CHAPTER 6
CRT DRIVE UNIT

CONTENTS

6.1 General

The 12-inch CRT Drive Unit (hereinafter called CDU) comprises a Cathode-Ray Tube (CRT) deflecting circuit and a video circuit. It receives video and synchronizing signals from the controller (Q10GMS board) and displays 640 x 400 pixcells on the CRT screen.

6.2 General Specifications

6.2.1 Deflecting frequency:

Horizontal : 19.3 kHz
Vertical : 45.8 Hz

6.2.2 Power conditions:

At the CDU input terminal
DC input voltage: 12V ±5%
Power consumption:
1.5A or less (mean value)
2.2A or less (peak value)

6.2.3 Environmental conditions:

(1) Temperature and humidity

	Storage	Operation
Temperature:	−20 – +65°C	0 – 55°C
Humidity:	5 – 90% (with no dew)	5 – 90% (with no dew)

(Wet bulb temperature: 27°C max.)

(2) Insulation resistance (between GF and GL):
10 MΩ (500 Vdc)
(with GF and GL separated)

6.3 Interface Specifications

6.3.1 Pin Definition

Pin No.	Function
1	Video signal
2	Vertical synchronizing signal
3	Horizontal synchronizing signal
4	Power supply +12V DC
5	Grounding (power supply horizontal)
6	Grounding (video vertical)
7	Grounding (power supply horizontal)
8	Frame grounding

Table 6-1

6.3.2 Input Conditions

Video signal:

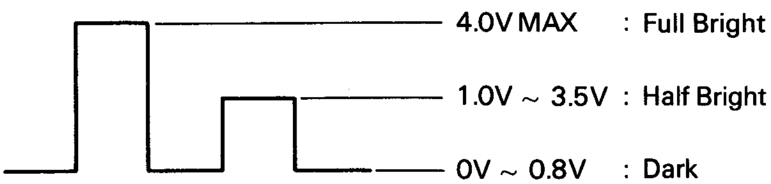


Fig. 6-1

Video input impedance	:	300 Ω min. 100 pF max.
Horizontal driving signal	:	TTL (positive) L: 0 – 0.8V H: 2.4 – 5.5V
Horizontal input impedance	:	500Ω min.
Vertical driving signal	:	TTL (positive) L: 0 – 0.3V H: 2.4 – 5.5V
Vertical input impedance	:	3.0 kΩ min.

6.3.3 Input signal timing

(a) Horizontal driving signal
19.3 kHz

Video signal

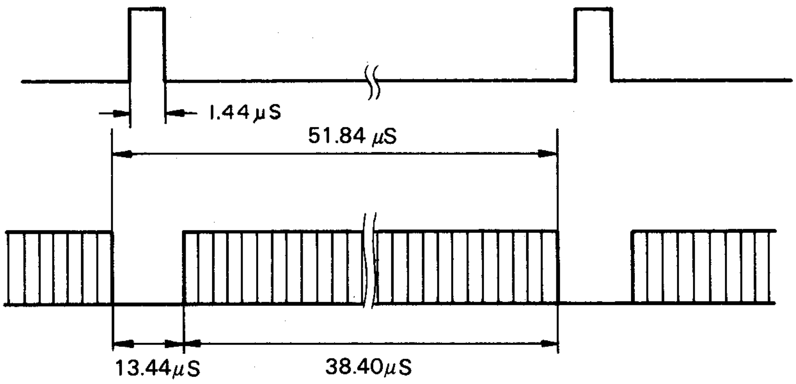
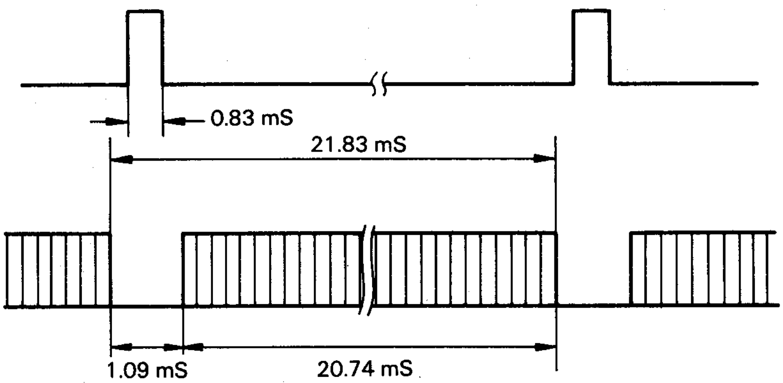


Fig. 6-2

(b) Vertical driving signal
45.8 Hz

Video signal



(c) Video signal

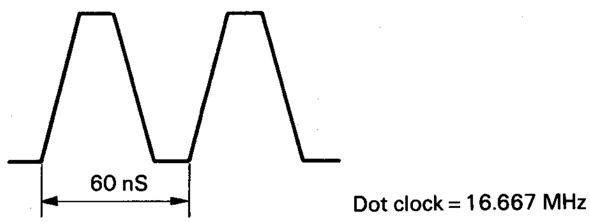


Fig. 6-3

6.4 Block Diagram

The CDU takes a video signal and horizontal/vertical synchronizing signals as input signals. The primary components are signal drive circuits to drive these signals, and a CRT deflecting circuit as shown in the block diagram (Fig. 6-4).

The video signal is applied to the CRT's cathode through the drive circuit. Horizontal and vertical synchronizing signals go through the respective drive circuits and are applied to the fly-back transformer (FBT) and the deflecting yoke (DY) to supply deflecting current to the CRT deflecting magnet field. The CDU is provided with a high voltage limiter which detects abnormally high voltage applied to the CRT and stops the horizontal drive circuit and reduces the high voltage to zero.

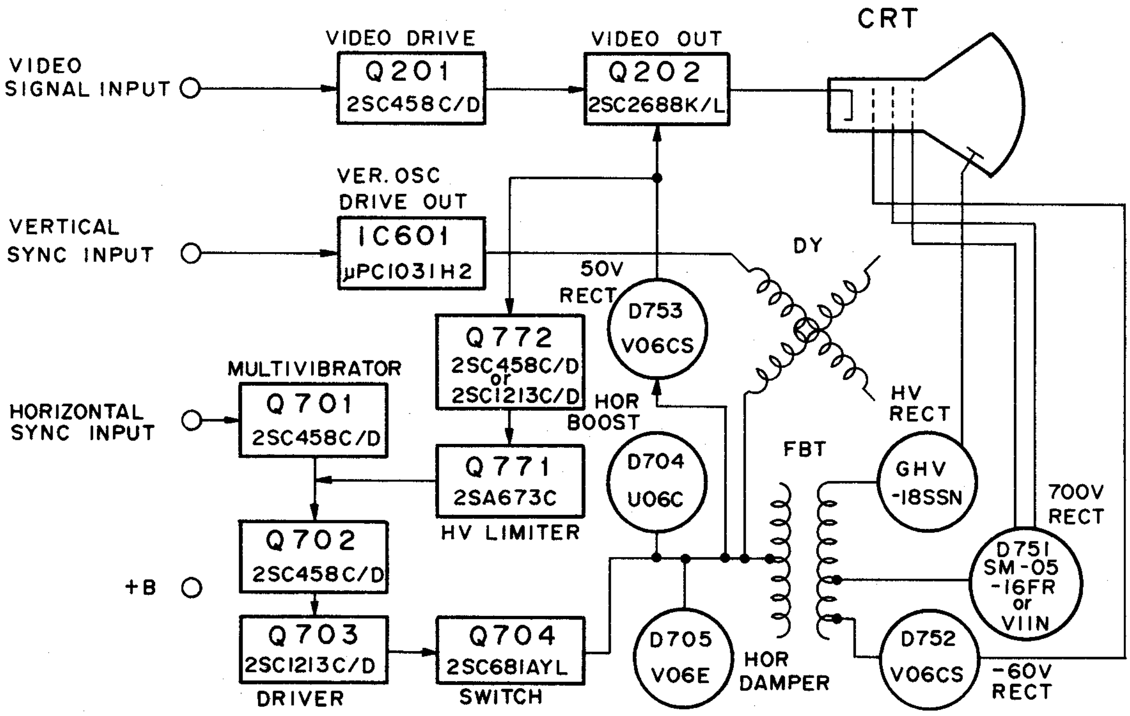


Fig. 6-4 CDU Block Diagram

6.5 Vertical Deflection Circuit

The vertical deflection circuit comprises a synchronous circuit, an oscillator, a saw tooth waveform generator, a linearity correction circuit, and an output circuit. It supplies the deflecting yoke with the saw tooth wave current.

In the CDU, the above operations are made by IC601 (μPC1031H2). A basic block diagram of this IC is shown in Fig. 6-8. The basic operation is as follows:

Self-oscillation is effected by the CR time constant of terminals 5 and 6, and synchronization is effected at terminal 5. The oscillator drives the saw tooth wave generator, and generates a saw tooth wave through the discharge slope of the CR circuit connected to the terminal 4. The saw tooth wave is applied to terminal 7, and amplified by the output amplifier to allow the saw tooth wave deflecting current flow in the deflecting yoke connected to the terminal 1.

The output amplifier comprises a current feedback amplifier circuit which feeds the voltage proportional to the saw tooth wave back to terminal 9.

The basic circuit is shown in Fig. 6-9.

The oscillator comprises a CR time constant Schmitt trigger circuit. The time constant or oscillation frequency is determined by R611, R613 and C612. Synchronization is effected at terminal 5 by capacitor coupling.

