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Title:

RC730 Keyboard for the RC750 Microcomputer Technical Manual

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Keywords:

RC730, KBC751/KBC752, KSA751, RC730
Keyboard controller, Keyswitch assembly.

Abstract:

This manual contains the technical description and the diagrams for the RC730 Keyboard.

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1. DESCRIPTION

The RC730 is the keyboard for the RC750 microcomputer. The keyboard is based on the position-code principle. I.e. that a depression of a key results in the transmission of a position code. Therefore the host computer must perform a translation from position codes to e.g. ASCII. When a key is released, 128 (decimal) is added to the position code and this code is then to be transmitted. I.e. that a single "hit" on a key results in the transmission of 2 codes. The position code allocation is shown in fig. 1.2.

The position codes is transmitted to the host in a serial form. The keyboard provides both data and clock information.

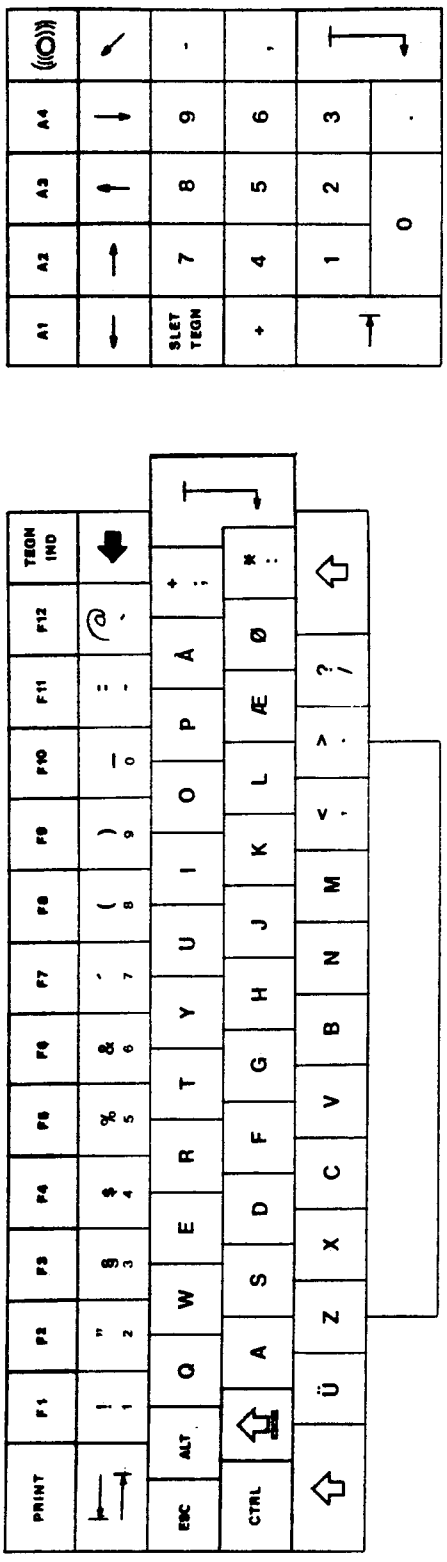


Figure 1.1: Keyboard layout.

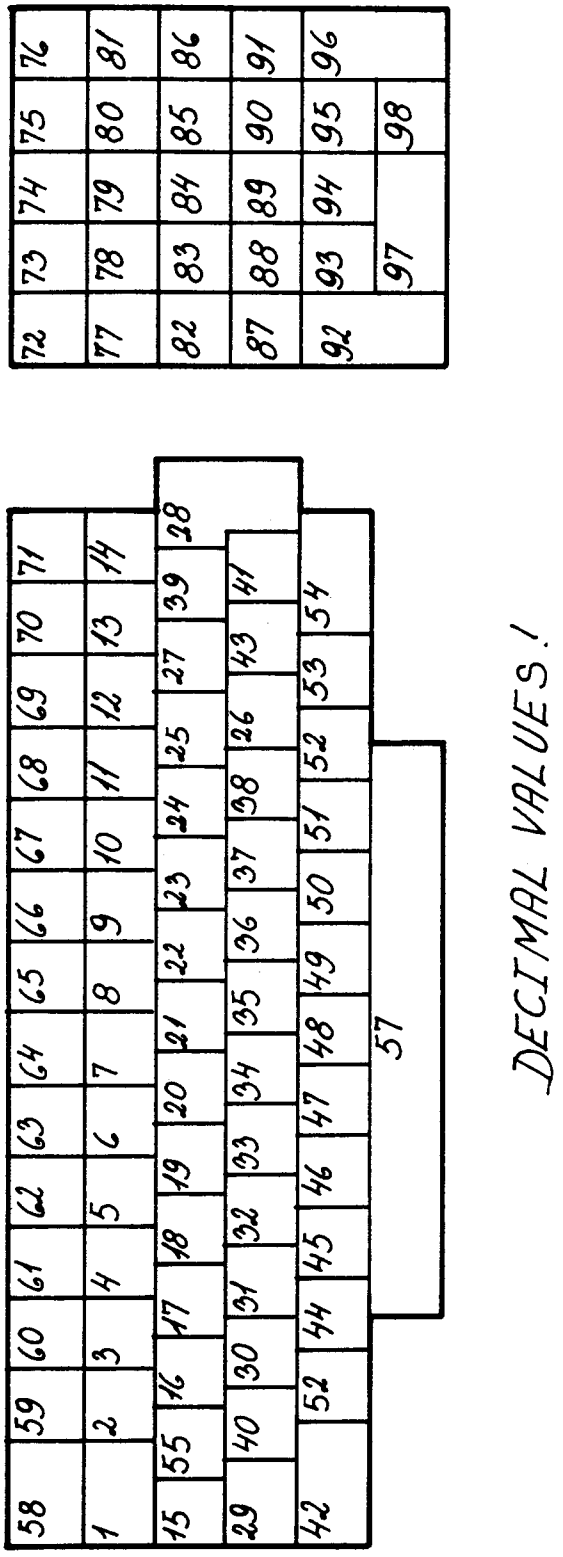


Figure 1.2: Positioncode allocation.

