sinclair
SERVICE MANUAL

ZX Microdrive
ZX Interface 1
ZX Interface 2

SERVICING MANUAL

FOR

ZX MICRODRIVE, INTERFACE 1 AND INTERFACE 2

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

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SECTION 1

SYSTEM DESCRIPTION

1. ZX INTERFACE 1

The ZX interface 1 combines the three functions of microdrive controller, local area network and RS232 interface. Using it the Spectrum can control up to 8 microdrives; can connect up to 64 other Spectrums to form a network, and can communicate with other computers and peripheral devices via the RS232 serial data link.

ZX interface 1 also provides an extension to the Basic Spectrum software which incorporates all the microdrive, RS232 link and network functions. A block diagram of the unit is given in Figure 1.1

The circuit comprises 4 integrated circuits. These and their major functions are set out below:

(a) IC4 - oscillator for IC1,

(b) IC3 - address decoder to page ROM IC2,

(c) IC2 - ZX interface 1 ROM,

(d) IC1 gate array - controller of microdrive, RS232 serial link and network.

1.1 Oscillator and Buffer IC4

1.1.1 IC4 is a fast CMOS integrated circuit which forms, with crystal X1, a clock oscillator for the gate array IC1. It provides a very high drive level to IC1 with a very high slew rate.

1.1.2 The link shown on the circuit diagram between IC1 pin 5 and capacitor C3 is included so that the circuit can accommodate, some time in the future, a self-oscillating replacement for IC1.

1.2 Address Decoder IC3

1.2.1 The function of IC3 is to enable IC1 to substitute the interface 1 ROM (IC2) for the Spectrum ROM whenever an error code is generated by the Spectrum BASIC.

1.2.2 In normal operation, the Spectrum program transfers to address 8 when it finds an instruction it does not recognise, and an error message is displayed on the screen. With interface 1 connected, the Spectrum software brings up all zeros on the address line inputs to IC3, forcing input pin 3 (DECODE) on IC1 high. This signal sets a latch which asserts the outputs on pins 7 (ROMEN) and 6 (ROMCS) of IC1 which enable the interface 1 ROM (IC2) and disable the Spectrum ROM, respectively.

1.2.3 At this time the new software examines the content of the machine stack produced by the original error indication. If it recognises one of its own instructions it takes over. If it sees a genuine error it passes control back to the Spectrum via a message on the data bus.

1.2.4 Transistors Q10 and Q11 control the IORQ line input to the Spectrum ULA (IC1 pin 33). The IORQ line from the Spectrum CPU supplies both the interface 1 gate array IC1 and the Spectrum ULA, and is an active low signal.

1.2.5 When IORQ is asserted from the Spectrum, the Spectrum's own ULA may inhibit the CPU clock for several cycles. Transistor Q10 disables this action for any I/O transaction except for those during which AØ is low (i.e. I/O transactions with Spectrum ULA). This transistor is duplicated inside the Spectrum in later issues. Transistor Q11 is provided to speed up the propagation of IORQ from Z80 to Spectrum ULA. This is necessary to overcome the extra capacitance on the processor bus and particularly on IORQGE.

1.3 ZX Interface 1 ROM IC2

1.3.1 All the additional software needed to operate the interface 1 functions resides in IC2. IC2 enable is discussed in paragraph 1.2.2 above. In addition to control from IC1, the ROM may be disabled by a device connected to the expansion connector J1. ROMCS2 from, for example, Interface 2 connected to J1 would disable both ROM IC2 and the Spectrum ROM, via isolating diodes D10 and D9 respectively.

1.4 Gate Array IC1

1.4.1 The major functions of IC1 are to control the following:

(a) RS232 serial link,

(b) network,

(c) microdrive.

1.4.2 IC1 is clocked at 8.0 MHz from its own external crystal oscillator on pin 5, and is controlled by the Spectrum CPU which uses a standard three bus input/output arrangement. These busses are the address bus, data bus and control bus.

1.4.3 **Address Bus.** Addresses A0-A15 are decoded to select particular port or memory addresses depending on the required function. Eight of these lines are decoded in IC3 as previously discussed.