C611 is a coupling capacitor. R601 adjusts the size of the synchronizing signal.
The oscillation frequency can be varied by varying the value of R611. The circuit equivalent to the saw tooth wave generator is shown in Fig. 6-5. SW is formed within IC. By varying the value of R622, the saw tooth voltage can be varied to permit height adjustment.

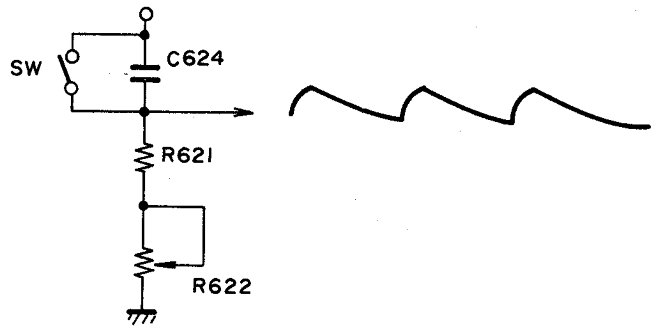


Fig. 6-5 Saw Tooth Wave Generator (Equivalent Circuit)

The linearity correction circuit is of the CR time constant type comprising R623, R624 and C621. The operating principle is shown in Fig. 6-6.
The saw tooth wave form can be changed by changing the value of R624. When the saw tooth wave form is changed, the saw tooth voltage is also changed and the screen size is changed. Thus, the picture size needs to be adjusted by R622 after adjustment of the linearity.

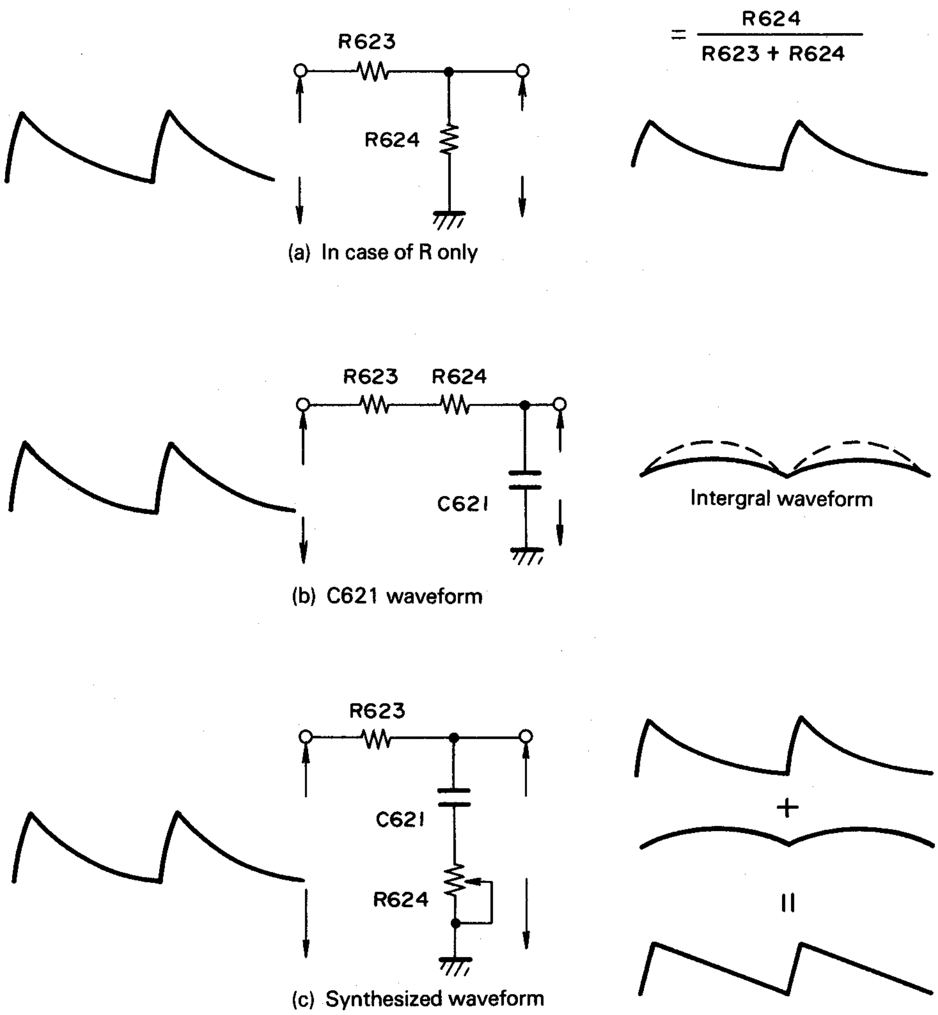


Fig. 6-6 Principle of Linearity Correction circuit

The output amplifier comprises a differential amplifier as shown in Fig. 6-7.

The saw tooth voltage is applied to the positive input terminal 7 of the differential amplifier through the coupling capacitor C622.

The deflecting yoke L601 and current feedback resistors R651 and R652 are connected in series to the output terminal 1 through capacitor C651.

The voltage with the same wave form as that of the deflecting yoke current is fed back to the negative input terminal 9 of the differential amplifier through the coupling capacitor C653. C652 is a bootstrap capacitor of the differential amplifier circuit. C654 is a capacitor to prevent oscillation of the output amplifier.

