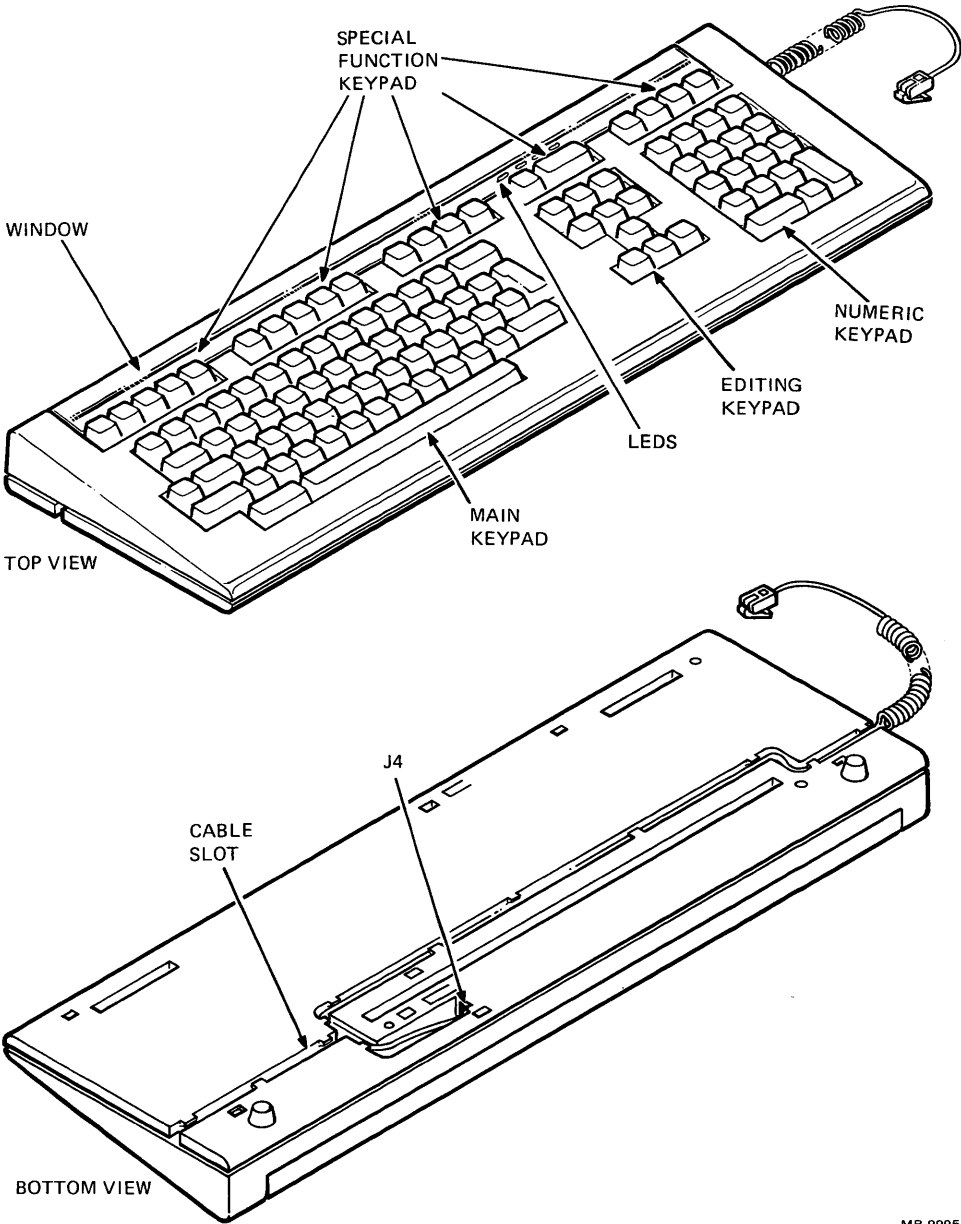
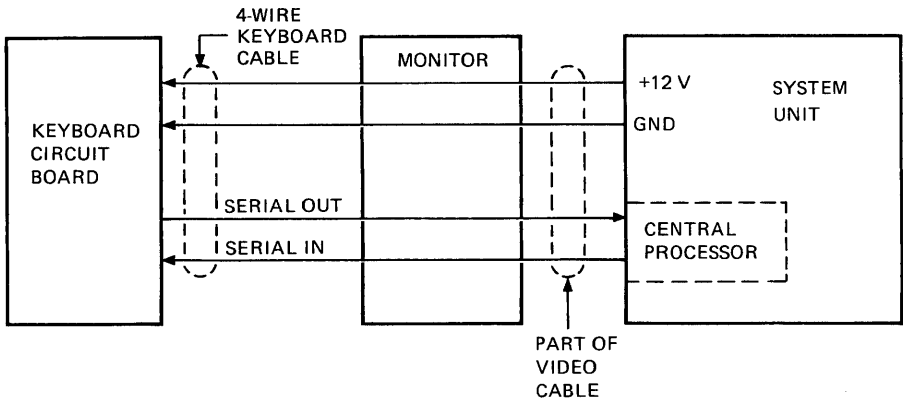MR-9995

Figure B-1   LK201 Keyboard

A plastic window along the top edge above the special function keys can be lifted to insert a keyboard label strip. The label, a thin paper strip, fits into the indented space and varies according to the application program.

Four LEDs are located beneath the plastic window: hold screen, lock, compose, and wait.

A coiled cable (PN BCC01), with a 4-pin modular connector on each end, connects the keyboard to the video monitor. The keyboard transmits four types of signals to the monitor that pass unchanged via the video cable to the system enclosure as shown in Figure B-2. The four signals are

- +12 V power to keyboard
- Ground to keyboard
- Serial Out (transmit line from keyboard)
- Serial In (receive line to keyboard).

The cable can be placed into a channel in the bottom case, and the modular-type telephone connector fits into the jack, J4. The cable can be inserted into the channel at either side of the keyboard.

Figure B-2   Keyboard Cable Connections

B.3   BLOCK DIAGRAM DESCRIPTION

Figure B-3 is a simplified block diagram of the keyboard circuitry. All diagram blocks except the block marked "keyboard matrix" are on the printed circuit board. This block represents the connections between the keyboard switches and the signals from the 8051 microprocessor.

The firmware in the 8051 8-bit microprocessor controls the following three major keyboard operations at the same time.

  1.   Scans the keyboard to detect changes in the keyboard matrix.

  2.   Transmits the results of the keyboard scan to the system's central processor.

  3.   Receives information from the system's central processor.

B.3.1   Keyboard Scanning

The keyboard switches are connected at the intersections of an 18 X 8 line matrix. This provides a fixed-position identifier for each key.

The firmware scans the 18-line axis and detects a depressed or newly released key by reading the 8-line axis. The firmware then verifies the detected keystroke and changes this positional information into an 8-bit code that is unique to that key.

B.3.2   Control of Audio Transducer and Indicators

Two circuits control the audio transducer and the indicators. One circuit receives its inputs from the 8051 microprocessor and controls the transducer (beeper). A long beep represents the bell, a short beep represents the keyclick.

A separate circuit, controlled by a signal from the 8051 microprocessor, controls each of the four indicators. The firmware, responding to commands received from the system's central processor, turns the indicators on or off.

B.3.3   Keyboard Firmware Functions

This paragraph describes the keyboard firmware functions. The functions are divided into two categories: those that cannot be changed by instructions from the system's central processor, and those that can.

B.3.3.1   Functions Not Changed by the System's Central Processor

Instructions -- The following functions cannot be changed by instructions from the system's central processor.

  ●   Power-up test
  ●   Keycodes
  ●   Special codes
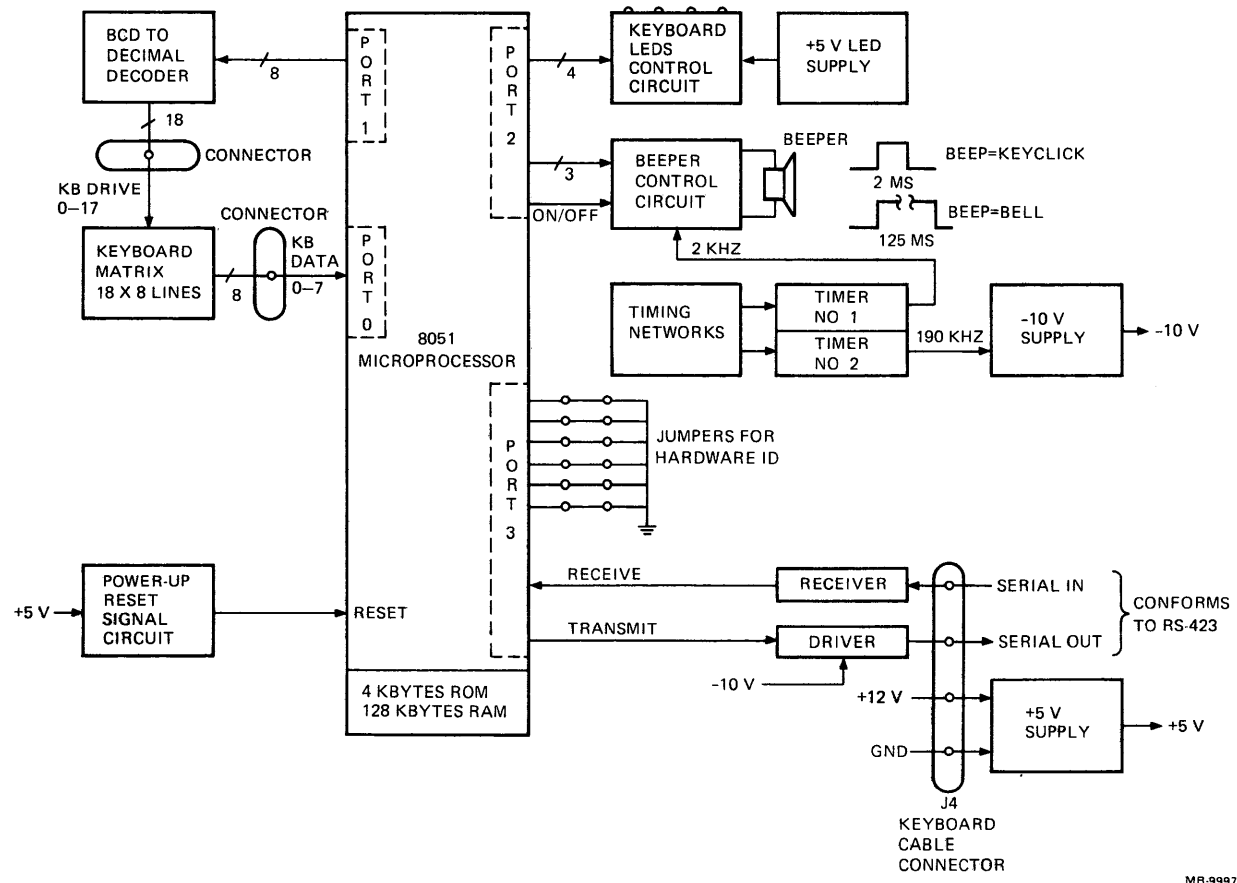
MR-9997

Figure B-3   LK201 Keyboard Circuitry,
Simplified Block Diagram

Power-Up Test
Upon power-up, the firmware performs a self-test in less than 70 ms. The test results are transmitted to the system's central processor in four bytes.