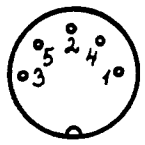
1.1 Hardware Survey

The RC730 keyboard consists fo two modules: KBC751/KBC752 and KSA751.

KBC751 is the controller module and KSA751 is simply the PCB where the keyswitches are mounted.

The controller performs the "reading" of the switches, the transmission of position codes and the generation of "keyswitchclicks". The controller has also got a connector which is intended to be used in conjunction with a mouse. Fig. 1.3 shows the physical interconnection of the modules.

The connection to the computer is made through the cable KBL574. The definition of the cable is as follows:



Front view
5P DIN-connector
(DIN 41524)

Pin 1: Strobe Clock from keyboard
2: Serial Data from keyboard
3: no connection
4: 0 V
5: 6,5 V - 7,5 V supply
Shield connected to housing

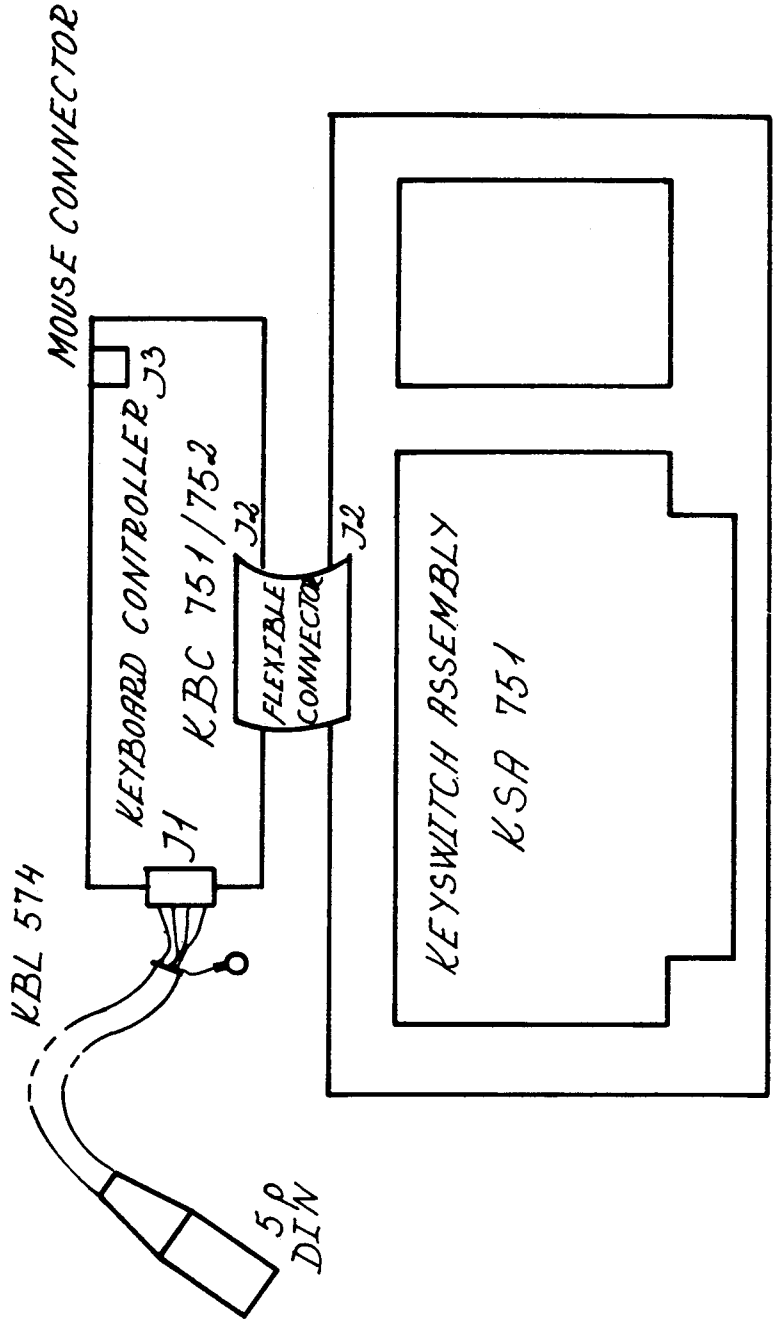

MOUSE CONNECTOR
J3
KEYBOARD CONTROLLER
KBC 751/752
J2
FLEXIBLE CONNECTOR
J2
J1
KEYSWITCH ASSEMBLY
KSA 751
KBL 574
5P DIN

Figure 1.3:

2. THE KEYBOARD CONTROLLER (KBC751/KBC752)

The KBC751/KBC752 is based upon a 8039 single chip microcomputer. The program for the microcomputer is stored in 2 K x 8 ROM (2716).

In this section the hardware around the microcomputer will be described. The KBC751/KBC752 assembly drawing is shown in fig. 2.1.