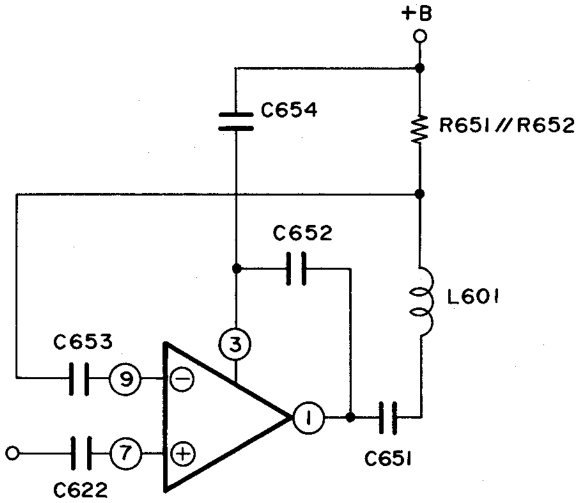


Fig. 6-7 Output Amplifier Basic Circuit

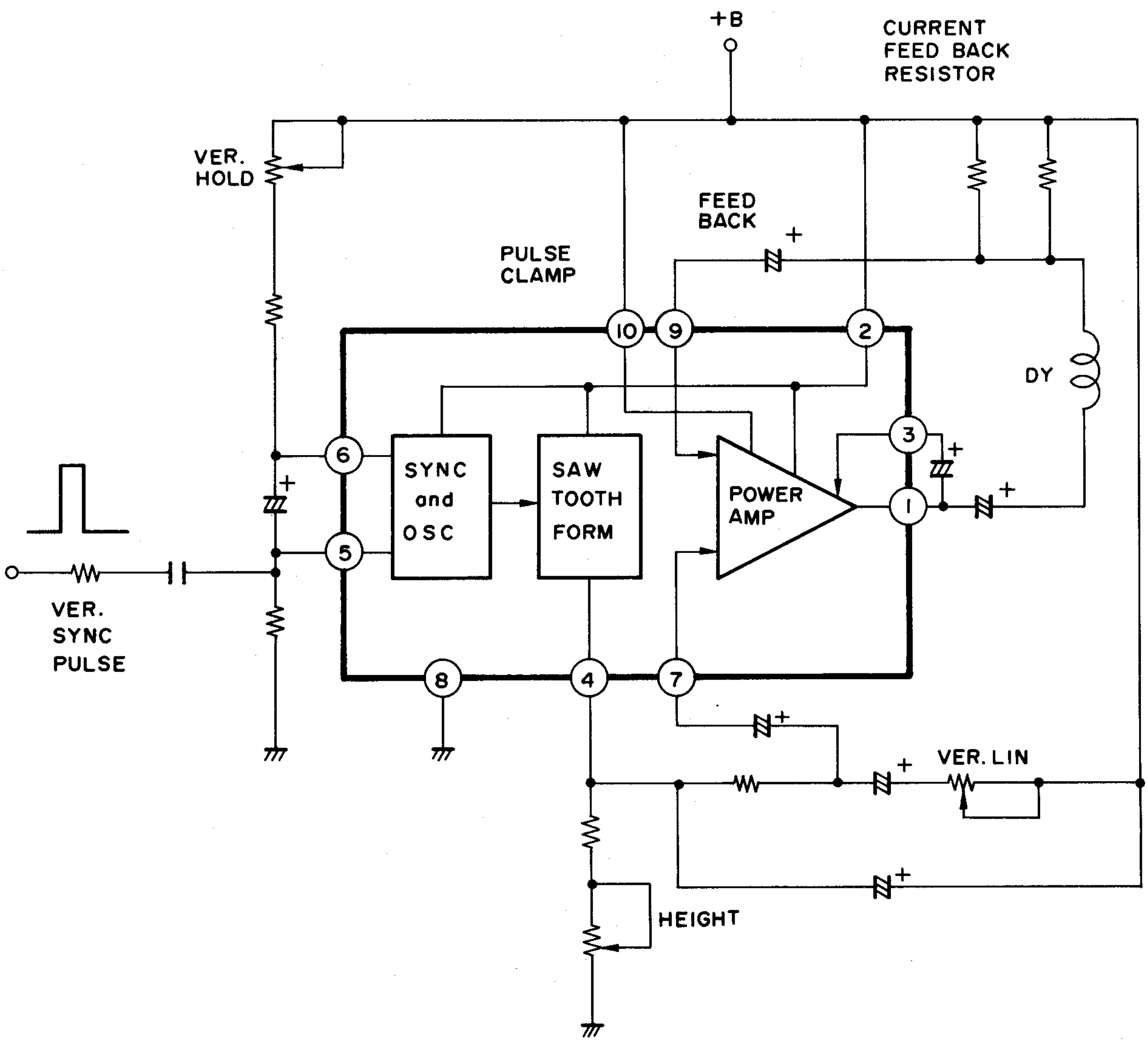


Fig. 6-8 Basic Block Diagram

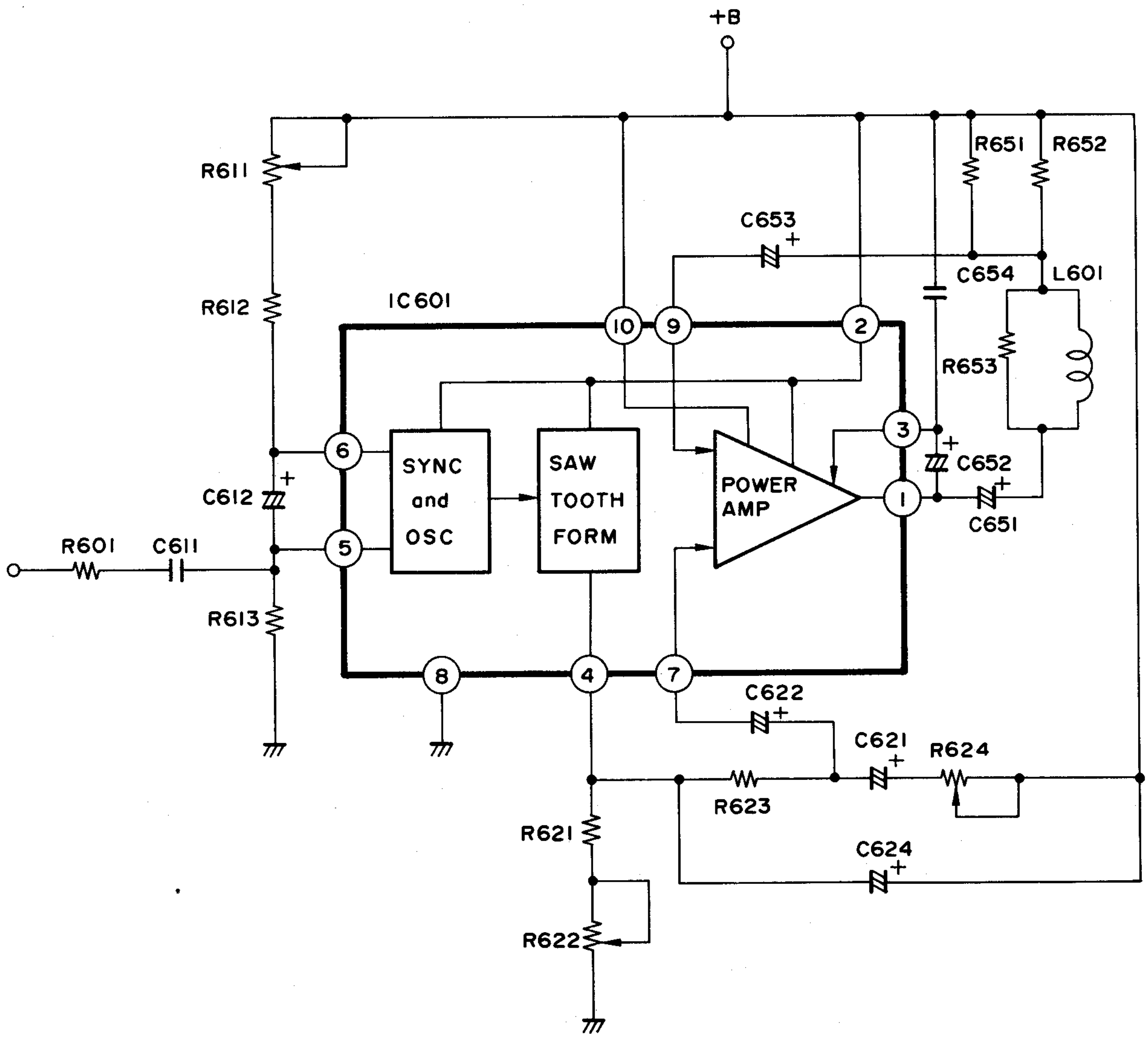


Fig. 6-9 Basic Circuit Diagram

6.6 Horizontal Deflection Circuit

The horizontal deflection circuit comprises a multivibrator, a drive transistor, an output transistor and a fly-back transformer. The basic block diagram is shown in Fig. 6-10. The multivibrator is triggered by an input synchronizing signal, and supplies a pulse of certain length to the drive transistor. This turns the output transistor on and off, thereby supplying a saw tooth current to the horizontal yoke winding and a voltage pulse to the fly-back transformer. The voltage pulse is boosted or reduced to CRT anode voltage or serveral bias voltages.

The positive edge of the input signal goes through D702 (the negative edge goes through D701) and triggers the monostable multivibrator. Then, Q702 turns on, and it turns off after the period determined by the time constants of R704, R705 and C702, thereby supplying a pulse of appropriate width to Q703.

The collector voltage of the drive transistor Q703 works as an inverse base current to the output transistor and turns it off.

When Q704 or D705 is ON, the yoke current flows like a saw tooth wave. When it is OFF, a fly-back pulse of about 200V is induced at the collector of Q704 by the resonance with the inductance composed mainly of the inductance L703 of C731 and yoke.

The peak-to-peak value of the yoke current, i.e. the picture width, can be adjusted by size inductor L704 provided on the board.

The asymmetrical form of the yoke current is modified by linearity inductor L705.

The fly-back pulse applied to the primary winding of flyback transformer T702 is divided and rectified into a high voltage of the CRT anode, 700V to G2, −60V to G1 and 50V to the video amplifier.

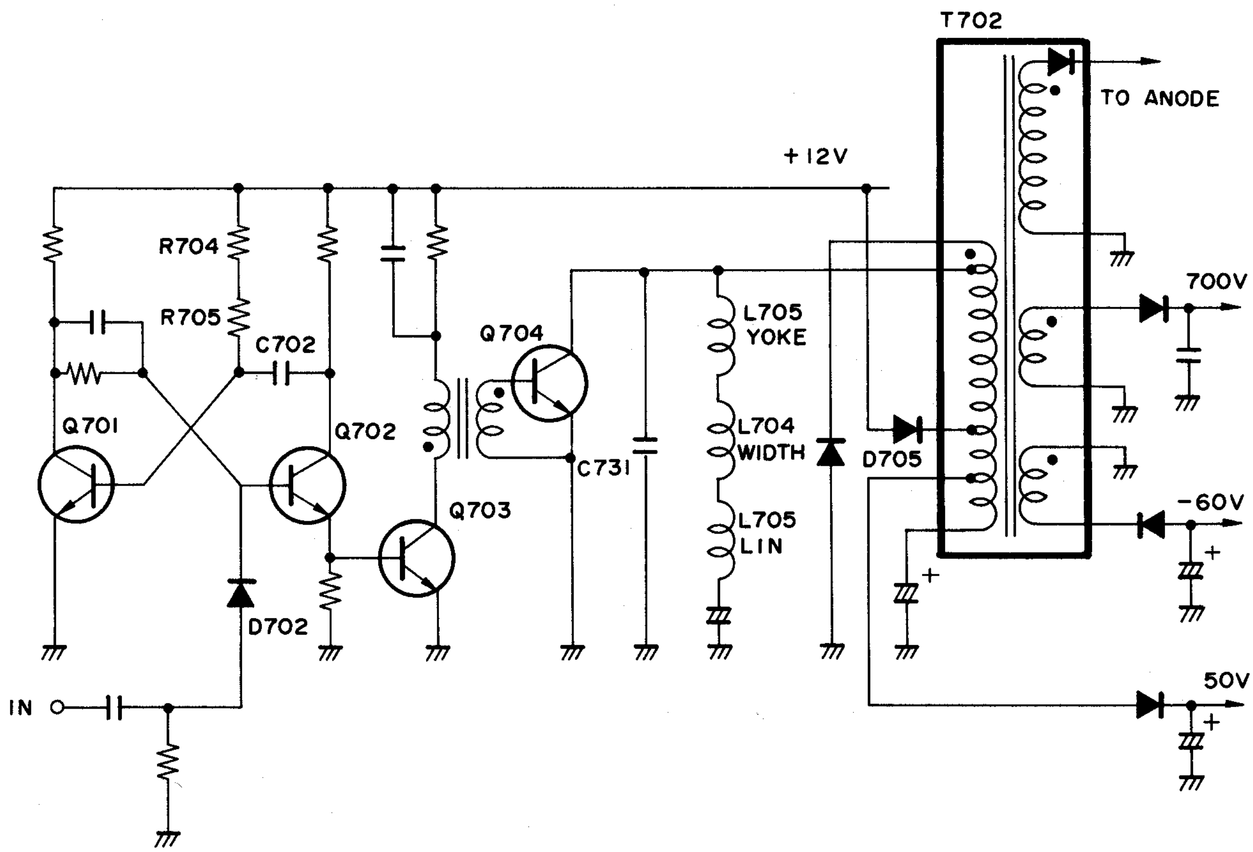


Fig. 6-10 Basic Horizontal Circuit

6.7 HV Limiter Circuit

If high voltage applied to the cathode-ray tube under abnormal operating conditions rises excessively, the cathode-ray tube may generate X-rays. To prevent this, the CDU employs a high voltage limiter which detects abnormally high voltage applied to the cathode-ray tube and stops operation of the horizontal drive circuit and reduces the high voltage to zero. Fig. 6-11 shows the high voltage limiter.