The keyboard indicators are lit during the self-test. The indicators blink once during the self-test routine. The indicators go off if the test is passed, but remain lit if the test fails. The system module can also request self-test at any time.

Keycodes
The keycodes represent fixed positions in the key switch matrix. The key associated with a particular matrix position is always represented by the same keycode.

Special Codes
Thirteen special codes are transmitted by the keyboard. Four codes transmit the results of the power-up self-test. The other nine codes are status indicators or command acknowledgements.

B.3.3.2   Functions Changed by the System's Central Processor Instructions -- The system's central processor can issue instructions to change some keyboard transmission characteristics and to control the keyboard indicators and beeper.

Upon completion of a successful power-up self-test, the firmware sets certain functions to predetermined conditions. These are referred to as "default" conditions. The conditions can be changed, but they always come up to the default condition after a successful power-up self-test.

B.3.3.3   Firmware Functions That Can Be Changed -- Certain firmware functions can be changed by commands (instructions) from the system's central processor. These commands are categorized as "transmission" commands and "peripheral" commands. Transmission commands include a mode set command and an auto-repeat rate set command. Peripheral commands include a variety of commands.

B.4   DETAILED KEYBOARD CIRCUIT DESCRIPTION
The following section describes the keyboard circuitry shown in Figure B-3.

B.4.1   Keyboard Matrix Scanning
The key locations are arranged in an 18 X 8 line matrix. Each key switch is connected across a matrix intersection. This gives a fixed position for each key connected in the matrix. This matrix accommodates all 105 keys in the LK201 keyboard.

Figure B-4 is a simplified block diagram of the matrix scanning circuit. Eight lines from port 1 of the 8051 microprocessor go to the binary-coded decimal (BCD) inputs of two 74LS145 BCD-to-decimal decoders. Ten outputs from one decoder and eight outputs from the other decoder provide the drive lines for the matrix. These 18 lines are called KB DRIVE 0-17.
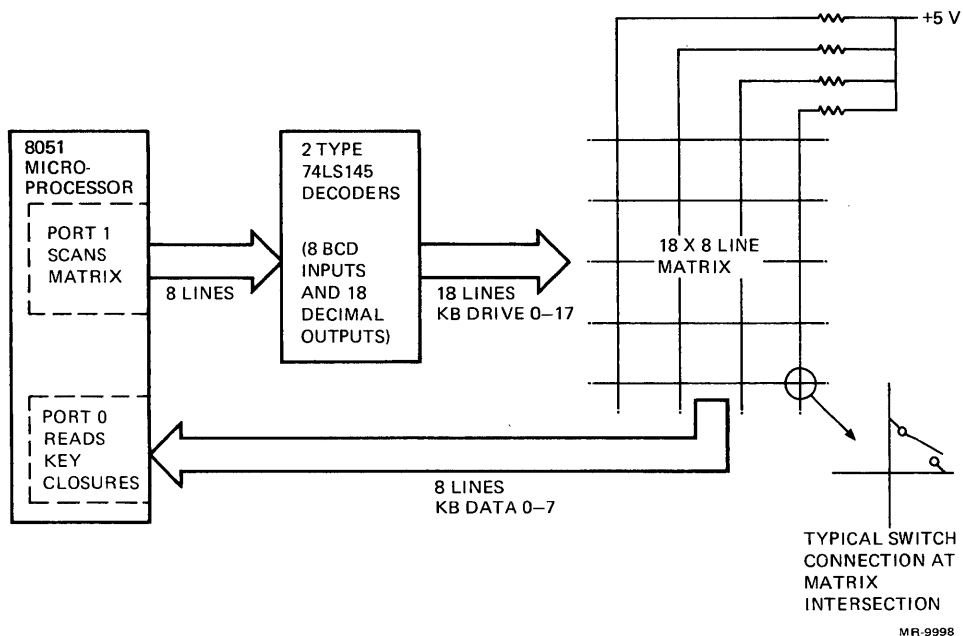
Figure B-4   Matrix Scanning Circuit,
Simplified Block Diagram

The other axis of the matrix consists of eight lines tied to +5 V
through pull-up resistors. These lines go to port 0 of the 8051
microprocessor and are called KB DATA 0-7.

The 8051 microprocessor scans the 18 drive lines. Key closures are
detected by reading the eight data lines. The complete matrix is
scanned every 8.33 ms. When a key closure is detected, it is
scanned again to verify that it is a key closure and not
electrical noise. Once the key closure is verified, the 8051
microprocessor firmware translates the position information into a
keycode, and transmits it to the system's central processor.
Transmission is handled by the universal asynchronous
receiver/transmitter (UART) in the 8051 microprocessor.

A "sneak path" or "ghost key" indication can occur when three of the four corners of a matrix rectangle are closed, as shown in Figure B-5. The key positions in the matrix are arranged to avoid sneak paths. However, if a sneak path does occur, the firmware prevents the keycode for the key (that caused the sneak path) to be transmitted until one of the involved keys is released. This prevents transmission of ghost keys entirely.

Table B-1 shows the keyboard matrix on the LK201-AA (U.S.A.) keyboard. Keycap designations are shown for reference only and can be compared to Figure B-6.
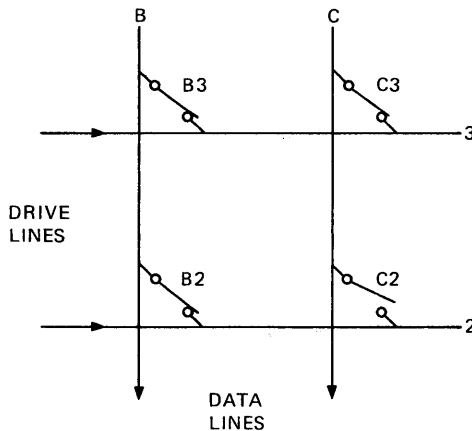
NOTES:

1. CONDITIONS ARE: SWITCHES B2, B3, AND C3 CLOSED, SWITCH C2 OPEN; LINE 2 IS BEING DRIVEN, AND LINE C IS BEING READ.

2. INTERSECTION C2 IS BEING LOOKED AT. IT SHOULD NOT SHOW A KEY CLOSURE BECAUSE SWITCH C2 IS OPEN.

3. HOWEVER, A SNEAK PATH IS PRESENT FROM LINE 2 THROUGH SWITCHES B2, B3, AND C3 TO LINE C. A GHOST KEY IS READ AT INTERSECTION C2.

MR-9999

Figure B-5   Example of Ghost Key Generation

Table B-1   Keyboard Matrix (LK201-AA)

KB Drive	KB Data 7	6	5	4	3	2	1	0
17	Reserved	F19 G22	Reserved	F20 G23	PF4 E23 |	N--- D23	N, (Note 1) C23	Enter A23
16	F18 G21	PF3 E22	Reserved	N9 D22	V B17	N6 C22	N3 B22	N A22
15	F17 G20	PF2 E21	Reserved	N8 D21	N5 C21	-> B18	N2 B21	N0 (Note 2)
14	PF1 E20	Next Screen D18	Remove E18	^ | C17	N7 D20	N4 C20	N1 B20	N0 A20
13	Insert Here E17	--- − E11	DO G16	Prev Screen D17	{ [D11	" ' C11	Reserved	Reserved
12	Find E16	+ = E12	Help G15	Select D16	}] D12	Return C13	<- B16	C12
11	Addtnl Options G14	<X| (delete) E13	Reserved	) 0 E10	P D10	(Note 3)	: ; C10	? / B10
10	Reserved	F12 (BS) G12	Reserved	F13 (LF) G13	(9 E09	O D09	L C09	. B09
9	Reserved	F11 (ESC) G11	Reserved	Reserved	* 8 E08	I D08	K C08	' , B08
8	Reserved	Main Screen G08	Reserved	Exit G09	& 7 E07	U D07	J C07	M B07

Table B-1   Keyboard Matrix (LK201-AA) (Cont)

KB Drive	KB Data 7	6	5	4	3	2	1	0
7	Reserved	Cancel G07	Reserved	Resume G06	^ 6 E06	Y D06	H C06	N B06
6	Reserved	Reserved	Reserved	Inter- rupt G05	% 5 E05	T D05	G C05	B B05
5	F4 G02	Break G03	Reserved	$ 4 E04	R D04	F C04	V B04	SPACE A01- A09
4	Reserved	Print Screen G00	Reserved	Set-Up G01	# 3 E03	E D03	D C03	C B03
3	Hold Screen G99	@ 2 E02	Reserved	Tab D00	W D02	S C02	X B02	> < B00
2	Reserved	Reserved	Reserved	~ E00	! 1 E01	Q D01	A C01	Z B01
1	Ctrl C99	Lock C00	Compose A99	Reserved				
0	Shift B99,B11							

NOTES:

1. Note that N0--N9, N---, N, and N. refer to the numeric keypad.

2. N0 of the numeric keypad can be divided into two keys.
   Normally only the N0 keyswitch is implemented as a double-size key.