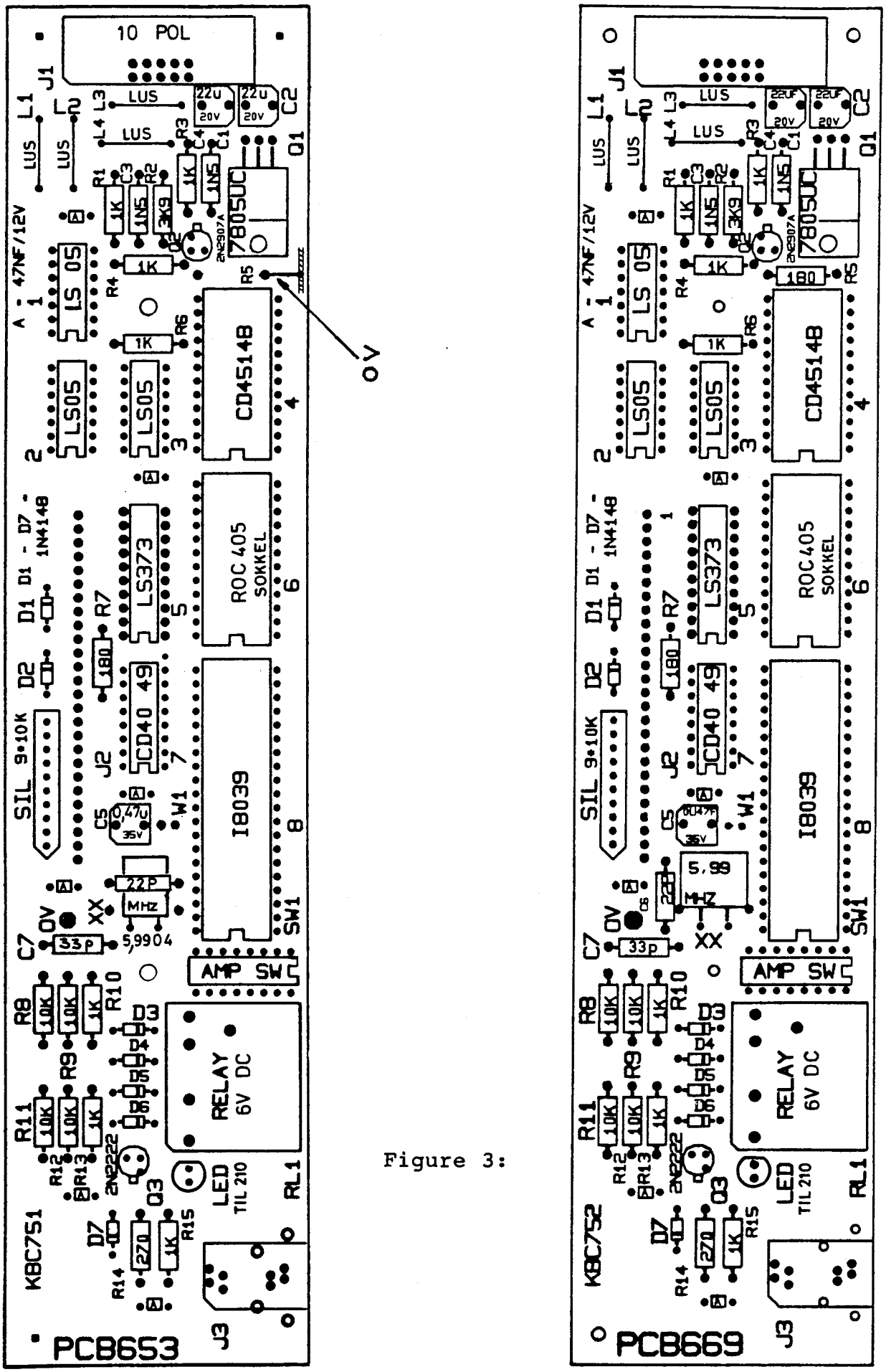
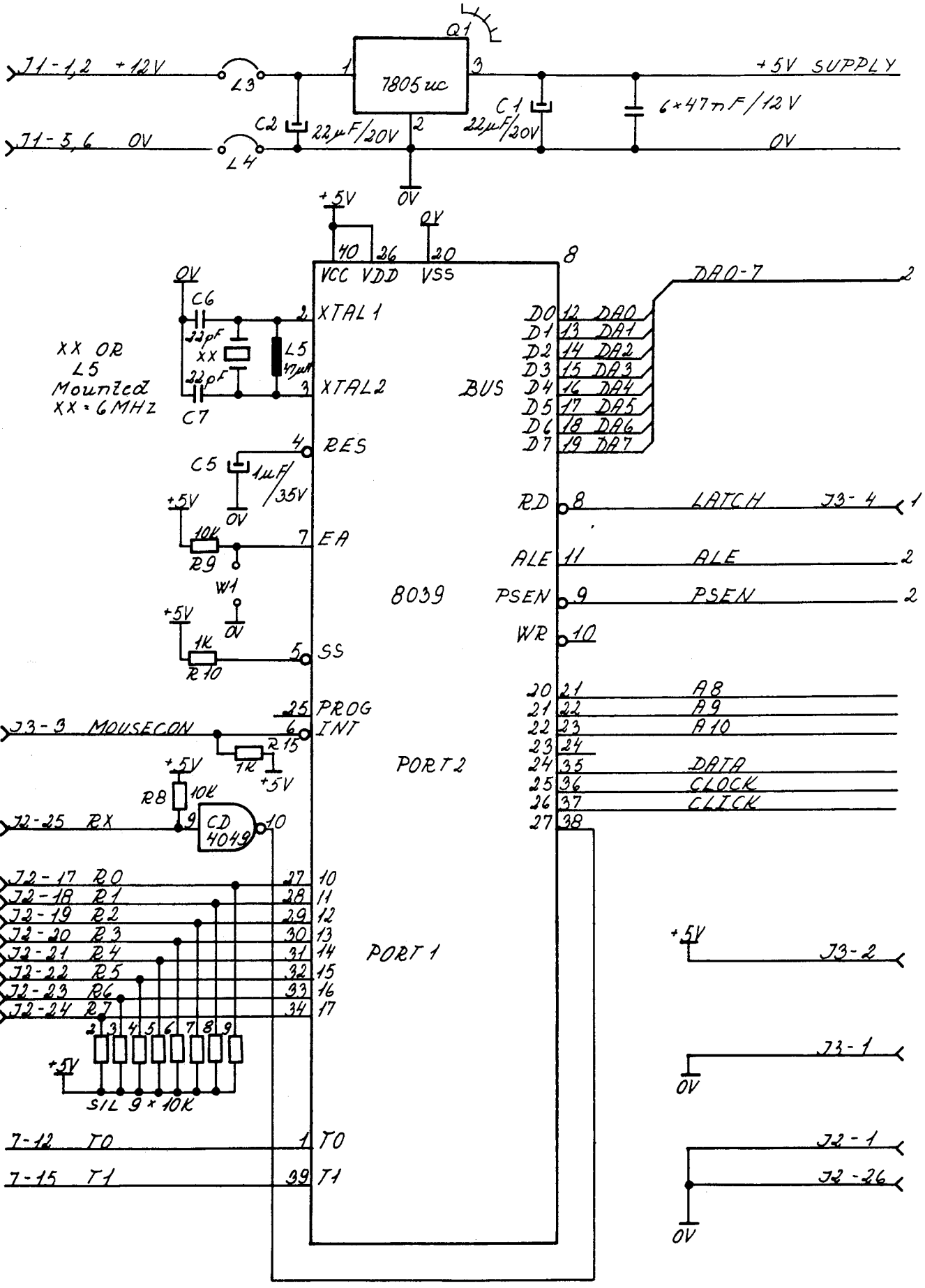