If an abnormally high voltage is generated, the pulse voltage at terminal 5 of the primary winding of fly-back transformer T702 is increased, and the medium voltage E50 obtained by rectifying the pulse voltage by D753 is also increased.

The base voltage of Q772 obtained by dividing medium voltage rises to a level where Q772 becomes conductive, and Q772 conducts. As a result, Q771 connected to Q772 via a thyristor conducts, too.

On the other hand, the collector of Q772 is connected to the base of Q702, the trigger input of the multivibrator comprising Q701 and Q702, through D771. If the potential at this base is grounded, the multivibrator stops operation. Therefore, when Q771 and Q772 conduct, the horizontal oscillation stops and the high voltage drops to zero. Once Q771 and Q772 conduct, they are held in the conduction state by the thyristor characteristic unless the power switch is turned off, and the high voltage is held at zero.

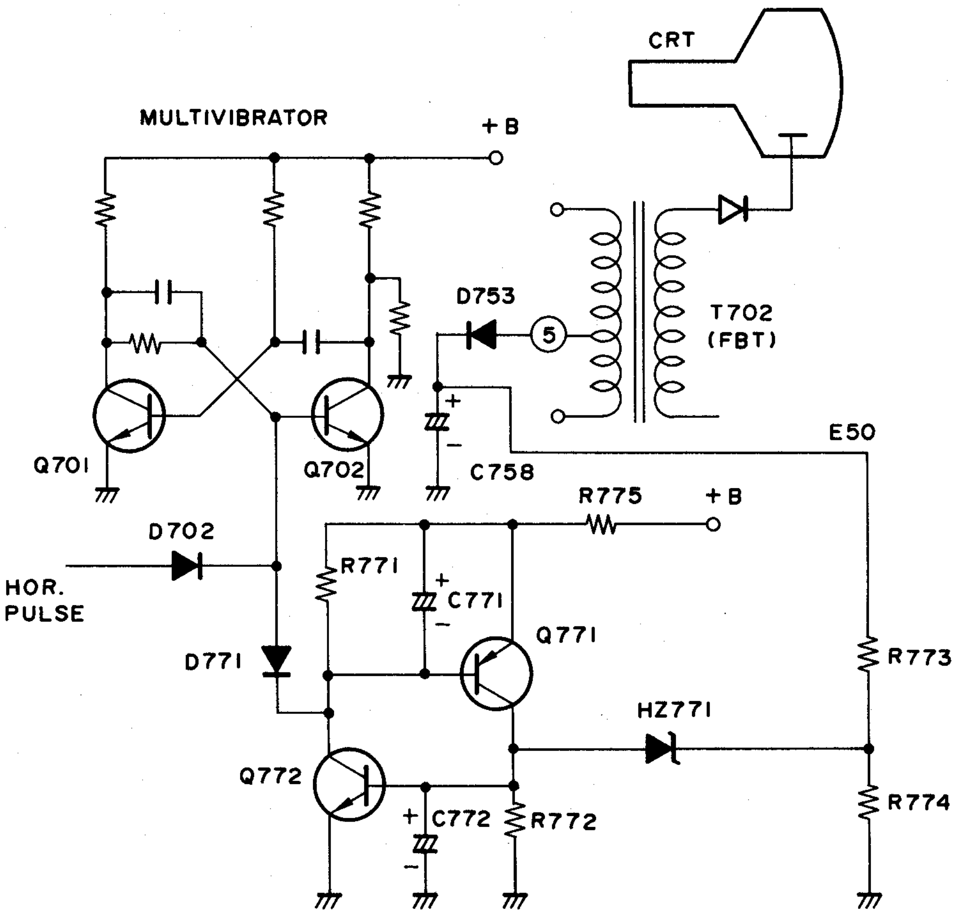
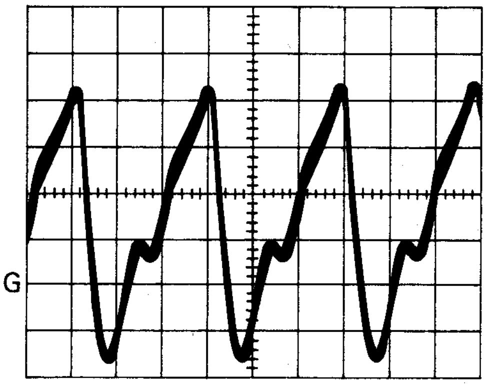