3. The Return key occupies two positions that are decoded as the
   Return (C13) key.
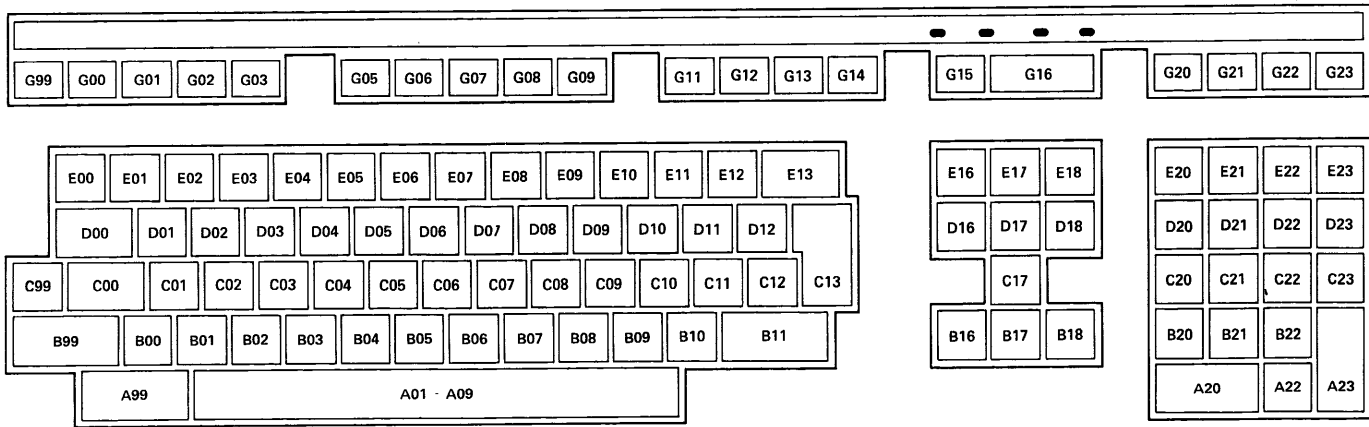
Figure B-6   LK201 Keyboard Layout

LJ-0059

B.4.2   Audio Transducer Control Circuit

Figure B-7 shows the audio transducer, or beeper, control circuit. The beeper is driven by a transistor whose base is connected to a 2 kHz square wave from a 556 timer IC. This signal is biased by a network of four type 74LS05 open collector inverters. The 8051 microprocessor controls all four inverters via the firmware. The on/off inverter connects directly to the transistor base. When the 8051 microprocessor puts a high on the on/off inverter input, its output goes low and removes the 2 kHz square wave from the transistor base. This cuts off the transistor and disables the beeper.

To turn on the beeper, the 8051 microprocessor puts a low on the on/off inverter input. Its output goes high and allows the 2 kHz signal to reach the transistor base. This turns on the beeper. The firmware generates a keyclick (on for 2 ms) or a bell tone (on for 125 ms). The 8051 microprocessor sets up the three level control inverters by putting one of eight binary combinations on the inverter inputs. All highs give the softest sound, all lows give the loudest sound.
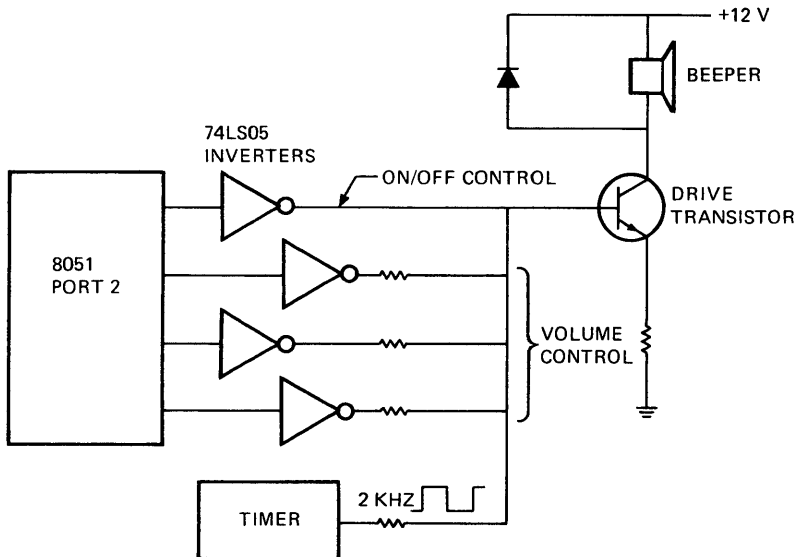
Figure B-7   Audio Transducer (Beeper) Control Circuit

The firmware controls the keyclick and the bell tone independently. The bell tone is sounded only upon request from the system's control processor. The keyclick is sounded (unless disabled) under the following conditions.

1. When a key is pressed.

2. When a metronome code is sent.

3. When a command to sound the keyclick is received from the system's control processor.

B.4.3   Indicator (LED) Control Circuit
Figure B-8 shows the LED indicator control circuit. The control signal for each LED goes from port 2 of the 8051 microprocessor to the input of a type 74LS05 open collector inverter. The inverter output goes to the LED cathode; its anode is connected to +5 V. A separate +5 V source relieves the LED's load on the main +5 V supply.

A low signal from the 8051 microprocessor drives the inverter output high, which cuts off the LED. A high signal from the 8051 drives the inverter output low. This provides a path to ground from the +5 V through the LED. The LED then turns on.
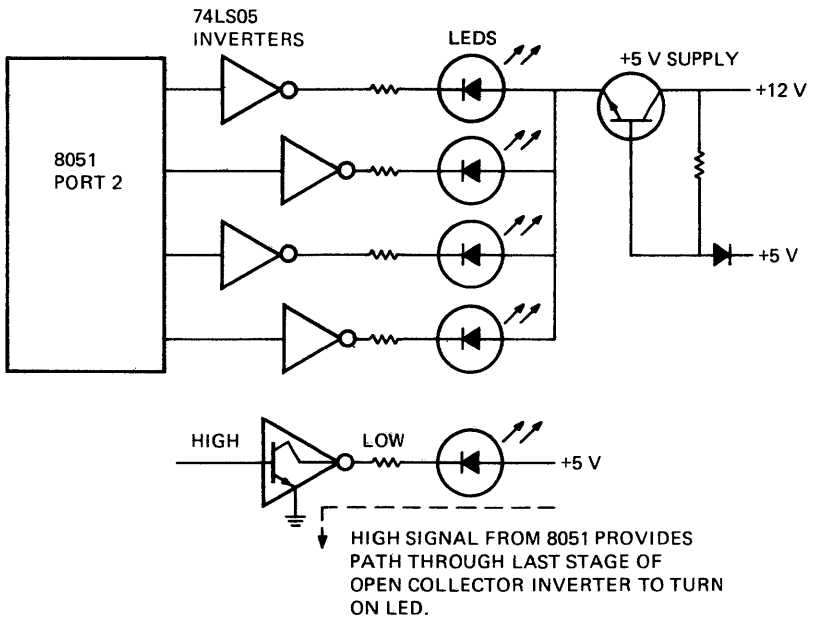
Figure B-8   Indicator (LED) Control Circuit

B.4.4   Keyboard Communication

B.4.4.1   Keyboard Transmit Mode -- The keyboard codes and a few
other special codes are transmitted via a serial line output in
port 3 of the 8051 microprocessor. The transmitted signal goes
from the 8051 microprocessor to a driver, through the keyboard
cable, monitor, and video cable to the system's central processor.
A UART within the 8051 controls the transmission.

Transmitted characters conform to a specific format. Each
character is 10 bits long. The first bit is the START bit. It is
always a logical 0 (space). The next eight bits represent the
encoded data. The last bit is the STOP bit. It is always a logical
1 (mark). Figure B-9 shows the character format.
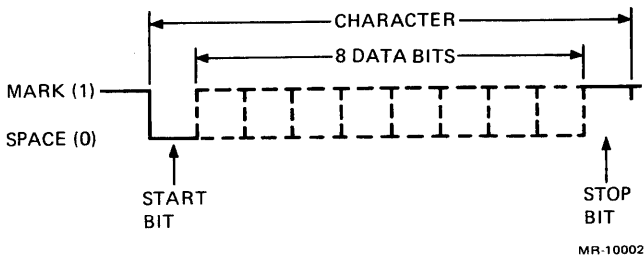
Figure B-9   Keyboard Transmit and Receive Character Format

B.4.4.2   Keyboard Receive Mode -- The firmware contains features
that can be enabled by commands from the system's central
processor. There are two categories of features: one sets keyboard
transmission characteristics, the other controls the keyboard
peripherals. A peripheral command covers indicator control, bell
and keyclick volume, keyboard ID code, and reinstate keyboard. The
commands come from the system's central processor, through the
video cable, monitor, and keyboard cable to the receiver, and into
the 8051 microprocessor via port 3. They go to the UART in the
8051.

Received characters conform to the same 10-bit format used for
transmitted characters. The eight data bits are arranged in a
specified protocol depending on the command type.

B.4.5   Reset Signal for the 8051 Microprocessor

Whenever the system is turned on, the 8051 microprocessor in the keyboard must be reset. This allows the 8051 to start operating.

The reset signal generator is active only during power-up. The input is +5 V. The output is connected to the reset input of the 8051. When power is turned on, the +5 voltage starts to rise from zero. The reset signal circuit output follows it, and drops off when a steady state of +5 V is reached. This circuit holds the 8051 reset input high (+3.5 V to +5 V) long enough to enable the reset action in the 8051. This action occurs only during power-up.

B.4.6   Hardware Keyboard Identification (ID)

At power-up, the keyboard performs a self-test and sends the results to the system's central processor. One piece of information to be sent is the keyboard hardware ID, which is read from hardwired jumpers.

There are six jumpers. Each jumper line goes from an input in port 3 of the 8051 microprocessor to ground. All jumpers are installed so the keyboard hardware ID is zero.

B.4.7   Voltage Supplies

The only voltage sent to the keyboard is +12 V. However, +5 V and −10 V are also needed. These voltages are derived from the +12 V.

A +5 V supply handles most of the requirements for this voltage. The four keyboard LEDs have their own +5 V supply. A −10 V supply provides voltage for the driver in the serial out line.

B.5   KEYBOARD PROGRAMMING

This section describes the functions the keyboard performs under system central processor control. It also describes keyboard programming machine language. High-level user programming is not described here.