10 POL
J1
L1
L3
L4
LUS
22U
20V
C2
C1
C4
R3
R1
C3
R2
1K
1N5
3K9
Q2
2N2907A
Q1
7805UC
A = 47NF/12V
LS 05
R4
R5
R6
LS05
CD45148
D1 D1 - D7 - 1N4148
D2
SIL 9*10K
R7
180
LS373
ROC405
SOKKEL
CD40 49
J2
C5
0,47
35V
W1
I8039
SW1
22P
MHz
5,9904
XX
OV
C7
33p
AMP SW
R8
R9
R10
10K
R11
R12
R13
2N3222
Q3
D3
RELAY
6V DC
LED
TIL 210
RL1
D7
R14
R15
270
J3
KBC751
PCB653
5V

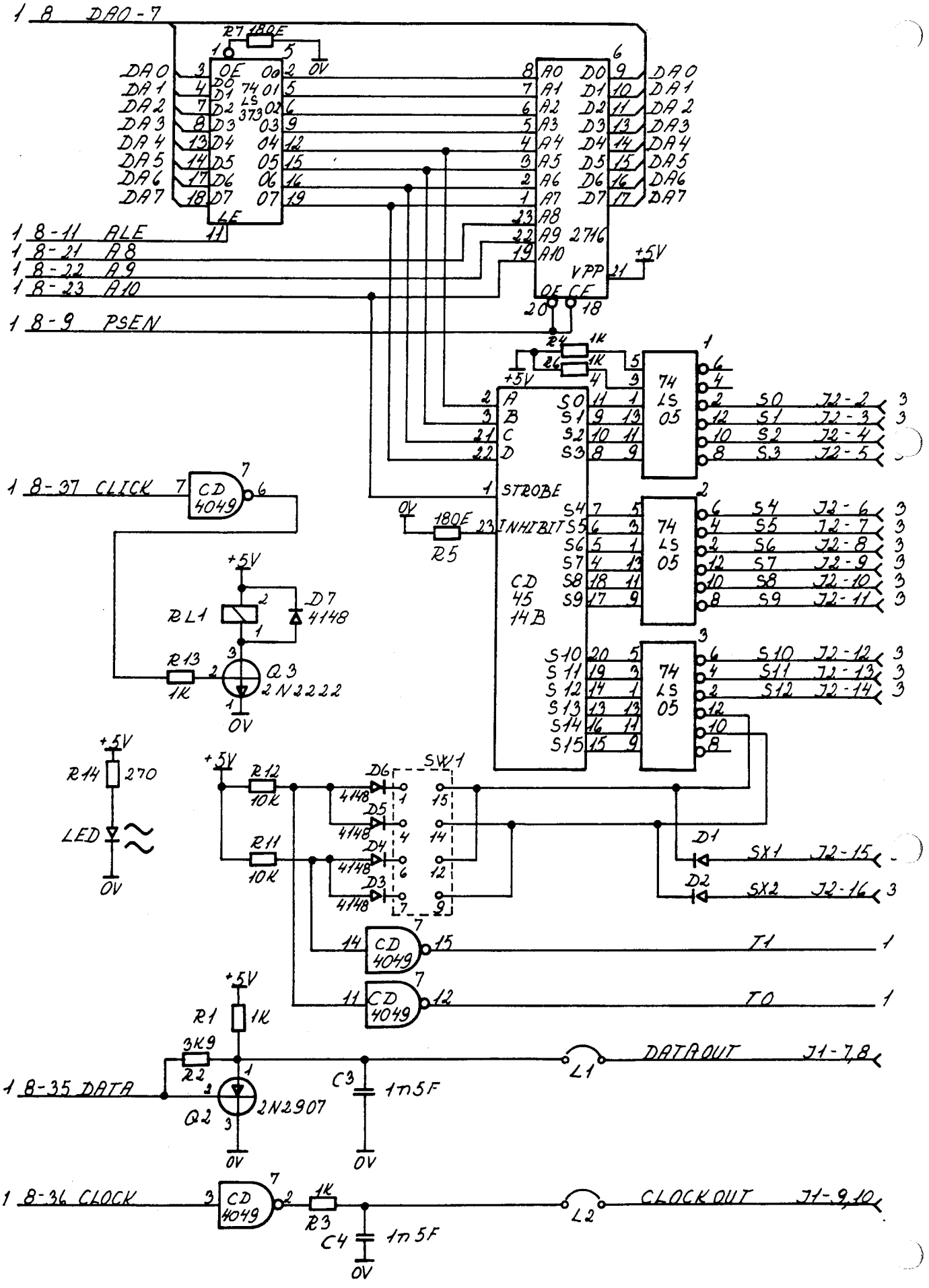
Figure 3:

10 POL
J1
L1
L3
L4
LUS
22UF
20V
C2
C1
C4
R3
R1
C3
R2
1K
1N5
3K9
Q2
2N2907A
Q1
7805UC
A = 47NF/12V
LS 05
R4
R5
180
R6
LS05
CD45148
D1 D1 - D7 - 1N4148
D2
SIL 9*10K
R7
180
LS373
ROC405
SOKKEL
CD40 49
J2
C5
0,47
35V
W1
I8039
SW1
22P
MHz
5,98
XX
OV
C7
33p
AMP SW
R8
R9
R10
10K
R11
R12
R13
2N3222
Q3
D3
RELAY
6V DC
LED
TIL 210
RL1
D7
R14
R15
270
J3
KBC752
PCB669

2.1 Logic Diagrams and Functional Description

Signal	Description
MOUSECON	Serial data input from mouse.
RX	Returnline for the two SHIFT-keys.
R0-7	Returnlines from the KSA751
T0, T1	Input from nationality switch
DA0-7	Data-Address bus.
LATCH	Strobe signal present in the mouse connector J3.
ALE	Address latch enable
PSEN	Program store enable
A8-A10	3 most significant address bits.
DATA	Unbuffered DATAOUT-line
CLOCK	Unbuffered inverted CLOCKOUT line
CLICK	Controls the activation of the relay
S0-12	Scanlines used on the KSA751
SX1, 2	Scanlines dedicated to the nationality switch and the two SHIFT-keys.
DATAOUT	Serial data from keyboard.
CLOCKOUT	Strobe clock from keyboard.