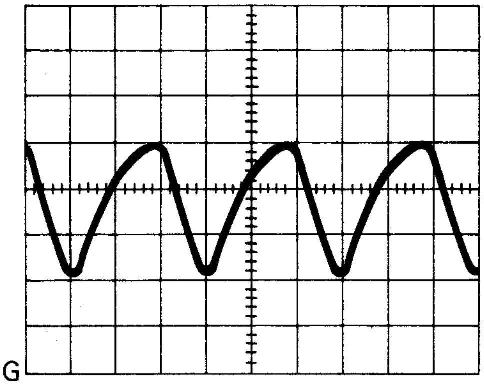
Fig. 6-11 High Voltage Limiter

CDU-12A01K CIRCUIT OPERATION WAVEFORM



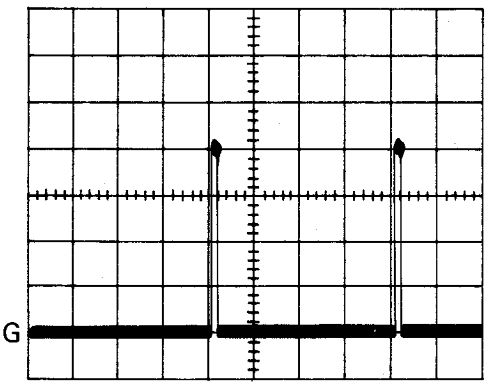
① 1V/DIV 20 nS/DIV

Fig. 6-12



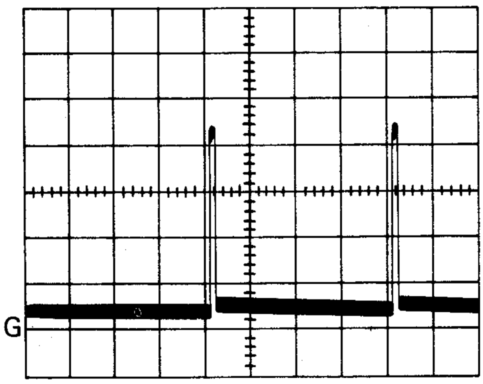
② 10V/DIV 20 nS/DIV

Fig. 6-13



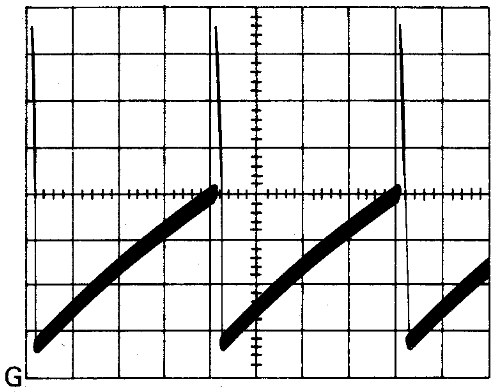
③ 1V/DIV 5 mS/DIV

Fig. 6-14



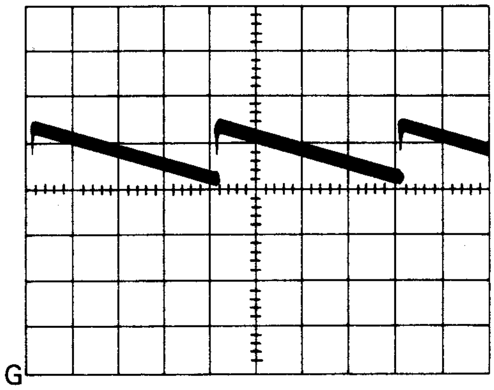
④ 1V/DIV 5 mS/DIV

Fig. 6-15



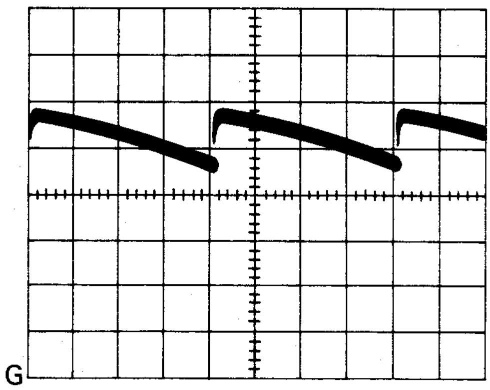
⑤ 1V/DIV 5 mS/DIV

Fig. 6-16



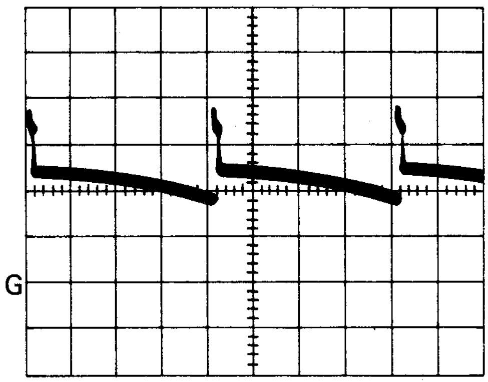
⑥ 2V/DIV 5 mS/DIV

Fig. 6-17



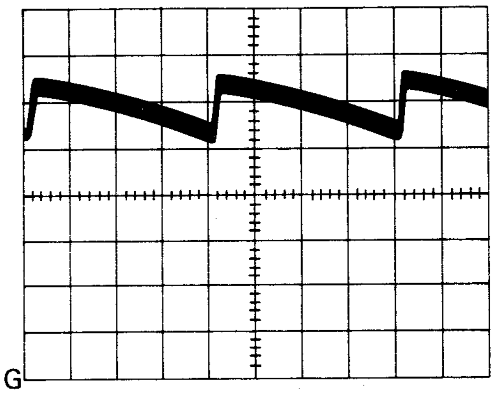
⑦ 1V/DIV 5 mS/DIV

Fig. 6-18



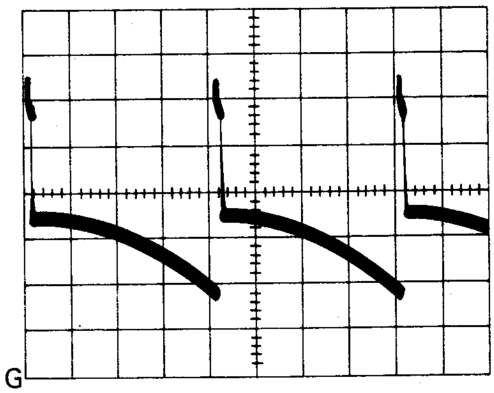
⑧ 5V/DIV 5 mS/DIV

Fig. 6-19



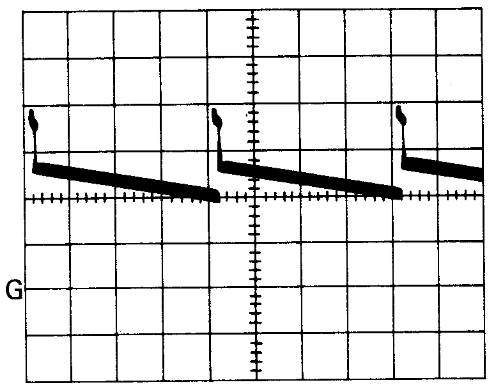
⑨
1V/DIV
5 mS/DIV

Fig. 6-20



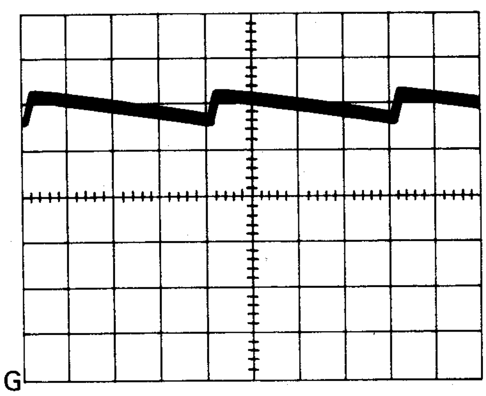
⑩
2V/DIV
5 mS/DIV

Fig. 6-21



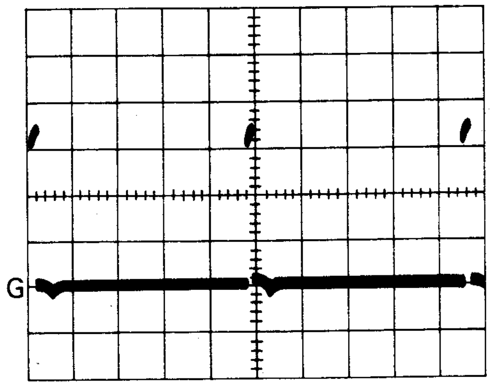
⑪
5V/DIV
5 mS/DIV

Fig. 6-22



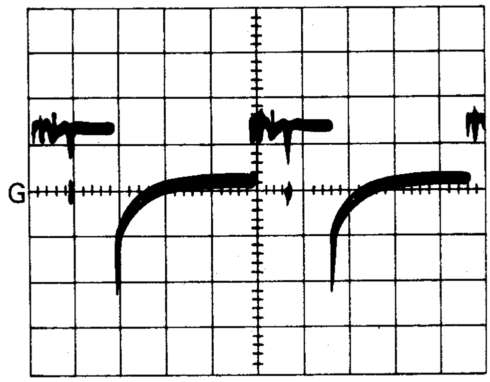
⑫
2V/DIV
5 mS/DIV

Fig. 6-23



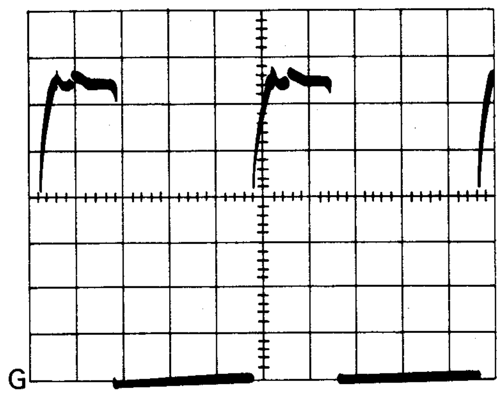
⑬
1V/DIV
10 μS/DIV

Fig. 6-24



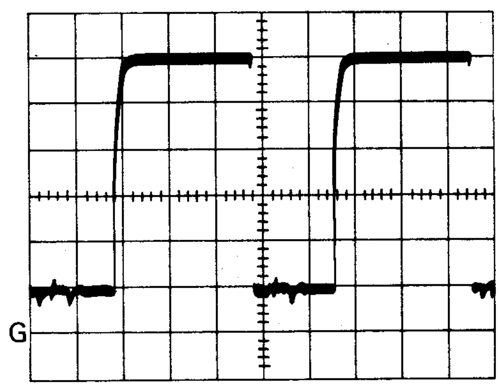
⑭
1V/DIV
10 μS/DIV

Fig. 6-25



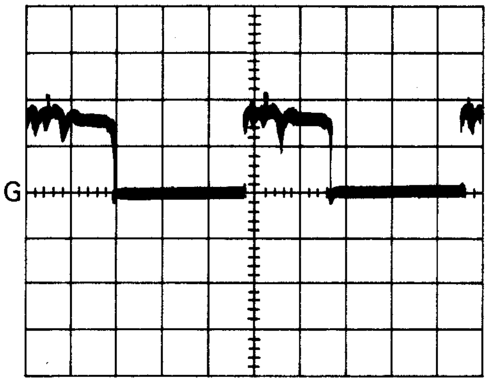
⑮
1V/DIV
10 μS/DIV

Fig. 6-26



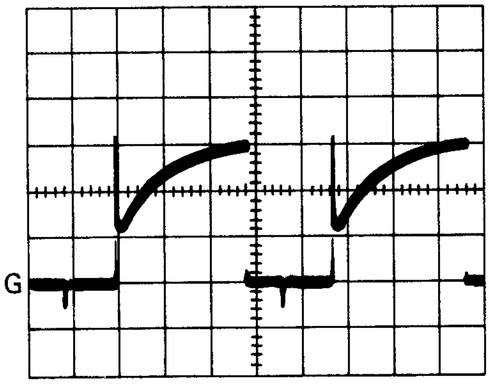
⑯
1V/DIV
10 μS/DIV

Fig. 6-27



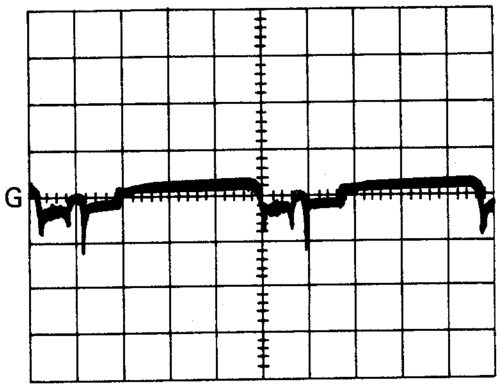
⑰
500 mV/DIV
10 μS/DIV

Fig. 6-28



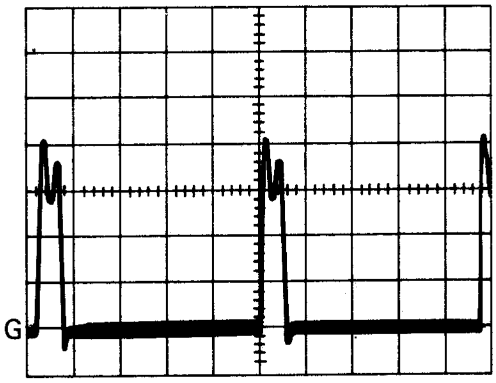
⑱
5V/DIV
10 μS/DIV

Fig. 6-29



⑲
5V/DIV
10 μS/DIV

Fig. 6-30



⑳
50V/DIV
10 μS/DIV

Fig. 6-31

CHAPTER 7
KEYBOARD UNIT

CONTENTS

7.1 General

The QX-10's keyboard is available in two types:

(a) ASCII type

(b) HASCI type

TYPE OF KEYBOARD ITEMS	ASCII TYPE	HASCI TYPE
Keyboard Diagram	See figure (Appendix)	See figure (Appendix)
Keyboard Scan code	See Table 7-5	See Table 7-4
Number of keys Typewriter keys Number keys Cursor keys Function keys	103 58 19 8 18	104 61 18 8 17
Remarks Keys with LED	CAPS LOCK INS SF1 SF2 SF3 SF4	SHIFT LOCK INSERT CALC DRAW SCHED
Temporarily shift keys	GRPH SHIFT (L) SHIFT (R) CTRL	GRPH SHIFT (L) SHIFT (R) CTRL (L) CTRL (R)

Table 7-1

In addition, the QX-10's ASCII type keyboard is available in eight language fonts as listed below.