B.5.1   Keyboard Layout and Key Identification

Each keyboard key has a unique location. Each location is scanned, and when closure or release is detected, the location is verified. This is then decoded to an 8-bit keycode. Figure B-6 shows the keyswitch locations. Table B-2 lists the 14 functional divisions of the keyboard. Table B-3 lists the divisions, keycaps, and keycodes.

Table B-2   **Keyboard Functional Divisions**

Division	Description	Representation
1	48 graphic keys, spacebar	0001
2	Numeric keypad	0010
3	Delete character (E12)	0011
4	Return (C13) Tab (D00)	0100
5	Lock (C00) Compose (A99)	0101
6	Shift (B99 and B11), Ctrl (C99)	0110
7	Horizontal cursors (B16 and B18)	0111
8	Vertical cursors (B17 and C17)	1000
9	Six keys directly above the cursor keys (D16-D18 and E16-E18)	1001
10	Function keys (G99-G03)	1010
11	Function keys (G05-G09)	1011
12	Function keys (G11-G14)	1100
13	Function keys (G15-G16)	1101
14	Function keys (G20-G23)	1110

Table B-3   Keycode Translation Table

Division	Position	Keycap*	Keycode** (decimal)	Keycode (hexadecimal)
FUNCTION KEYS				
10	G99	Hold Screen	086	56
	G00	Print Screen	087	57
	G01	Set-Up	088	58
	G02	F4	089	59
	G03	Break	090	5A
		Reserved	091-098	5B-62
11		Reserved	099	63
	G05	Interrupt	100	64
	G06	Resume	101	65
	G07	Cancel	102	66
	G08	Main Screen	103	67
	G09	Exit	104	68
		Reserved	105-110	69-6E
12			111	6F
		Reserved	112	70
	G11	F11 (ESC)	113	71
	G12	F12 (BS)	114	72
	G13	F13 (LF)	115	73
	G14	Addtnl Options	116	74
		Reserved	117-122	75-7A
13		Reserved	123	7B
	G15	Help	124	7C
	G16	Do	125	7D
14		Reserved	126-127	7E-7F
	G20	F17	128	80
	G21	F18	129	81
	G22	F19	130	82
	G23	F20	131	83
		Reserved	132-135	84-87
BASIC EDITING KEYS				
9		Reserved	136-137	88-89
	E16	Find	138	8A
	E17	Insert Here	139	8B
	E18	Remove	140	8C
	D16	Select	141	8D
	D17	Prev Screen	142	8E
	D18	Next Screen	143	8F
		Reserved	144	90

Table B-3   Keycode Translation Table (Cont)

Division	Position	Keycap*	Keycode** (decimal)	Keycode (hexadecimal)
NUMERIC KEYPAD				
2		Reserved	145	91
	A20	0	146	92
		Reserved	147	93
	A22	.	148	94
	A23	Enter	149	95
	B20	1	150	96
	B21	2	151	97
	B22	3	152	98
	C20	4	153	99
	C21	5	154	9A
	C22	6	155	9B
	C23	,	156	9C
	D20	7	157	9D
	D21	8	158	9E
	D22	9	159	9F
	D23	–	160	A0
	E20	PF1	161	A1
	E21	PF2	162	A2
	E22	PF3	163	A3
	E23	PF4	164	A4
		Reserved	165	A5
CURSOR KEYS				
7		Reserved	166	A6
	B16	Left	167	A7
	B18	Right	168	A8
8	B17	Down	169	A9
	C17	Up	170	AA
		Reserved	171-172	AB-AC
SHIFT, LOCK, CTRL, A99, and A10				
6		Reserved	173	AD
	B99,B11	Shift	174	AE
	C99	Ctrl	175	AF
5	C00	Lock	176	B0
	A99	Compose	177	B1
		Reserved	178	B2

Table B-3   Keycode Translation Table (Cont)

Division	Position	Keycap*	Keycode** (decimal)	Keycode (hexadecimal)
SPECIAL CODES				
		All Ups	179	B3
		Metronome	180	B4
		Output Error	181	B5
		Input Error	182	B6
		KBD LOCKED Acknowledge	183	B7
		TEST MODE Acknowledge	184	B8
		PREFIX to keys Down	185	B9
		MODE CHANGE Acknowledge	186	BA
		Reserved	187	BB
DELETE				
3	E13	Delete <X|	188	BC
RETURN and TAB				
4	C13	Return	189	BD
	D00	Tab	190	BE
48 GRAPHICS KEYS and SPACEBAR				
2	E00	~	191	BF
	E01	!1	192	D0
	D01	Q	193	C1
	C01	A	194	C2
	B01	Z	195	C3
		Reserved	196	C4
	E02	@2	197	C5
	D02	W	198	C6
	C02	S	199	C7
	B02	X	200	C8
	B00	><	201	C9
		Reserved	202	CA
	E03	#3	203	CB
	D03	E	204	CC
	C03	D	205	CD
	B03	C	206	CE
		Reserved	207	CF

Table B-3   Keycode Translation Table (Cont)

Division	Position	Keycap*	Keycode** (decimal)	Keycode (hexadecimal)
	E04	$4	208	D0
	D04	R	209	D1
	C04	F	210	D2
	C04	V	211	D3
	A01-A09	Space	212	D4
		Reserved	213	D5
	E05	%5	214	D6
	D05	T	215	D7
	C05	G	216	D8
	B05	B	217	D9
		Reserved	218	DA
	E06	^6	219	DB
	D06	Y	220	DC
	C06	H	221	DD
	B06	N	222	DE
1		Reserved	223	DF
	E07	&7	224	E0
	D07	U	225	E1
	C07	J	226	E2
	B07	M	227	E3
		Reserved	228	E4
	C08	*8	229	E5
	D08	I	230	E6
	C08	K	231	E7
	B08	"	232	E8
		Reserved	233	E9
	E09	(9	234	EA
	D09	O	235	EB
	C09	L	236	EC
	B09	. .	237	ED
		Reserved	238	EE
	E10	)0	239	EF
	D10	P	240	F0
		Reserved	241	F1
	C10	: ;	242	F2
	B10	? /	243	F3
		Reserved	244	F4
	E12	+ =	245	F5
	D12	}]	246	F6
	C12		\	247	F7
		Reserved	248	F8

Table B-3   Keycode Translation Table (Cont)

Division	Position	Keycap*	Keycode** (decimal)	Keycode (hexadecimal)
	E11	−	249	F9
	D11	ĺ [	250	FA
	C11	, '	251	FB
		Reserved	252-255	FC-FF

NOTES:

*   The legends under Keycap are taken from the keycap legends of the LK201-AA (U.S.A.).

** Keycodes 000 through 064 are reserved. Keycodes 065 through 085 are unused.

B.5.2   Modes

This section describes the functions of the keycode transmission modes. The mode set command allows any 1 of the 14 keyboard divisions to be set to any 1 of the following 3 modes. (Division defaults are described in subsequent paragraphs.)

1. Down-Only Mode   The keyboard transmits a keycode when the key is pressed.

2. Auto-Repeat Down   The keyboard transmits a keycode when the key is first pressed. If the key is held down past the specified timeout period (usually 300 to 500 ms), a fixed metronome code is sent at the specified rate until the key is released.

3. Down/Up   The keyboard transmits a keycode when the key is pressed and an up code when the key is released. If any other down/up keys are pressed, the up code is a repeat of the down code. If no other down/up keys are pressed, the keyboard sends an ALL UPS code.

B.5.2.1   Special Considerations Regarding Auto-Repeat -- The auto-repeat rate set command allows the following changes in auto-repeat mode:

    1. The auto-repeat rate buffer association can be changed for the selected keyboard division.

    2. The timeout and interval values can be changed in any one of the four auto-repeat rate buffers.

3. If multiple auto-repeating keys are held down, metronome codes are still generated. The metronome codes apply to the keycode transmitted most recently. If the last key pressed down is released, and another key is still down, the keycode of the key still down is retransmitted.

Example: The A key is held down.

This produces the following transmission.

A metronome metronome

Now the B key is pressed. This produces the following transmission.

A metronome metronome B metronome metronome

Now the B key is released. This produces the following transmission.

A metronome metronome B metronome metronome A metronome met.....................

While metronome codes are being generated for an auto-repeating key, a nonauto-repeating keycode or special code may be transmitted. The keyboard transmits this special code instead of the next metronome code, and then returns to the auto-repeated code. The keycode to be auto-repeated is always the last byte transmitted.

Example: The A key is held down.

This produces the following transmission.

A metronome metronome

Now the shift key is pressed. This produces the following transmission.

A metronome metronome shift A metronome

Now the shift key is released. This produces the following transmission.

A metronome metronome shift A metronome ALL UPS A metronome met...........

4. If an auto-repeating key is not to auto-repeat (for example, Ctrl C), the system module must issue a temporary inhibit auto-repeat command. This halts the transmission of any metronome codes or keyclicks for that key only. Metronome codes continue when another key is pressed. The command must be issued after the keycode for the auto-repeating key is received.

5. Auto-repeat can be enabled and disabled independently of the division settings by using the enable/disable auto-repeat commands. These commands apply to all keys on the keyboard. When auto-repeat is disabled, the keyboard continues to auto-repeat characters internally. However, it does not transmit metronome codes or keyclicks. When auto-repeat is enabled, the keyboard transmits the metronome codes from the point where they were before auto-repeat was disabled. This may be within either the timeout or interval period, depending on the time elapsed since the key was pressed.

6. If the keyboard receives a request to change a division mode to auto-repeat while a key is being pressed, the keyboard makes the change immediately. After the specified timeout period, the keyboard transmits metronome codes for the pressed key. In place of the first metronome code, the keyboard transmits the keycode of the auto-repeating key.

All auto-repeating division modes can be changed to down-only with one command. This and other auto-repeat commands are grouped with the peripheral commands.

B.5.2.2   Special Considerations Regarding Down/Up Mode -- If two down/up keys are released simultaneously (within the same scan), and there are no other down/up keys down on the keyboard, only one ALL UPS code is generated.