J1-1,2 +12V
L3
J1-3,6 0V
L4
Q1
7805 uc
C2 22µF/20V
C1 22µF/20V
6×47nF/12V
+5V SUPPLY
0V
+5V
0V
40 VCC
36 VDD
20 VSS
8
C6 33pF
XX
22pF
C7
L5 47µH
XX OR L5 Mounted XX = 6MHz
2 XTAL1
3 XTAL2
4 RES
C5 1µF/35V
10K R9
7 EA
W1
1K R10
5 SS
25 PROG
J3-3 MOUSECON
6 INT
R15 1K
R8 10K
3 J2-25 RX
CD 4049
9
10
3 J2-17 R0
3 J2-18 R1
3 J2-19 R2
3 J2-20 R3
3 J2-21 R4
3 J2-22 R5
3 J2-23 R6
3 J2-24 R7
27 10
28 11
29 12
30 13
31 14
32 15
33 16
34 17
PORT 1
2 3 4 5 6 7 8 9
SIL 9×10K
2 J7-12 T0
2 J7-15 T1
1 T0
39 T1
8039
BUS
D0 12 DA0
D1 13 DA1
D2 14 DA2
D3 15 DA3
D4 16 DA4
D5 17 DA5
D6 18 DA6
D7 19 DA7
DA0-7
2
RD 8
LATCH
J3-4
1
ALE 11
ALE
2
PSEN 9
PSEN
2
WR 10
20 21 A8
21 22 A9
22 23 A10
23 24
24 35 DATA
25 36 CLOCK
26 37 CLICK
27 38
PORT 2
+5V
J3-2
J3-1
0V
J2-1
J2-26
0V


1 8 DA0-7
R7 180E
74 LS 373
OE
LE
DA0
DA1
DA2
DA3
DA4
DA5
DA6
DA7
0V
1 8-11 ALE
1 8-21 A8
1 8-22 A9
1 8-23 A10
1 8-9 PSEN
2716
VPP
OE
CE
+5V
R4 1K
R6 1K
74 LS 05
STROBE
INHIBIT
CD 4514B
1 8-37 CLICK
CD 4049
R5 180E
RL1
D7 4148
R13 1K
Q3 2N2222
R14 270
LED
R12 10K
R11 10K
SW1
D6 4148
D5 4148
D4 4148
D3 4148
D1
D2
SX1 J2-15
SX2 J2-16
T1
T0
R1 1K
R2 3K9
Q2 2N2907
C3 1n5F
C4 1n5F
DATAOUT J1-7,8
CLOCKOUT J1-9,10
1 8-35 DATA
1 8-36 CLOCK
L1
L2

2.2 Special Hardware Features

The keyboard scanning

The scanning circuit consist of the 4 IC's 1, 2, 3 and 4. The IC4 is a 4-to-16 line demultiplexer. The IC's 1, 2 and 3 form a line of 18 inverters with open collector outputs. One, and only one, of the scanlines S0-S12 and SX1, 2 will be pulled low at a time. The rest of the scanlines will be in the high impedance state. The line to be pulled low is selected by the 4 selectlines A-D on IC4.

The selectlines A-D is connected to the addresslines A4-A7.

The STROBE-input on IC4 is connected to the most significant addressbit, A10. The following figure will describe the scanline addressing.

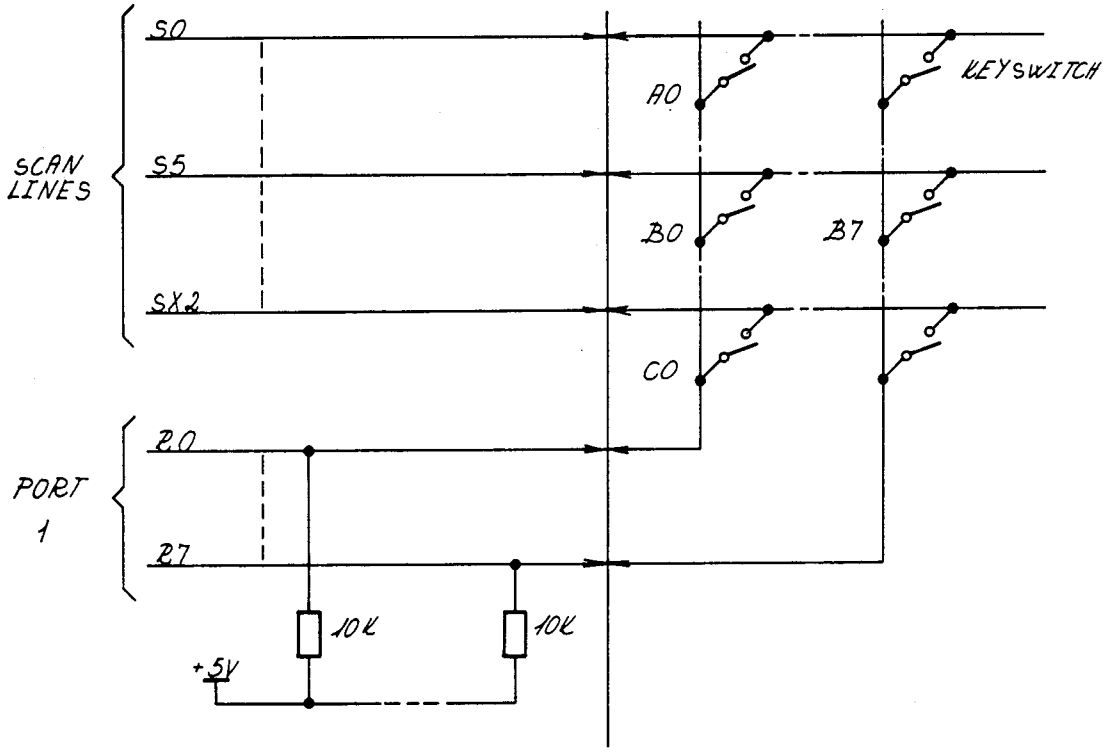
MSB ← ENABLES SCANNING LSB

	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	
H2				H1				H0				HEX
				CONTROLS SCANLINES				DON'T CARES				

Example: In the address 043B(H) the scanline S3 will be pulled low.
In the address 0431(H) the scanline S3 will be pulled low.
In the address 0331(H) none of the scanline will be pulled low. All lines will be in the high impedance state.
In the address 06D7(H) the scanline SX1 will be pulled low.