1	: US ASCII	2	: ENGLISH
3	: GERMAN	4	: FRENCH
5	: ITALIAN	6	: SPANISH
7	: DANISH	8	: SWEDISH

Actually, the only differences of these keyboards are in the key-top labels. They are all the same in physical design.

7.2 Key-switches

The key-switch is composed of the parts shown in Fig. 7-1. When the key top is depressed, metal reed Ⓐ descends to establish continuity with Ⓑ. The stroke of the contact is shown in Fig. 7-2.

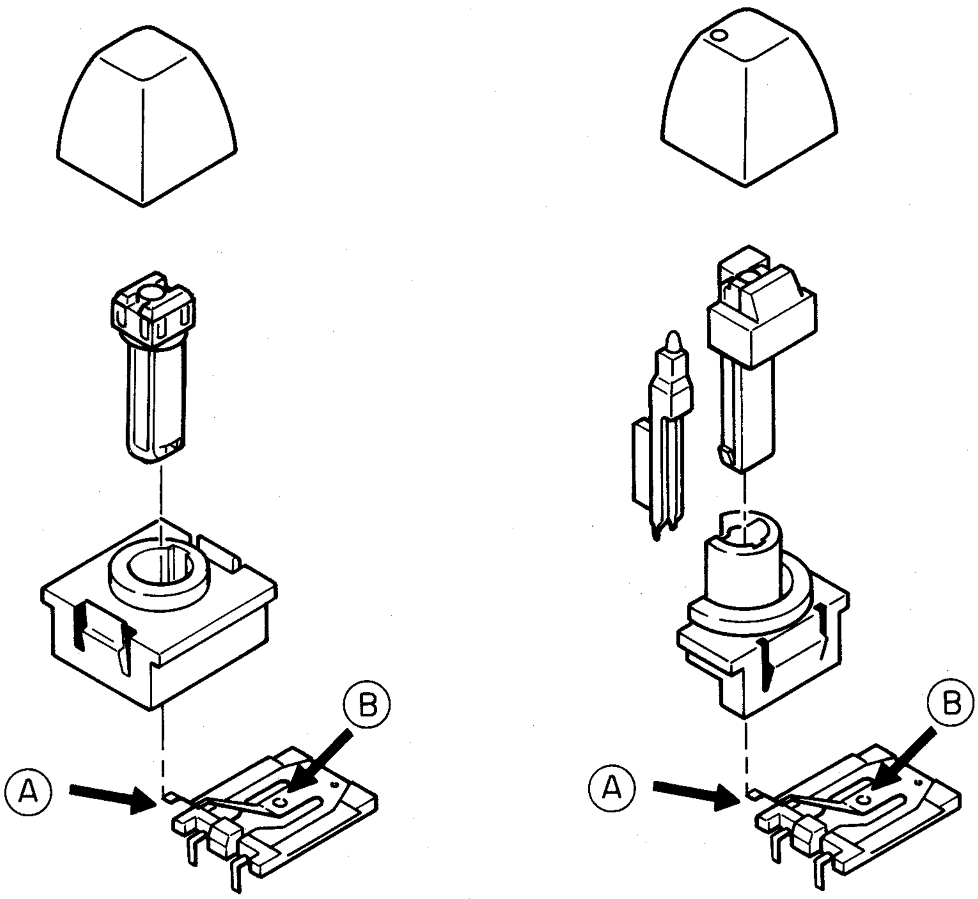


Fig. 7-1 Key-switch constructions

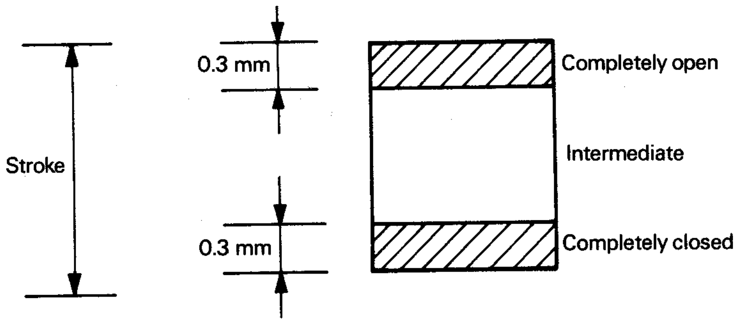


Fig. 7-2 Stroke of the key-switch contact

7.3 Key-switch Signals

(1) Fig. 7-1 shows the connections of the key-switches.

The key-switches are connected to some of the intersections of the row lines of the keyboard scan signals (KSC) generated by decoders LS145 (1A and 2A) and the column lines of the keyboard return signals (KRTN) which are the data bus lines of 8049 (5A). Thus, this arrangement of the key-switches looks like a 16 by 8 matrix in mathematical terminology.

The KSC lines and KRTN lines are pulled up by +5V. A pair of KSC and KRTN lines become continuous when a key-switch is depressed, otherwise they are open.

Suppose that a certain KSC line is low level. If a switch has been depressed, the KRTN line that becomes continuous with the KSC line also becomes low level and, since an inverter inverts it, high level develops at the associated data bus line of 8749 (5A).

This is the principle of detecting the depression of a key. Actually, an active-low signal scans over the KSC lines and, timed with it, levels of the data bus lines of the 8049 (5A) a lines of the 8049(5A) are checked so that the entire keyboard is equally sensed.

(2) The KSC signals are generated by two binary-to-decimal decoders LS145 from the output signals developing at P10 - P13 of the 8049 (5A).

The input signals to the two decoders (1A and 2A) are distinguishable because an inverter is connected to the D input terminal of decoder (1A). That is, the output of the decoder is of eight bits and, if input D is high level, the decoder is not selected and consequently it does not output any scanning signal.

Thus, keyboard scanning proceeds with only one KSC line put to low level at a time. The scanning signal is normally 830 μsec.

Table 7-2 below summarizes the relationships of the inputs and outputs of decoder LS145.

NO.	INPUT				OUTPUT									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L								Unused	
1	L	L	L	H		L								
2	L	L	H	L			L							
3	L	L	H	H				L						
4	L	H	L	L					L					
5	L	H	L	H						L				
6	L	H	H	L							L			
7	L	H	H	H								L		