B.5.2.3   Auto-Repeat Rates -- Four buffers in the keyboard, numbered 0 through 3, store auto-repeat rates. Each buffer stores two values, which can be changed by the system module:

1. Timeout value
2. Interval value.

Timeout is the amount of time the keyboard waits before starting to auto-repeat a character. The timeout value is the amount of time between the detection of a down key and the transmission of the first metronome code. (Defaults range from 300 to 500 ms.) The rate of auto-repeating a character is called the "interval." The interval value is the number of metronome codes per second (defaults to 30).

Each division is associated with one of the four buffers. Rates are taken from the associated buffer each time the auto-repeat timers are loaded. This buffer-to-division association can be changed by the system module or left to default.

B.5.3   Keyboard Peripherals
This section describes the peripherals available on the keyboard. The keyclick, bell, and LEDs are all considered keyboard peripherals.

B.5.3.1   **Audio** -- The keyclick is a 2 ms beep; the bell is a 125 ms beep. The bell is sounded only upon request from the system module. The keyclick (if not disabled by the system module) is sounded when:

1.   A key is pressed
2.   A metronome code is sent
3.   The system module receives a sound keyclick command.

If either the B11 or B99 key (the left or right shift key on the LK201) or the C99 key (the Ctrl key on the LK201) is pressed, the keyclick is not generated. However, if a command is sent from the system module to enable the keyclick on the C99 key, the keyclick is generated. Figure B-6 shows the positions of these keys.

The keyclick or bell (or both) may be disabled not to sound. If the system module requests sound (see Paragraph B.5.5.3), the keyclick or the bell does not sound.

Both the keyclick and bell may be set independently to one of the following eight volume levels:

    000 - highest
    001
    010 - default
    011
    100
    101
    110
    111 - lowest

B.5.3.2 **Indicators (LEDs)** -- The system module normally transmits indicator control commands. However, the following are exceptions.

1.   Upon power-up, the keyboard turns all LEDs off.

2.   After receiving the inhibit transmission command, the keyboard turns on the lock LED. The LED is turned off after the keyboard receives a resume transmission command.

B.5.4   **Keyboard-to-System Module Protocol**
The following paragraphs describe the keyboard-to-system module protocol.

B.5.4.1   **Keycode Transmission** -- The keyboard transmits single-byte keycodes that reflect the keyboard matrix status. The 8-bit codes above 64 (decimal) are used for keycodes. Every key is identified by a unique keycode. There are no special codes for shifted or control keys.

Refer to Figure B-6 and Tables B-1 and B-2 for the complete keycode matrix translation table.

B.5.4.2 **Special Code Transmission** -- There are 13 special codes: 9 codes with values above 64 (decimal) and 4 codes below. Table B-4 lists the nine special codes above the 64 (decimal) keycode value range. Table B-5 lists the four special codes below the 64 (decimal) value range.

Table B-4   Special Codes Above 64 (Decimal)

Special Codes	Keycode (Decimal)	(Hexadecimal)
All Ups	179	B3
Metronome Code	180	B4
Output Error	181	B5
Input Error	182	B6
KBD Locked ACK	183	B7
Test Mode ACK	184	B8
Prefix to Keys Down	185	B9
Mode Change ACK	186	BA
Reserved	127	7F

All Ups -- Indicates to the system module that a down/up mode key was just released and no other down/up keys are being pressed.

Metronome Code -- Indicates to the system module that an interval has passed, a keyclick has been generated, and the last key received by the system module is still being pressed.

Output Error -- Indicates an output buffer overflow to the system module. The overflow occurred after receiving a keyboard inhibit command from the system module and some keystrokes may be lost.

Input Error Code -- Indicates to the system module that the keyboard received a meaningless command, too many, or too few parameters.

Keyboard Locked Acknowledge -- Indicates to the system module that the keyboard received an inhibit transmission command.

Test Mode Acknowledge -- Indicates that the keyboard has entered test mode. This is a special mode used during the production test. If the system module receives this acknowledge, it sends 80 (hexadecimal). This terminates the test mode and jumps to power-up.

Prefix to Keys Down -- Indicates that the next byte is a keycode for a key already down in a division that has been changed to down/up.

Mode Change Acknowledge -- Indicates that the keyboard has received and processed a mode change command.

Reserved -- Keycode 7F is reserved for internal use.

Table B-5   Special Codes Below 64 (Decimal)

Special Codes	Keycode (Decimal)	(Hexadecimal)
Keyboard ID -- Firmware	01	01
Keyboard ID -- Hardware	00	00
Key Down on Power-Up Error Code	61	3D
Power-Up Self-test Error Code	62	3E

Keyboard ID -- This is a 2-byte identification code, transmitted after the power-up self-test (power-up transmission). It is also sent on request from the system module.

Key Down on Power-Up Error Code -- Indicates that a key was pressed on power-up.

Power-Up Self-Test Error Code -- Indicates to the system module that the ROM or RAM self-test of the system module failed.

B.5.4.3   Power-Up Transmission -- Upon power-up, the keyboard performs a self-test in less than 70 ms. It transmits the self-test results to the system module in 4 bytes.

Byte 1: KBID (firmware) -- This is the keyboard identification (ID) that is stored in the firmware.

Byte 2: KBID (hardware) -- This is the keyboard ID that is read from hardware jumpers.

Byte 3: ERROR -- Two error codes indicate either failure of the ROM or RAM self-test within the processor (3E hexadecimal), or key-down on power-up (3D hexadecimal). No error is indicated by 00.

Byte 4: KEYCODE -- This byte contains the first keycode detected if there was a key down on power-up. No error is indicated by 00.

If the ROM self-test (CHECKSUM) fails and the error is fatal, the keyboard is unable to transmit. Nonfatal errors permit the keyboard to continue operation.

If the keyboard finds a key down on the first scan, it continues
to look for an ALL UP condition. The keyboard sends the corrected
4-byte power-up sequence when the pressed key is released. This
avoids a fatal error condition if a key is pressed by mistake
while powering up.

The keyboard LEDs are lit during the power-up self-test. If the
self-test is passed, the keyboard turns the LEDs off. If a bell is
selected on power-up, the system module can transmit a sound bell
command to the keyboard. However, this should not be done until
the system module receives the last byte of the 4-byte sequence.
The request for self-test tests the serial line and system module
connection. The power-up self-test takes 70 ms or less.

The system module can request a jump to power-up at any time. This
causes the LEDs on the keyboard to blink on and off (for the
power-up self-test).

B.5.5   System Module-to-Keyboard Protocol

The system module controls both the peripherals associated with
the keyboard and the keyboard transmit characteristics. Figure
B-10 shows the protocol for the transmission of commands and
parameters from the system module to the keyboard.

COMMAND

07	06	05	04	03	02	01	00

0	REPRESENTATION	MODE OR OFF/ON	TYPE

PARAMETERS

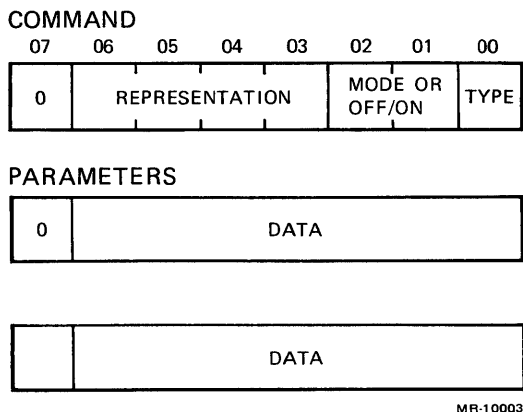| 0	DATA

	DATA

MR-10003

Figure B-10   System Module-to-Keyboard Protocol

Table B-6   Command Types

Transmission Commands	Peripheral Commands
Mode Set	Flow Control
Auto-Repeat Rate Set	Indicator
	Audio
	Keyboard ID
	Reinitiate Keyboard
	Some Auto-Repeat Control
	Jump to Test Mode
	Reinstate Defaults

B.5.5.1   **Commands** -- Table B-6 lists the two kinds of commands: those that control keyboard transmission characteristics, and those that control keyboard peripherals. The low bit of the command is the TYPE flag. It is clear if the command is a transmission command; it is set if the command is a peripheral command.

The high-order bit of every command is the PARAMS flag. If there are any parameters to follow, this flag is clear. If there are no parameters, this flag is set.

B.5.5.2   **Parameters** -- The high-order bit of every parameter is the PARAMS flag. It is clear if there are parameters to follow. It is set on the last parameter. The remaining seven bits of the parameter are for data.

B.5.5.3   **Peripheral Commands** -- Two commands can turn the data flow from the keyboard off and on:

1.   Inhibit Keyboard Transmission -- This command shuts off, or locks, the keyboard and turns on the lock LED. After receiving the inhibit command, the keyboard sends a special command to the system's central processor. If the central processor receives this code without requesting it, this indicates that noise on the line was interpreted as the inhibit command. The central processor then responds immediately with the resume keyboard transmission command.

2.   Resume Keyboard Transmission -- This command turns on, or unlocks, the keyboard and turns off the lock LED. If any keystrokes are lost, the keyboard responds with an error code.

Each keyboard LED can be turned on and off. The following are the
eight commands that control the keyclick and bell sounds.

    1.   Disable Keyclick
    2.   Enable Keyclick and Set Volume
    3.   Disable Ctrl Keyclick
    4.   Enable Ctrl Keyclick
    5.   Sound Keyclick
    6.   Disable Bell
    7.   Enable Bell and Set Volume
    8.   Sound Bell

The following four commands are related to the control of
auto-repeat mode.

    1.   Temporary Auto-Repeat Inhibit -- Auto-repeat is stopped
         for a specific key only. It resumes automatically when
         another key is pressed.

    2.   Enable Auto-Repeat Across the Board -- Starts transmission
         of metronome codes without affecting auto-repeat timing or
         keyboard division.

    3.   Disable Auto-Repeat Across the Board -- Stops transmission
         of metronome codes without affecting auto-repeat timing or
         keyboard division.

    4.   Change All Auto-Repeat to Down-Only -- Changes all
         keyboard auto-repeating divisions to down-only mode.

The following are three other miscellaneous commands.

    1.   Request Keyboard ID -- The keyboard sends the 2-byte ID
         (firmware and hardware). The keyboard does not jump to the
         power-up sequence.

    2.   Reinitiate Keyboard -- The keyboard jumps to the power-up
         sequence. Transmission to the keyboard should be held
         until the host processor receives the last byte of the
         power-up self-test.