The return lines

Port 1 defines the returnlines from the keyswitch assembly (KSA751). The figure shown below shows the principal function of the returnlines, R0-R7.



Example: Assume that the switch B0 is closed.
Assume that the return-lines is read, and that the address for this operation is 0456(H).
The S5-line is then pulled low, and the reading will then show that the LSB of part 1 (R0) is "0". This will mean that B0 is closed.
The MSB of part 1 (R7) will be "1" since B7 is open.
If the reading of part 1 was done while the address was e.g. 050F(H) then the LSB of part 1 (R0) will reflect the status of switch A0.

The nationality switch

SW1 in the KBC751 diagram is the nationality switch. This switch is a binary-count switch. The switchfunction is described in the following scheme.

					SX1 LOW		SX2 LOW	
Pin pair:	7-9	6-12	4-14	1-15	T1	T0	T1	T0
switch position 0	O	O	O	O	L	L	L	L
1	O	O	O	S	L	H	L	L
2	O	O	S	O	L	L	L	H
3	O	O	S	S	L	H	L	H
4	O	S	O	O	H	L	L	L
5	O	S	O	S	H	H	L	L
6	O	S	S	O	H	L	L	H
7	O	S	S	S	H	H	L	H
8	S	O	O	O	L	L	H	L
9	S	O	O	S	L	H	H	L
A	S	O	S	O	L	L	H	H
B	S	O	S	S	L	H	H	H
C	S	S	O	O	H	L	H	L
D	S	S	O	S	H	H	H	L
E	S	S	S	O	H	L	H	H
F	S	S	S	S	H	H	H	H

S = Shorted O = Open L = Low H = High

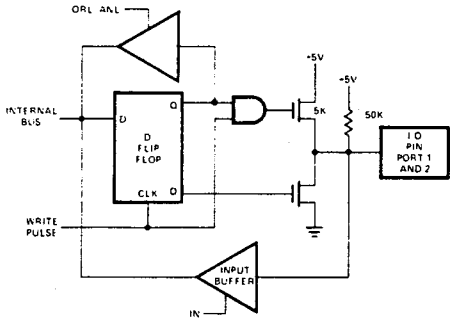
To the right in scheme is the state of the two test inputs shown; as a function of the switch position and the state off the two scanlines (IC no. 3 pin 10 and 12).

The handshake

Port 1 and 2 of the 8039 microcomputer has a special feature: Each bit in the ports can function as both an input and an outputline. this feature is used in making the DATAOUT-line bidirectional.

The DATAOUT-line is, when inactive, pulled high via an 50 K Ohm resistor located inside the 8039.

The internal structure of the I/O-parts is shown below.



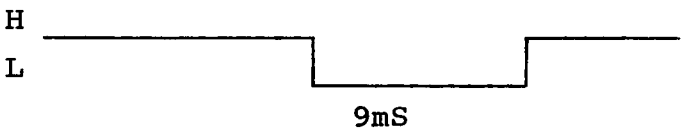
Whenever the computer is not ready for receiving data from the keyboard, the computer will pull the DATAOUT-line low. this low level will be detected at port 2's bit no. 4.

This handshake feature is a very efficient way to avoid overrun in the keyboard-receiver-circuit.

The click device

In order to simulate the "click"-sound of a ordinary typewriter, the KBC751/KBC752 is equipped with a relay (RL1). This relay can be used to create a "click"-sound whenever a key is pressed. The relay is controlled by bit no. 6 in port 2. A low voltage on this pin will turn on the relay.

In order to create a well defined "click"-sound, the pulse to the relay is as follows:



Mouse connection

KBC751/752 is prepared for the connection of a mouse. The mouse will send serial data to the KBC at a baudrate of 1200. The KBC is then to pass on the mouse-information to the computer.

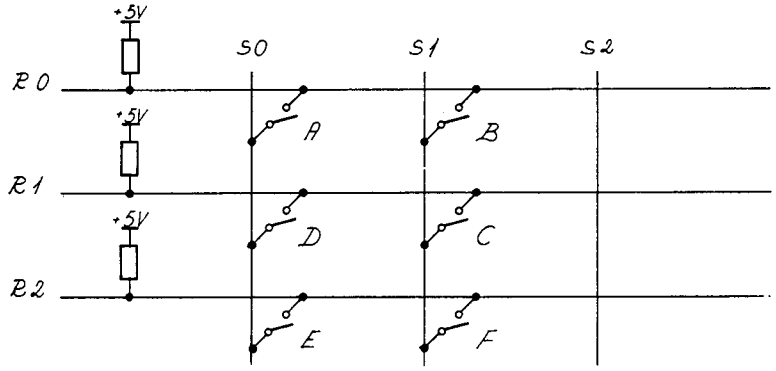
Two types of mouseconnectors can be used; this is shown by the double layout of J3 (J3A) in fig. 2.1.

3. THE KEY SWITCH ASSEMBLY (KSA751)

The KSA is simply the printed circuit board where the switches are mounted. The diagram is shown on page 18.