H: High level
L: Low level

Table 7-2

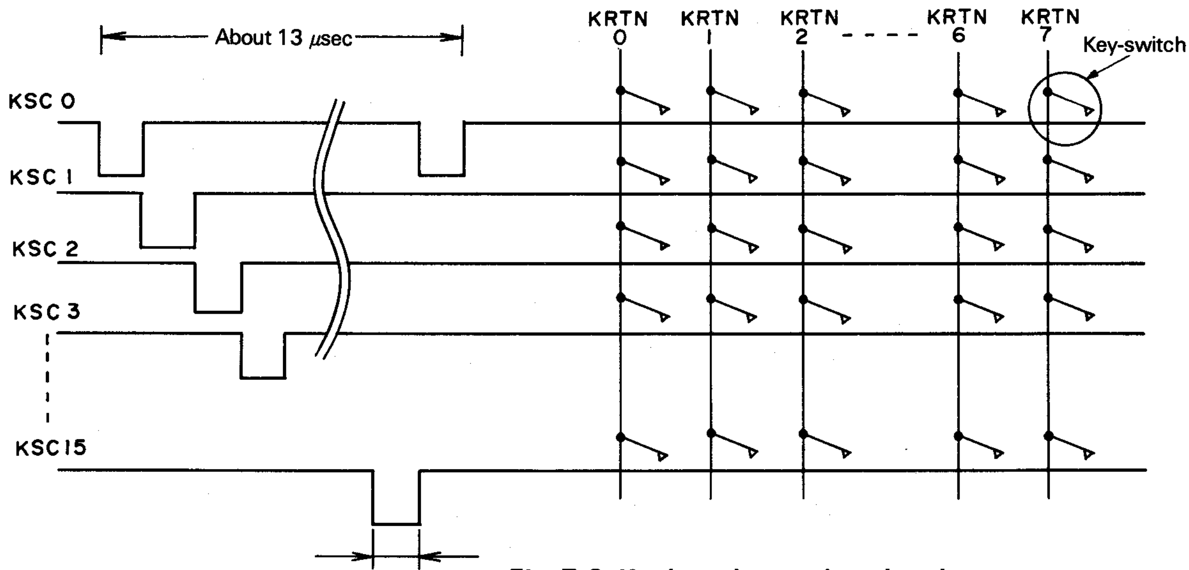


Fig. 7-3 Keyboard scanning signals

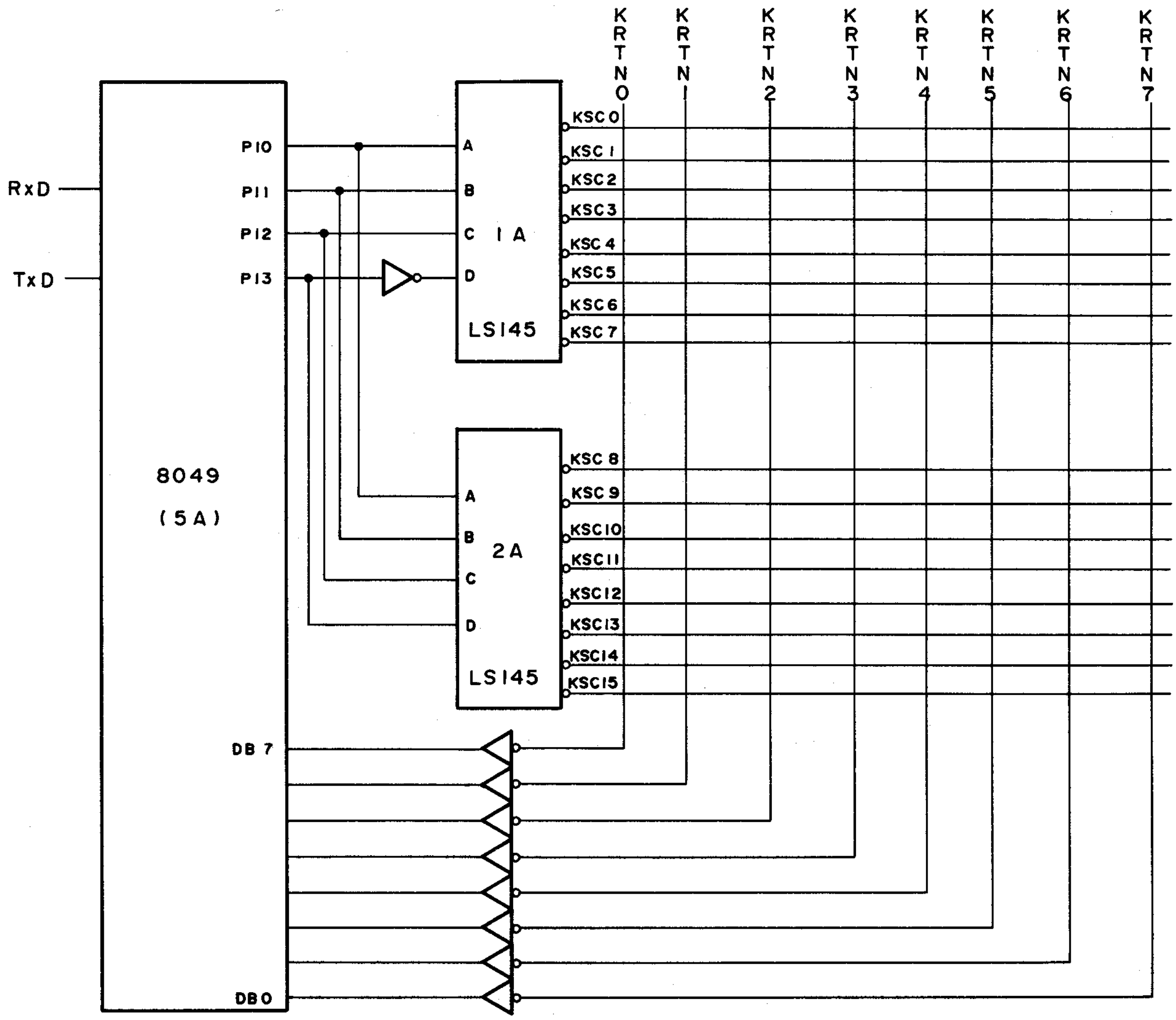


Fig. 7-4

(3) P20 – P27 of the 8749 (5A) are connected to the LEDs built in some key-switches. When a key-switch with key-top LED is depressed, the associated line out of P20 – P27 turns to low level to light the LED. A program held in the ROM (2 KB) of the 8749 (5A) is executed to find a depressed key and light its built-in LED.

7.4 Data Transfer to and from the Keyboard

Data are synchronously transferred between the keyboard and the QX-10 at the rate of 1,200 baud. The clock signal used at this time is supplied from terminal OUT 1 of the programmable interval timer 8253 (16E) mounted on the main board (Q10SYM board).

Commands given to the keyboard enter terminal T1 (pin 39) of the 8749 (5A) from external RXD.

Output data exit from TXD through P17 of the 8749 (5A).

The input commands and output data are explained below.

(1) Input commands (data coming from RXD)

1) Reset

1	1	1	X	X	X	X	Diagnostic program

Functions:
Initializes the keyboad controller.
Clears the key code buffer (of 32 characters' capacity).
Validates repeat function.
Designates repeat start time (500 msec).
Designates repeat interval (50 msec).
Extinguishes all LEDs.

Diagnostic program bit:
0: Causes one LED to another to blink; lights, then extinguishes all LEDs; scans key matrix; and sends out 00H if no key is depressed and FFH if one or more keys are depressed.
1: Does not execute the diagnostic program.

2) Set repeat start time

0	0	0	300 ms + N × 25 ms

Function:
Sets the time interval after which repeat is to start when a key is kept depressed. This parameter may be varied from 300 msec to 1,075 msec in intervals of 25 msec. The least significant five bits of the command represent the interval in such a manner that 00H corresponds to 300 msec, 01H to 325 msec, ..., and 1FH to 1,075 msec.

3) Read SW status

1	0	0	X	X	X	X	X

Function:
Sends back the current on/off statuses of all SWs. The 8-byte output data is sent out in preference to other key codes.

4) Control repeat

1	0	1	X	X	X	X	ON/OFF

Function:
Enables or inhibits repeat according to the content of bit 0 of this command.
Bit 0 = 0 .... Inhibits repeat function and, if repeat function is operating, stops it.
Bit 0 = 1 .... Enables repeat.

5) Enable keyboard to send

1	1	0	X	X	X	X	ON/$\overline{\text{OFF}}$

Function: Enables or inhibits the keyboard sending data.
Bit 0 = 0 .... Inhibits the keyboard sending data. Transmission of data which is in progress will be completed.
Bit 0 = 1 .... Enables the keyboard to send data.

6) Set Repeat Interval

0	0	1	30 ms + N x 5 ms

Function: Sets the interval at which repeat function is to work after it has begun. The least significant five bits of the command represent the interval in such a manner that 00H corresponds to 30 msec and the interval becomes longer by 5 msec up to 185 msec as the parameter increases by one.

7) Turn On/Off LED

0	1	0	X	LED No.	ON/$\overline{\text{OFF}}$

Function: Turns on (ON/$\overline{\text{OFF}}$ = 1) or off (ON/$\overline{\text{OFF}}$ = 0) the LED designated with parameter LED No.

8) Read LED status

0	1	1	X	X	X	X	X

Function: Sends back the current on/off statuses of all LEDs. The output data is of eight bytes in total, with one byte assigned to each LED. The data is output with the highest priority and placed at the top of the key code buffer. If overflow takes place in the key code buffer, some of the latest input data (but not of LED statuses) will be discarded.

(2) Output Data (data going out from TXD)

1) Key code

0	DB 0 ~ 7	P13 P12 P11 P10

Operation: A key code is generated by combining KSC signal (P13, P12, P11, and P10) with KRTN signal (DB0 – 7).

2) SW data

1 0 0 0	DB 0 ~ 7	ON/OFF

Operation: The statuses of the SHIFT, CTRL, and GRPH SHIFT keys are read as SW data. DB0 – 7 are associated with the keys as assigned in the key code tables. The least significant bit becomes "1" if the key is on and "0" if it is off.

3) LED status

1 1 0 0	LED No.	ON/OFF

Operation: The status of a key-top LED is sent out. LED No. is supplied from the contents of the least significant byte of the code given from the key code tables. The least significant bit is "1" if the LED is on and "0" if it is off.

► Timing Diagram

Fig. 7-5 is the timing diagram of the transmitted and received data (RXD and TXD) of the keyboard.

The clock signal is supplied from teh counter timer μPD8259 mounted on the Q10SYM board for transmission at 1,200 baud.

The interface between the keyboard and CPU is channel A of the serial controller μPD7201 mounted on the Q10SYM board.