    3.   Reinstate Defaults -- Sets the following functions back to
         the default settings after a successful completion of the
         power-up self-test.

         Division mode settings
         Auto-repeat interval and timeout rates
         Auto-repeat buffer selections
         Audio volume
         Ctrl key keyclick

To send a peripheral command, set the TYPE flag (low-order bit).
Bits 6-3 contain a command representation from the table below.
Bits 2 and 1 specify on (01), off (00), or sound (11). Bit 7
should be set if there are no parameters to follow.

Table B-7 lists the peripheral commands (in hexadecimal) and Table B-8 indicates the representation for each command function.

The jump to power-up command is FD (hexadecimal).

The following are some of the peripheral commands.

1. Flow Control -- The system module can lock the keyboard with the inhibit keyboard transmission command. When the keyboard is unlocked, it responds with an error code if any keystrokes were missed.

Table B-7   Peripheral Commands in Hexadecimal

Function	Hexadecimal	Parameters
FLOW CONTROL		
Resume Keyboard Transmission	8B	None
Inhibit Keyboard Transmission	89	None
INDICATORS		
Light LEDs	13	Bit pattern
Turn Off LEDs	11	Bit pattern
AUDIO		
Disable Keyclick	99	None
Enable Keyclick, Set Volume	1B	Volume
Disable Ctrl Keyclick	B9	None
Enable Ctrl Keyclick	BB	None
Sound Keyclick	9F	None
Disable Bell	A1	None
Enable Bell, Set Volume	23	Volume
Sound Bell	A7	None
AUTO-REPEAT		
Temporary Auto-Repeat Inhibit	C1	None
Enable Auto-Repeat Across Keyboard	E3	None
Disable Auto-Repeat Across Keyboard	E1	None
Change All Auto-Repeat to Down-Only	D9	None
OTHER		
Request Keyboard ID	AB	None
Jump to Power-Up	FD	None
Jump to Test Mode	CB	None
Reinstate Defaults	D3	None

Table B-8   Command Function Representation

Command	Representation
Flow Control	0001
Indicator (LEDs)	0010
Keyclick	0011
Bell	0100
Keyboard ID	0101
Keyclick for Ctrl Key	0111
Temporarily Inhibit Auto-Repeat	1000
Jump to Test Mode	1001
Change All Auto-Repeat Characters to Down-Only	1010
Enable/Disable Auto-Repeat	1100

2. Indicators (LEDs) -- Figure B-11 shows the LED parameter. Figure B-12 shows the LED layout on the LK201 keyboard without the label strip installed.

3. Audio -- Figure B-13 shows the audio volume parameter.

07	06	05	04	03	02	01	00
1	0	0	0	LED 4	LED 3	LED 2	LED 1

MR-10004
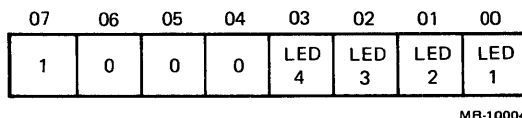
Figure B-11   Indicator (LED) Parameter

O   O   O   O
LED 4   LED 3   LED 2   LED 1

MR-10005
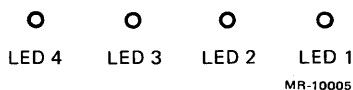
Figure B-12   Indicator (LED) Layout

07	06	05	04	03	02	01	00
1	0	0	0	0	3-BIT VOLUME		

MR-10006
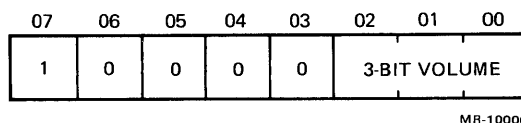
Figure B-13   Audio Volume Parameter

The volume levels for the audio are as follows.

    000 - highest
    001
    010
    011
    100
    101
    110
    111 - lowest

The keyclick or the bell (or both) can be disabled. When the keyclick or bell is disabled, it does not sound, even if the system module requests it.

The following are additional peripheral commands.

1. Temporary Auto-Repeat Inhibit -- Stops auto-repeat for this key only. Auto-repeat automatically continues when another key is pressed.

2. Disable/Enable Auto-Repeat Across Keyboard -- Stops/starts transmission of metronome codes without affecting auto-repeat timing or division settings.

3. Change All Auto-Repeat to Down-Only -- Changes division settings for all auto-repeating divisions to down-only.

4. Request Keyboard ID -- Keyboard sends a 2-byte keyboard ID. Keyboard does not jump to power-up.

5. Reinitiate Keyboard -- Keyboard jumps to its power-up routine. The system module should not try to transmit anything to the keyboard until the last byte of the power-up sequence is received.

6. Jump to Test Mode -- Special test mode for manufacturing testing.

7. Reinstate Defaults -- Set the following functions back to the default settings after a successful completion of the power-up self-test.

    Division mode settings
    Auto-repeat interval and timeout rates
    Auto-repeat buffer selections
    Audio volume
    Ctrl key keyclick

B.5.5.4 **Mode Set Commands** -- The following describe the mode set commands.

1. Division mode settings -- Refer to Paragraph B.5.2.

2. Each division on the keyboard has a unique 4-bit representation. Table B-2 describes these representations.

3. Each mode has a unique 2-bit code as indicated in Table B-9.

To set the key transmission mode on a particular keyboard division, the system module must send the PARAMS flag, then the keyboard division representation with the mode code, and then the TYPE flag (cleared).

Example: Set main array to down/up. Refer to Figure B-14.

The PARAMS flag is set to 1 if there are no parameters. The PARAMS flag is clear if there are parameters.

Table B-9   **Mode Representation**

Modes	Representation
Down-only	00
Auto-repeat down	01
Down/up	11
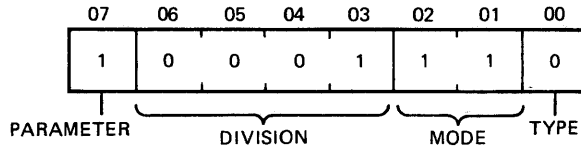
Figure B-14   Setting Key Transmission Mode

Auto-repeat rate buffer association -- If the auto-repeat mode is selected, the system module can transmit a parameter to change the buffer association of the selected division.

Example: Set main array to auto-repeat, change buffer association to buffer 3. Refer to Figure B-15.

Auto-repeat rate buffer values -- At keyboard power-up time, the four auto-repeat rate buffers contain default values. The system module may change these values.

In the command byte, bit 7 (PARAMS flag) should be clear, bits 6-3 are 1111 (to indicate that this is a rate set command), bits 2 and 1 should be the buffer number (0 to 3), bit 0 (TYPE flag) is clear. There should be two parameters carrying the rate set data.

Example: Change rates in buffer 3. Refer to Figure B-16.

The first parameter specifies the timeout to the store in the selected buffer. The second parameter specifies the interval.

PARAMETER		DIVISION			MODE		TYPE
07	06	05	04	03	02	01	00
0	0	0	0	1	0	1	0
1	0	0	0	0	0	1	1
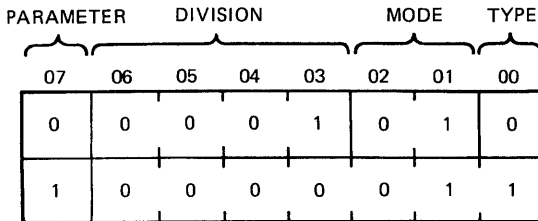
MR-10008

Figure B-15   Setting Auto-Repeat Rate Buffer Association

PARAMETER		RATE CHANGE COMMAND			BUFFER NUMBER		TYPE
07	06	05	04	03	02	01	00
0	1	1	1	1	1	1	0
0	PARAMETER 1 (TIME-OUT)						
1	PARAMETER 2 (INTERVAL)						
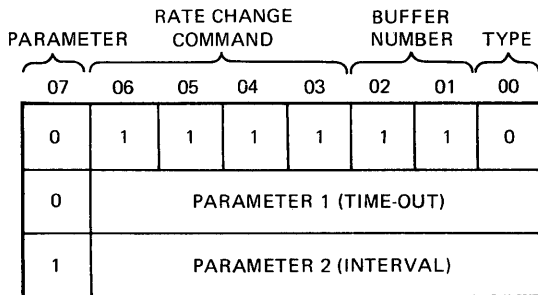
MR-10009

Figure B-16   Setting Auto-Repeat Rate Buffer Values

For example, to set the auto-repeat rate in buffer 1, the system module firmware transmits 00000011, followed by 2 bytes of numeric parameters.

The auto-repeat timeout is the transmitted number times 5 ms. To specify a rate of 5 ms delay, the first parameter received is 00000001. The maximum allowable time is 630 ms (01111110). The system module must not send 635 (01111111).

NOTE
The code (01111111) is reserved for internal keyboard use. 00 is an illegal value.

Auto-repeat timeout is implemented as a multiple of 8.33 ms, the keyboard's internal scan rate. Timeout rates can vary + 4.15 ms.

The auto-repeat interval is the number of metronome codes per second. In order to specify a speed of 16 Hz, the second parameter received is 10010000. Note that the high-order bit is set because it is the last parameter. The highest value that may be sent is 124 (11111100).

The lowest rate that can be implemented by the keyboard is 12 Hz. Values as low as 1 can be transmitted, but are translated to 12 Hz.

NOTE
The system module must not send 125, or 11111101. This code is the power-up command.

B.5.6   Special Considerations
The following paragraphs describe the special codes and their considerations.

B.5.6.1   Error Handling -- There are four error codes. The first two are sent at power-up if the self-test fails. The other two are the input error code and the output error code.

The output error (B5 hexadecimal) is sent after the keyboard receives a resume transmission command, if the output buffer overflowed while the keyboard was locked.

The input error (B6 hexadecimal) is sent when the keyboard detects noise (an unidentified command or parameter) on the line. B6 is also sent if the keyboard detects a delay of more than 100 ms while expecting a parameter.

B.5.6.2   Keyboard Locked Condition -- When the keyboard receives
an inhibit transmission command, it lights the lock LED and
transmits one more byte - a special code indicating the keyboard
is locked (keyboard locked acknowledge). If the system module
receives this code without a request, noise on the line was
interpreted as an inhibit transmission command. The system module
should immediately send the resume transmission command to unlock
the keyboard.