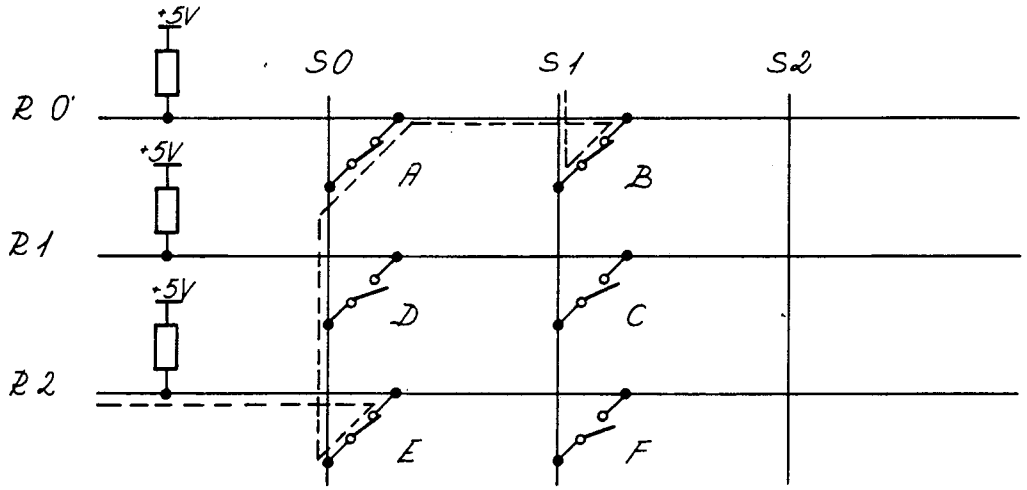
3.1 The Phantom Phenomenon

The KSA is very simple but there is still a problem concerning the detection of depressed keys. Consider the example shown below:



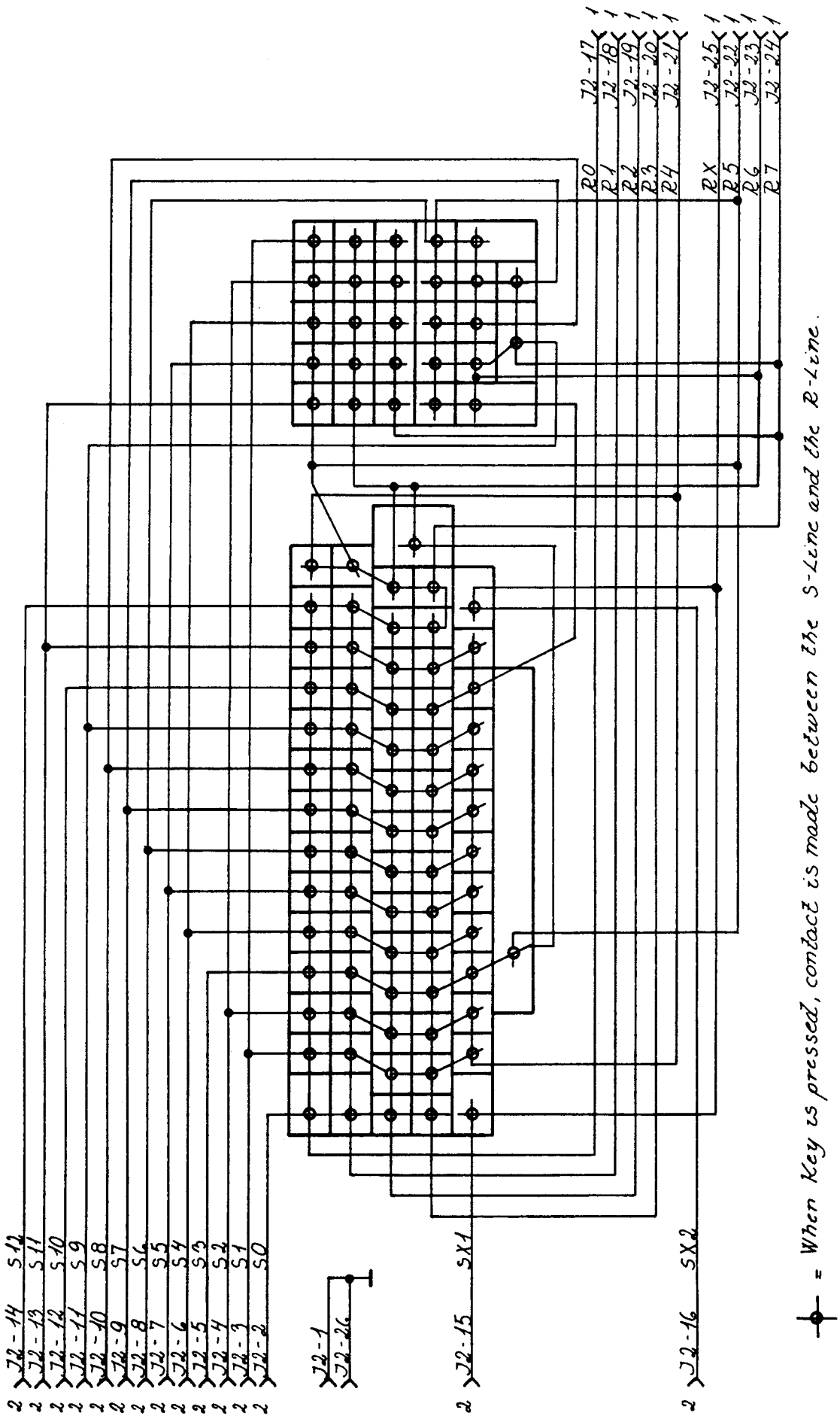
If S0 is pulled low, R0 and R2 will also be pulled low, indicating that A and E are closed. The next step in the scanningprocedure will now be to pull S1 low. R0-R2 will now be high indicating that none of the switches B, C and F are closed. The situation described here will be normal.

Consider now this situation:



When S0 is pulled low, R0 and R2 will be pulled low indicating that A and E is closed. When now S1 is being pulled low, R0 and R2 will be pulled low. This would normally indicate that F is closed, but this is actually not so. This condition is called a phantom condition. The condition is caused by the connection from B to A and to E. This is shown in the figure. We will see that the phantom condition will occur whenever the switches in 3 corners of a layout switch quadrangle is closed. The effect of the phantom conditionis that two scanlines (here S0 and S1) will look as though they were equal. I.e. that A and E are closed and B and F are closed.