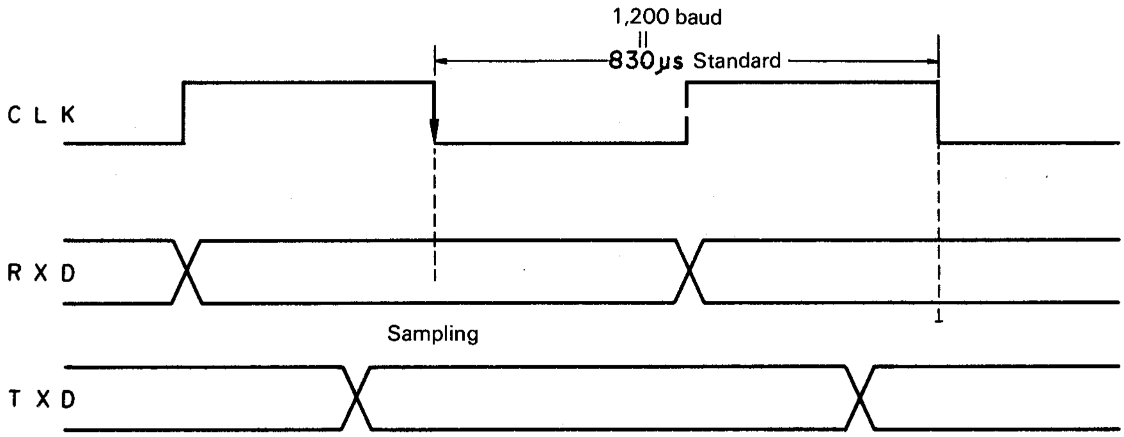


Fig. 7-5 Timing diagram

7.5 Key Code Tables

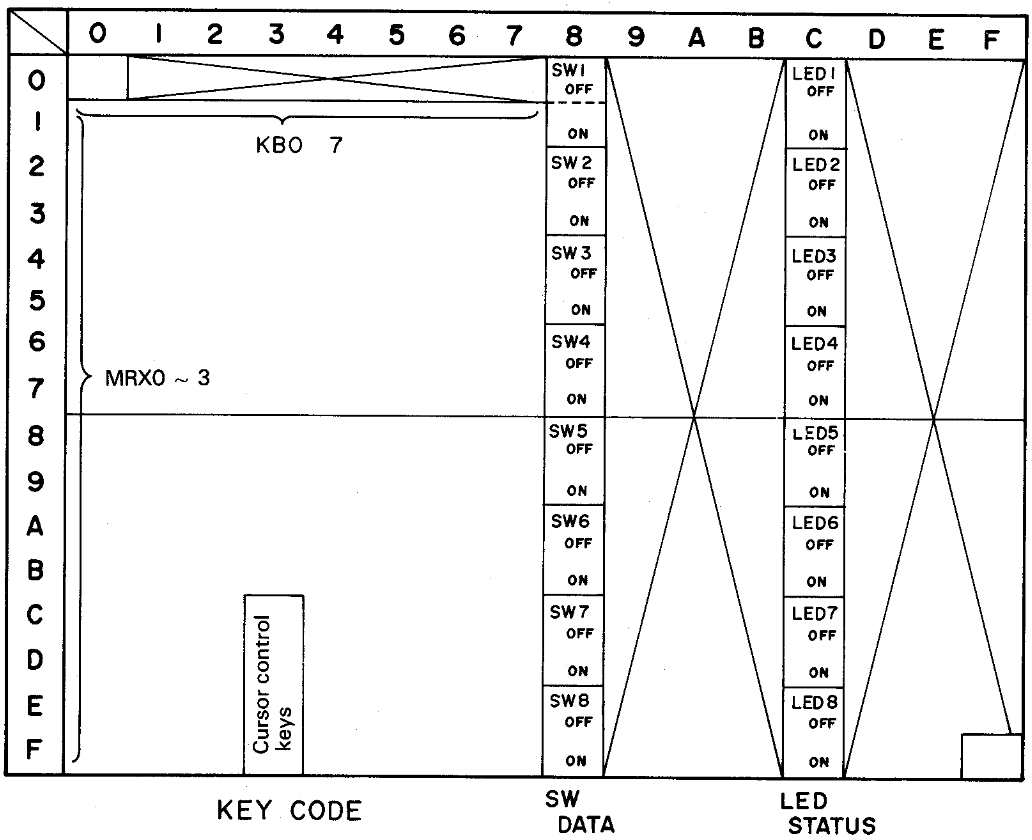


Table 7-3

KEYBOARD SCAN CODES (HASCI)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0			SHIFT (R)	SHIFT (L)		CTRL (R)	GRPH SHIFT	CTRL (L)					(H6) OFF			
1	UNDO			(H6)	TAB REL	Q	@ 2	COPY DISK					(H6) ON			
2	(H1)			SPACE	SHIFT LOCK	W	# 3	HELP								
3	STORE			Z	A	E	$ 4	STOP								
4	RE-TRIEVE			X	S	R	% 5	MAR SEL	SHIFT (R) BRK				INS OFF			
5	PRINT	ENTER	3	C	D	T	¢ 6	^ ±	SHIFT (R) MAKE				INS ON			
6	INDEX	·	2	V	F	Y	& 7	! 1	SHIFT (L) BRK				SHIFT LOCK OFF			
7	MAIL	0	1	B	G	U	* 8	TAB	SHIFT (L) MAKE				SHIFT LOCK ON			
8	(H2)	=	+	N	H	I	(9	TAB SET					(H4) OFF			
9	MENU	6	9	M	J	O	) 0						(H4) ON			
A	CALC	5	8	' ,	K	P	— -		CTRL (R) BRK				DRAW OFF			
B	SCHED	4	7	:	L	1/4 1/2	+ =		CTRL (R) MAKE				DRAW ON			
C	DRAW	(H5)	—	↑	: ;	[<	° \		GRPH BRK				SCHED OFF			
D	(H3)	(H4)	X	←	▼▼ ▼	] >	⌫		GRPH MAKE				SCHED ON			
E	BOLD	STYLE	÷	→	RETURN	INSERT	⌦		CTRL (L) BRK				CALC OFF			
F	ITALIC	SIZE	DEC TAB	↓	? /	WORD	LINE		CTRL (L) MAKE				CALC ON			

⇑ Shift key (column 8) ⇑ LED (column C)

When a key is pressed, the keyboard generated above matrix code only.

Table 7-4

KEYBOARD SCAN CODES (ASCII)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0													CAPS LOCKS OFF			
1	F4	LF		CAPS LOCK		Q	▼▼ 2	F3					CAPS LOCK ON			
2	F5	(A5)	(A4)	(SPACE)		W	# 3	F2								
3	F6			Z	A	E	$ 4	F1								
4	F7	000		X	S	R	% 5		SHIFT (R) BRK				INS OFF			
5	F8	↵	3	C	D	T	& 6	ESC	SHIFT (R) MAKE				INS ON			
6	F9	.	2	V	F	Y	▼ 7	! 1	SHIFT (L) BRK							
7	F10	0	1	B	G	U	(8	TAB	SHIFT (L) MAKE							
8	(A1)	+	–	N	H	I	) 9						MF4 OFF			
9	BREAK	6	9	M	J	O	Ō						MF4 ON			
A	PAUSE	5	8	< ,	K	P	= -		CTRL BRK				MF3 OFF			
B	SCRN DUMP	4	7	> .	L	` @	~ Δ		CTRL MAKE				MF3 ON			
C	HELP		=	↑	+ ;	{ [	¦ \		GRPH BRK				MF2 OFF			
D	(A2)	MF4	*	←	* :	}]	BS		GRPH MAKE				MF2 ON			
E	(A3)	MF3	/	→	↵	INS	HOME						MF1 OFF			
F	MF1	MF2	'	↓	? /	DEL	CLS						MF1 ON			

↑ Shift key (column 8) ↑ LED (column C)

When a key is pressed, the keyboard generated above matrix code only.

Table 7-5

7.6 N-Key Rollover Function

Suppose that two keys, G and F, are depressed as shown in Fig. 7-6. The depression is detected and the keys are identified as the key matrix is scanned.

If the V key is also depressed, current would flow via the path shown in Fig. 7-6 (b) and it could not be distinguished from the depression of key B.

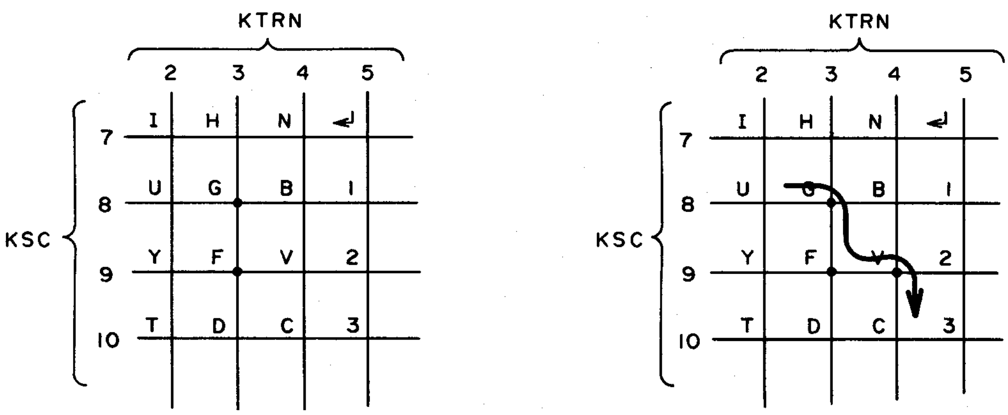
In the QX-10, if more than one key is depressed at a time (during a cycle of scanning), the keyboard encoder program does not work until only one key is depressed.

Note that two-key rollover is employed for the SHIFT, CTRL, and GRPH SHIFT keys, which are normally used along with other keys, by installing blocking diodes.

The keyboard is provided with a 32-byte buffer for transmitted data. When more than one key is depressed one after the another, key codes will be sent out serially.

Transmitted data are transfered to the TXD buffer from the 32-byte buffer on the FIFO baiss and further to the main unit as serial data whose format is shown in Fig. 7-5.

As to SW data, all data will be transmitted every time a status changes, regardless of the depression of other keys.



(a) G and F are identifiable individually.

(b) Current would flow as shown with the directed line and key B would be recognized as depressed.

Fig. 7-6

7.7 Repeat Function

The keyboard is provided with a repeat function so that, when a key is kept depressed, generation of its code repeats in predetermined intervals. Not only the repetition intervals but also the time when repetition is to start after the first-time generation of the code are predetermined for the system.

The repeat function works as follows.

(1) With cursor control keys, if more than one key at a time is kept depressed, the codes of the keys are generated cyclically.

(2) If more than one non-cursor control key is kept depressed, the code of the key depressed later than the others is generated repeatedly unless error results.

(3) If more than one key, including cursor control key and non-cursor control keys, is kept depressed, the code of the non-cursor control key depressed later than the other non-cursor control keys is generated alternately with the code of the cursor control key unless error results.

(4) If a key has been released in the middle of repeated generation of its code, the repeat function stops even when another key is kept depressed.