The output first-in/first-out (FIFO) buffer in RAM is four bytes.
When the keyboard is locked, the buffer attempts to store
characters received from the keyboard. The keyboard stops scanning
its matrix. When the keyboard is unlocked by the system module, it
transmits all four bytes in the output buffer. If any keystrokes
were missed due to buffer overflow, the keyboard transmits an
error code as the fifth byte (output error). Keys that were not
transmitted and are being held down when the keyboard is unlocked
are processed as new keys. Upon unlocking the keyboard, an error
code indicates a possible loss of keystrokes to the system module.

The keyboard stops scanning its matrix when its buffer is full.
However, it processes all incoming commands.

B.5.6.3   Reserved Code -- The number 7F (hexadecimal) is reserved
for the internal keyboard input and output buffers handling
routines.

B.5.6.4   Test Mode -- The keyboard jumps to a test mode by command
during production test. It transmits a special code to the system
module to confirm the test mode. If the system module receives
this code, it should send the byte 80 (hexadecimal) to continue.
This causes a jump to power-up.

B.5.6.5   Future Expansion -- Some keycodes are reserved for future
use as special codes or keycodes.

B.5.7   Default Conditions
Certain keyboard divisions have specific default modes. Some
divisions default to the auto-repeat mode; therefore, they have an
associated buffer that contains the default values for timeout and
interval. Table B-10 lists the default modes and Table B-11 lists
the default rates in the four keyboard division auto-repeat rate
buffers.

The volume level for the keyclick and bell has an 8-step range.
The default volume level for the keyclick and bell is the third
loudest. Both keyclick and bell volumes are 2 (decimal) (010
binary) by default. The key in position C99 of the keyboard (the
Ctrl key on the LK201) does not generate a click unless enabled by
the system module. The keys in position B99 and B11 (shift keys on
the LK201) never generate a keyclick.

For the LK201 keyboard, the Ctrl key defaults to the no-keyclick
state.

Table B-10   Keyboard Division Default Modes

Keyboard Division	Mode	AR Buffer
Main array	Auto-repeat	0
Keypad	Auto-repeat	0
Delete	Auto-repeat	1
Cursor keys	Auto-repeat	1
Return and Tab	Down-only	
Lock and Compose	Down-only	
Shift and Control	Down/up	
Six basic editing keys	Down/up	

Table B-11   Default Rates in Auto-Repeat Buffers

Buffer Number	Timeout (ms)	Internal (Hz)
0	500	30
1	300	30
2	500	40
3	300	40

B.6   SPECIFICATIONS

FUNCTIONAL

Electronics	8-bit microprocessor, 4 Kbytes of ROM, 256 bytes of RAM, 4 LEDs, transducer
Cord	1.9 m (6 ft), coiled, 4-pin telephone-type modular connectors, plugs into display monitor (PN BCC01)
Keypad	Sculptured key array
Home row key height	3 cm (1.2 in) above desk top
Keys	105 matte, texture-finished keys
Main keypad	57 keys
Numeric keypad	18 keys
Special function keypad	20 keys; firmware- and software-driven
Editing keypad	10 keys

Spacing	1.9 cm (0.75 in) center-to-center (single-width keys)
Wobble	Less than 0.5 cm (0.020 in)
Diagnostics	Power-up self-test, generates identification upon passing test

PHYSICAL

Height	5 cm (2.0 in) at highest point
Length	53.3 cm (21 in)
Width	17.1 cm (6.75 in)
Weight	2 kg (4.5 lb)

B.7   CHARACTER SETS

The MicroVAX workstation recognizes all the 8-bit character codes of Digital's multinational character set, shown in Figure B-17. It also recognizes the special graphics character set, shown in Figure B-18, when preceded by a select character set (SCS) sequence (described in subsequent paragraphs).

Using Digital's multinational character set allows the MicroVAX workstation to process character codes from the keyboards listed in Table B-12.

Each of the 15 keyboards supported is used with corresponding language ROMs that are inserted into the system module. The language ROMs translate keyboard position codes into the required character codes necessary for further processing.

Table B-12   Multinational Character Set Keyboards

Keyboard	Part Number
American (English)	LK201-AA
Austrian/German	LK201-AG
Belgian/Flemish	LK201-AB
Belgian/French	LK201-AP
British	LK201-AE
Canadian (French)	LK201-AC
Danish	LK201-AD
Dutch	LK201-AH
Finnish	LK201-AF
Italian	LK201-AI
Norwegian	LK201-AN
Spanish	LK201-AS
Swedish	LK201-AM
Swiss (French)	LK201-AK
Swiss (German)	LK201-AL

b4 b3 b2 b1	ROW	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0 0 0 0	0	NUL	DLE	SP	0	@	P	`	p		DCS	▨	°	À		à	
0 0 0 1	1	SOH	DC1	!	1	A	Q	a	q		PU1	¡	±	Á	Ñ	á	ñ
0 0 1 0	2	STX	DC2	"	2	B	R	b	r		PU2	¢	²	Â	Ò	â	ò
0 0 1 1	3	ETX	DC3	#	3	C	S	c	s		STS	£	³	Ã	Ó	ã	ó
0 1 0 0	4	EOT	DC4	$	4	D	T	d	t	IND	CCH			Ä	Ô	ä	ô
0 1 0 1	5	ENQ	NAK	%	5	E	U	e	u	NEL	MW	¥	µ	Å	Õ	å	õ
0 1 1 0	6	ACK	SYN	&	6	F	V	f	v	SSA	SPA		¶	Æ	Ö	æ	ö
0 1 1 1	7	BEL	ETB	'	7	G	W	g	w	ESA	EPA	§	·	Ç	Œ	ç	œ
1 0 0 0	8	BS	CAN	(	8	H	X	h	x	HTS		¤		È	Ø	è	ø
1 0 0 1	9	HT	EM	)	9	I	Y	i	y	HTJ		©	¹	É	Ù	é	ù
1 0 1 0	10	LF	SUB	*	:	J	Z	j	z	VTS		ª	º	Ê	Ú	ê	ú
1 0 1 1	11	VT	ESC	+	;	K	[	k	{	PLD	CSI	«	»	Ë	Û	ë	û
1 1 0 0	12	FF	FS	,	<	L	\	l	|	PLU	ST		¼	Ì	Ü	ì	ü
1 1 0 1	13	CR	GS	-	=	M	]	m	}	RI	OSC		½	Í	Ÿ	í	ÿ
1 1 1 0	14	SO	RS	.	>	N	^	n	~	SS2	PM			Î		î	
1 1 1 1	15	SI	US	/	?	O	_	o	DEL	SS3	APC		¿	Ï		ï	▨

ASCII CONTROL SET (CO)		ASCII GRAPHIC CHARACTER SET (GL)						ADD'L CONTROL SET (C1)		DEC SUPPLEMENTAL GRAPHIC SET (GR)					

DEC MULTINATIONAL CHARACTER SET

MR-10132

Figure B-17   Digital's Multinational Character Set

The MicroVAX workstation processes 7-bit character codes as though they were 8-bit character codes with the eighth bit not set. Each character set consists of displayable or graphic characters, and nondisplayable or control characters.

In 7-bit-coded character sets, control characters are contained in columns 0 and 1, and in position 7/15, while graphic characters are contained in the remaining positions of columns 2 through 7.

In 8-bit-coded character sets, control characters are contained in columns 0, 1, 8, and 9, and in positions 7/15 and 15/15, while graphic characters are contained in the remaining positions of columns 2 through 7, and 10 through 15.

Figure B-18 — Special Graphics Character Set. Each cell lists the character with its octal / decimal / hex codes.

COLUMN	0	1	2	3	4	5	6	7
BITS →	0 0 0 0	0 0 0 1	0 0 1 0	0 0 1 1	0 1 0 0	0 1 0 1	0 1 1 0	0 1 1 1
ROW / b4 b3 b2 b1								
0 — 0 0 0 0	NUL 0/0/0	20/16/10	SP 40/32/20	0 60/48/30	@ 100/64/40	P 120/80/50	♦ 140/96/60	— SCAN 3 160/112/70
1 — 0 0 0 1	1/1/1	DC1 (XON) 21/17/11	! 41/33/21	1 61/49/31	A 101/65/41	Q 121/81/51	▓ 141/97/61	— SCAN 5 161/113/71
2 — 0 0 1 0	2/2/2	22/18/12	" 42/34/22	2 62/50/32	B 102/66/42	R 122/82/52	⌐ 142/98/62	— SCAN 7 162/114/72
3 — 0 0 1 1	ETX 3/3/3	DC3 (XOFF) 23/19/13	# 43/35/23	3 63/51/33	C 103/67/43	S 123/83/53	⌡ 143/99/63	— SCAN 9 163/115/73
4 — 0 1 0 0	EOT 4/4/4	24/20/14	$ 44/36/24	4 64/52/34	D 104/68/44	T 124/84/54	⎧ 144/100/64	├ 164/116/74
5 — 0 1 0 1	ENQ 5/5/5	25/21/15	% 45/37/25	5 65/53/35	E 105/69/45	U 125/85/55	⎦ 145/101/65	┤ 165/117/75
6 — 0 1 1 0	6/6/6	26/22/16	& 46/38/26	6 66/54/36	F 106/70/46	V 126/86/56	° 146/102/66	┴ 166/118/76
7 — 0 1 1 1	BEL 7/7/7	27/23/17	' 47/39/27	7 67/55/37	G 107/71/47	W 127/87/57	± 147/103/67	┬ 167/119/77
8 — 1 0 0 0	BS 10/8/8	CAN 30/24/18	(50/40/28	8 70/56/38	H 110/72/48	X 130/88/58	⎨ 150/104/68	│ 170/120/78
9 — 1 0 0 1	HT 11/9/9	31/25/19	) 51/41/29	9 71/57/39	I 111/73/49	Y 131/89/59	⎩ 151/105/69	≤ 171/121/79
10 — 1 0 1 0	LF 12/10/A	SUB 32/26/1A	* 52/42/2A	: 72/58/3A	J 112/74/4A	Z 132/90/5A	┘ 152/106/6A	≥ 172/122/7A
11 — 1 0 1 1	VT 13/11/B	ESC 33/27/1B	+ 53/43/2B	; 73/59/3B	K 113/75/4B	[133/91/5B	┐ 153/107/6B	π 173/123/7B
12 — 1 1 0 0	FF 14/12/C	34/28/1C	, 54/44/2C	< 74/60/3C	L 114/76/4C	\ 134/92/5C	┌ 154/108/6C	≠ 174/124/7C
13 — 1 1 0 1	CR 15/13/D	35/29/1D	- 55/45/2D	= 75/61/3D	M 115/77/4D	] 135/93/5D	└ 155/109/6D	£ 175/125/7D
14 — 1 1 1 0	SO 16/14/E	36/30/1E	. 56/46/2E	> 76/62/3E	N 116/78/4E	^ 136/94/5E	┼ 156/110/6E	· 176/126/7E
15 — 1 1 1 1	SI 17/15/F	37/31/1F	/ 57/47/2F	? 77/63/3F	O 117/79/4F	_ 137/95/5F	— SCAN 1 157/111/6F	177/127/7F

KEY

CHARACTER	ESC	33 OCTAL
		27 DECIMAL
		1B HEX

MR-10133

Figure B-18   Special Graphics Character Set

In all character sets, the control characters in columns 0 and 1, and position 7/15, are designated as belonging to the control character group C0. The graphic characters in the remaining positions of columns 2 through 7 are designated as belonging to the graphics left character group GL.