The equality will in the program be used as a criteria for the presence of a phantom condition.


J2-14 S12
J2-13 S11
J2-12 S10
J2-11 S9
J2-10 S8
J2-9 S7
J2-8 S6
J2-7 S5
J2-6 S4
J2-5 S3
J2-4 S2
J2-3 S1
J2-2 S0
J2-1
J2-26
J2-15 SX1
J2-16 SX2
J2-17 R0
J2-18 R1
J2-19 R2
J2-20 R3
J2-21 R4
J2-25 RX
J2-22 R5
J2-23 R6
J2-24 R7
= When Key is pressed, contact is made between the S-Line and the R-Line.

4. THE MICROPROGRAM

The microprogram for the 8039 single chip micro-computer is stored in a 2716PROM.

There exists 3 versions of the PROM:

ROC191 is the originally PROM with no mouse-support.

ROC315 is basicly a ROC191 except for the selftest-routine. ROC315 will transmit an error-code when a key is depressed during power-up.

ROC405 is basicly a ROC315 with a mouse-handling-routine added.

4.1 Error-Codes

When power is applied the KBC performs a selftest. The test is divided into 3 "sub-tests" which are performed in the sequence shown below:

1. First the PROM is being testet for a zero checksum. If this test fails 4 "cliks" are being transmitted and the "position code" 254 decimal is send to the computer.

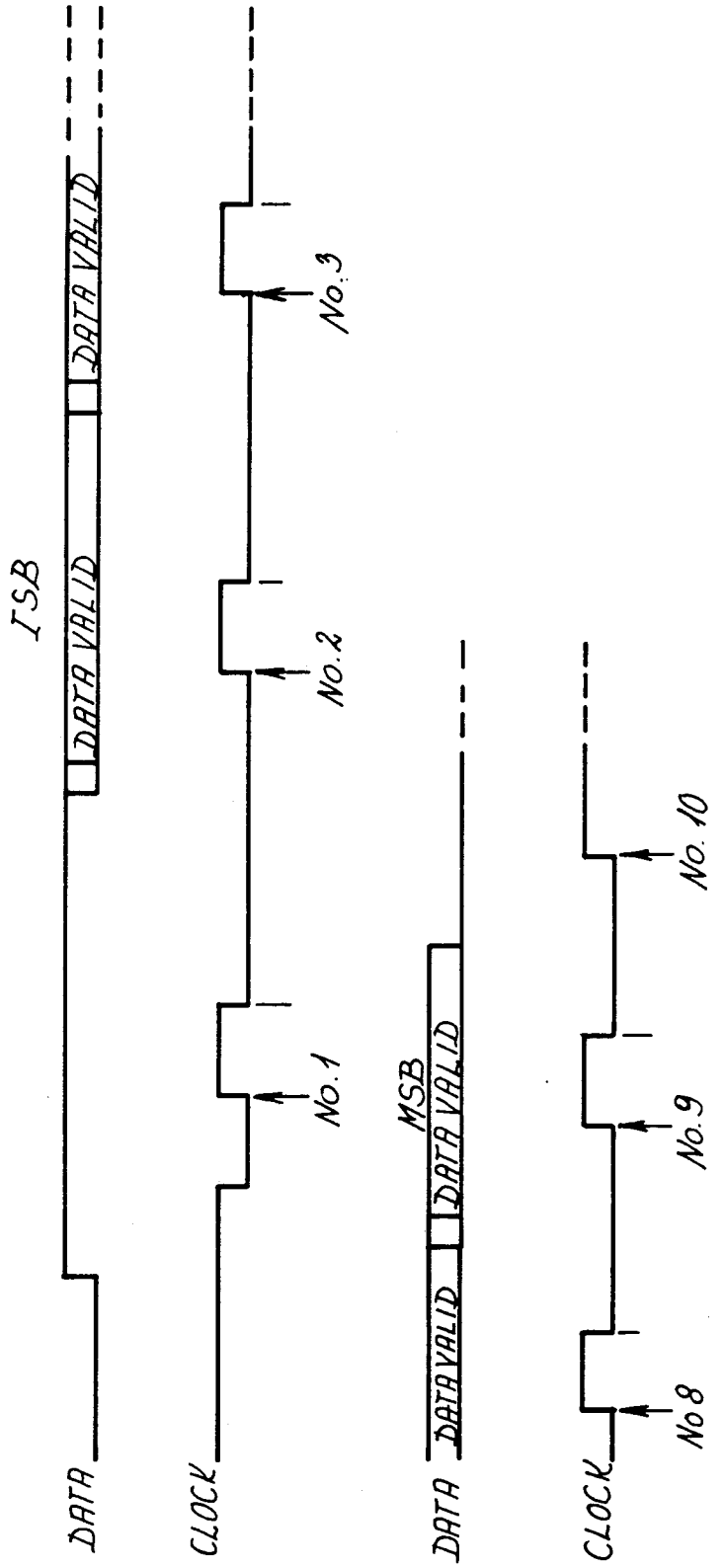
2. The keyswitch-assembly is then being tested for any depressed key during power-up. If a depressed key is detected 1 "click" is transmitted and 253 decimal is send to the computer.

3. Port 2 are the 8039 microcomputer is then being tested. The test fails if the setup value written to the port does not match the actual read value. If the test fails 2 "clicks" are transmitted and 252 decimal is send to the computer.

If no error conditionis detected 3 "clicks" are transmitted and 255 decimal is send to the computer.

CODE ASSIGNMENT

CODE	DECRIPTION
255	OK-code
214 . . . 244	Available error-codes
243 . . . 228	Nationality codes
227	Not used
226 . . . 129	Release codes
128 . . . 99	Not used
98 . . . 1	Position codes
0	Not used


LSB
DATA VALID
DATA VALID
DATA
CLOCK
No.1
No.2
No.3
MSB
DATA VALID
DATA VALID
DATA
CLOCK
No.8
No.9
No.10
= 2,5 µS

RETURN LETTER

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How can this manual be improved?

Other comments?

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Date: _____

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