The control characters in columns 8 and 9, and position 15/15, are designated as belonging to the control character group C1. The graphic characters in the remaining positions of columns 10 through 15 are designated as belonging to the graphics right character group GR.

Figure B-19 shows how the character sets are designated and used in the MicroVAX workstation.

CHARACTER SET LIBRARY

US   UK   SPECIAL GRAPHICS   DEC MULTINATIONAL

0 1 2   7   0 1 2   7   0 1 2   6 7   0 1 2   7 8 9 10   15

CØ   GL   CØ   GL   CØ   GL   CØ   GL   C1   GR

▨ = CONTROL CHARACTERS

ACTIVE GL CHARACTER SETS

┌────FULLY ACTIVE────┐   ┌────PARTIALLY ACTIVE────┐

SCS SEQUENCE

UK ESC (A
US ESC (B
SG ESC (Ø

GØ

SHIFT IN (017)

SHIFT OUT (016)

SCS SEQUENCE

UK ESC) A
US ESC) B
SG ESC) Ø

G1

ESC N (033-015)

DEFAULT CHARACTER SET (US OR UK)

ESC Ø (033-017)

G2

DEFAULT CHARACTER SET (US OR UK)

G3

CHARACTER GENERATOR ROM MAPPING

0   1   2   3   4   5   6   7   8   9   10   11   12   13   14   15

0

| COLUMNS 6 AND 7 OF SPECIAL GRAPHICS (FIG. B-18) | DEC MULTINATIONAL GL (FIG. B-17) | REVERSE QUESTION MARKS | DEC MULTINATIONAL GR (FIG. B-17) |

15

MR-10134

Figure B-19   Character Set Designations

B.8 CHARACTER SET SELECTION

A GL character set is selected by using select character set (SCS) sequences. SCS sequences are used to designate two GL character sets as fully active, and two GL character sets as partially active. Once designated, the two fully active GL character sets are selected with a shift-in or shift-out control character. Once a fully active GL character set is selected, all subsequent characters are assumed as belonging to that GL character set until an SCS sequence is again detected.

The two partially active GL character sets are selected with an escape N or escape O control character. Once a partially active GL character set is selected, only the following character is assumed as belonging to that GL character set. All subsequent characters are assumed as belonging to the previously selected, fully active GL character set.

If the MicroVAX workstation firmware does not detect an SCS sequence, it assumes that all characters belong to the default GL character set. The default GL character set is assigned or determined by the value of the twelfth bit that appears on the screen in the set-up mode, under parameter settings (PARAM SET). If this bit is 1, the default character set is UK; if it is 0, the default character set is USASCII.

The SCS sequences and their octal equivalents for selecting the fully active GL character sets (G0 and G1) and the partially active GL character sets (G2 and G3) are listed in Figure B-20. Note that both the G2- and G3-designated GL character sets will always be the default character sets determined in the set-up mode under parameter settings (PARAM SET).

CHARACTER SET	SCS SEQUENCE (NUMBERS IN SEQUENCE ARE IN OCTAL)			
	G0	G1	G2	G3
UK	ESC (A 033 050 101	ESC) A 033 051 101	ESC N 033 115 (IF UK SELECTED IN SET-UP MODE)	ESC O 033 117 (IF UK SELECTED IN SET-UP MODE)
USASCII	ESC (B 033 050 102	ESC) B 033 051 102	ESC N 033 115 (IF US SELECTED IN SET-UP MODE)	ESC O 033 117 (IF US SELECTED IN SET-UP MODE)
SPECIAL GRAPHICS	ESC (0 033 050 060	ESC) 0 033 051 060		

NOTE: ALL NUMBERS ARE IN OCTAL

MR-10135

Figure B-20   Character Set Selection

B.9   DISPLAYING CHARACTERS
All character codes are processed by the MicroVAX workstation firmware in the following order.

1. If no SCS sequences are detected, all character codes are assumed to belong to the default character set.

2. If an SCS sequence is detected, the character code is translated so that, when it is input to the character generator ROM, it produces the proper character display.

> **NOTE**
> A translation between the character code received and the character code expected by the character generator ROM is necessary because, as shown in Figure B-21, the ROM mapping for graphic characters does not always agree with the character set mapping in Figures B-17 and B-18.

3. All character codes with the eighth bit set are processed as belonging to Digital's multinational GR character set.

Figure B-22 shows the data paths in various modes. When character codes are input to the workstation application programs in console mode, the application software is responsible for transmitting the actual codes for each key pressed. If the escape key is pressed, the applications software must send the workstation firmware the character code for the escape key (27 decimal, 33 octal, or 18 hexadecimal). The same applies to host processor software, when the workstation is in line mode. In local mode, keyboard outputs are transmitted directly to the translation process firmware.
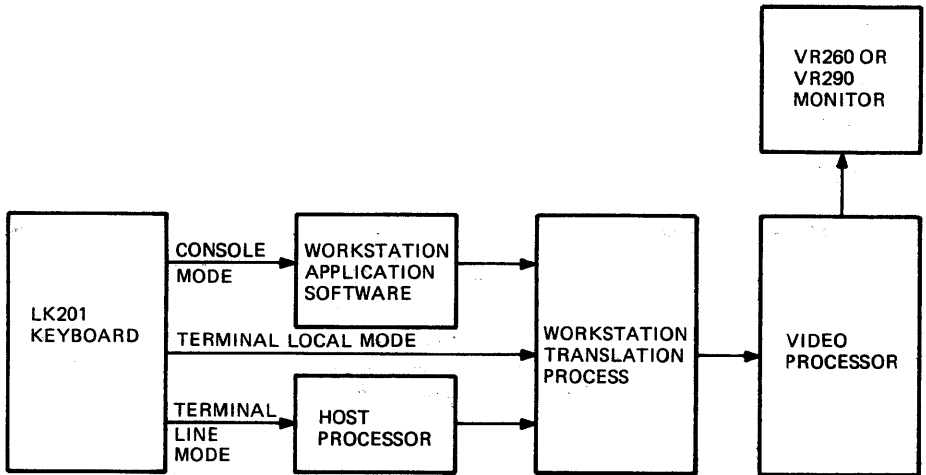
COLUMN	ROW	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
b8 b7 b6 b5 →		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	0	◆	SCAN 3	SP	0	@	P	`	p	⎕	⸮	▨	°	À	⸮	à	⸮
0001	1		SCAN 5	!	1	A	Q	a	q	⸮	⸮	¡	±	Á	Ñ	á	ñ
0010	2		SCAN 7	"	2	B	R	b	r	⸮	⸮	¢	²	Â	Ò	â	ò
0011	3		SCAN 9	#	3	C	S	c	s	⸮	⸮	£	³	Ã	Ó	ã	ó
0100	4		⊢	$	4	D	T	d	t	⸮	⸮	⸮	⸮	Ä	Ô	ä	ô
0101	5		⊣	%	5	E	U	e	u	⸮	⸮	¥	µ	Å	Õ	å	õ
0110	6	°	⊥	&	6	F	V	f	v	⸮	⸮	⸮	¶	Æ	Ö	æ	ö
0111	7	±	⊤	'	7	G	W	g	w	⸮	⸮	§	·	Ç	Œ	ç	œ
1000	8		│	(	8	H	X	h	x	⸮	⸮	¤	⸮	È	Ø	è	ø
1001	9		⟨	)	9	I	Y	i	y	⸮	⸮	©	¹	É	Ù	é	ù
1010	10	⌐	⟩	*	:	J	Z	j	z	⸮	⸮	ª	º	Ê	Ú	ê	ú
1011	11	⌐	¶	+	;	K	[	k	{	⸮	⸮	«	»	Ë	Û	ë	û
1100	12	⌐	≠	,	<	L	\	l	|	⸮	⸮	⸮	¼	Ì	Ü	ì	ü
1101	13	L	⌡	-	=	M	]	m	}	⸮	⸮	⸮	½	Í	Ÿ	í	ÿ
1110	14	╪	·	.	>	N	^	n	~	⸮	⸮	⸮	⸮	Î	⸮	î	⸮
1111	15	─ SCAN 1	⸮	/	?	O	_	o	DEL	⸮	⸮	⸮	¿	Ï	ß	ï	▨
		SPECIAL GRAPHICS		GL						NOT USED		GR					

NOTE: REVERSE QUESTION MARKS (⸮) ARE POSITIONS RESERVED FOR FUTURE STANDARDIZATION

MR-10136

Figure B-21 Character Generator ROM Displayable Characters

```
                                           ┌──────────────┐
                                           │  VR260 OR    │
                                           │  VR290       │
                                           │  MONITOR     │
                                           └──────────────┘
```

CONSOLE MODE

WORKSTATION APPLICATION SOFTWARE

LK201 KEYBOARD

TERMINAL LOCAL MODE

WORKSTATION TRANSLATION PROCESS

VIDEO PROCESSOR

TERMINAL LINE MODE

HOST PROCESSOR

MR—10137

Figure B-22   Keyboard Output Processing