1.4.4 **Data Bus.** D0-D7 constitutes an 8-bit bi-directional data bus used for data exchanges with the CPU or memory. Parallel data input/output on this bus is converted to/from serial data within IC1 since all input/output devices connected to IC1 are serial data devices.

1.4.5 **Control Bus.** This is a set of individual signals which organises the flow of data on the address and data busses. $\overline{\text{MREQ}}$ indicates that the address bus holds a valid address for a memory read or write operation. The $\overline{\text{RD}}$ and $\overline{\text{WR}}$ signals indicate that the CPU wishes to read or write data to a memory location or I/O device. $\overline{\text{IORQ}}$, the input/output request, indicates that the address bus holds a valid address for the gate array during gate array input/output operations. The $\overline{\text{WAIT}}$ signal is used to instruct the Spectrum to wait until a looked-for signal arrives on the network.

1.4.6 **Port Addresses.** The following table sets out the port addresses and individual bits which control IC1 input/output operations. These ports and bits may be addressed in BASIC from the keyboard.

ADDRESS HEX (DECIMAL)	PORT		BIT 7 (MSB)	6	5	4	3	2	1	BIT Ø (LSB)
EF(239)	STATUS	READ				BUSY	DTR	GAP	SYNC	WRITE PROTECT
	CONTROL	WRITE			WAIT	CTS	ERASE	R/$\overline{\text{W}}$	COMMS CLK	COMMS DATA
E7(231)	MICRO-DRIVE DATA	Accessing this port from BASIC will almost certainly cause the computer to crash								
F7(247)	RS232/ NETWORK	READ	TXDATA (R232 DATA INPUT)							NET INPUT
		WRITE								NET OUTPUT/ RXDATA

I/O PORT ASSIGNMENTS FOR INTERFACE 1

1.5 RS232 Serial Link

1.5.1 The same pin on IC1, pin 33, is used for the network transmit data and for the RS232 transmit data. In order to select the required function IC1 uses its COMMS OUT signal, borrowed from the microdrive control when the microdrive is not being used. This signal is routed from pin 30 to the emitter of transistor Q3 and, via resistor R4, to the base of transistor Q1. When COMMS OUT is high Q3 is enabled thus selecting RS232, and when it is low Q1 is enabled selecting the network.

1.5.2 The RS232 link provides a signal of ±12V. This is obtained directly from the Spectrum via pin 22B on the expansion connector and the -12V is derived from the output of a charge pump, formed by diodes D1 and D2 and capacitors C1 and C2. The output may in fact fall as low as -7V but since the RS232 interface specifies -3V this is adequate.

1.5.3 The RS232 serial data interface can be sent 2 types of data, 8-bit binary code and 7-bit text-only information. Refer to the interface 1 manual for details. The RS232 employs 4 data and control lines as set out in the table below:

LINE	FUNCTION	IC1 PIN
Rx DATA (Receive Data)	Transmitted data.	33
Tx DATA (Transmit Data)	Received data.	4
CTS (Clear to Send)	Tells remote station that Spectrum wishes to send data.	34
DTR (Data Terminal Ready)	Tells Spectrum that remote station wishes to send data.	1

1.5.4 In operation, serial data prepared in the Spectrum is transmitted to line via transistors Q3 and Q4. These form an amplifier which produces a large voltage swing. The same circuit is used for the transmission of the CTS signal using transistors Q6 and Q5. The Tx DATA and DTR signals received from the line are fed into a terminating and clamping circuit formed by resistors R24 and R25, R28 and R29 and diodes D6 and D7. Negative excursions of signals are prevented and the signals input to IC1 are limited to +5V.

1.5.5 The RS232 interface is output on a 9-pin connector SK1 which provides a ground signal and a pull-up signal. This allows for a high level signal to be fed back into DTR, when the remote device does not provide a DTR signal.

1.6 Network

1.6.1 The NET jack sockets SK2 and SK3 are connected in parallel to the NET input pin 36 on IC1. The network is common emitter in that all stations on the network can either source current into the net or be turned off. Jack plugs are used in such a way that any socket not used automatically terminates the network.

1.6.2 When a jack is inserted in the socket it breaks the connection to a 330Ω resistor, R22 and R23, disconnecting it from the circuit. With a network set up, the two end stations would be the only ones with the 330Ω resistors in circuit. There is therefore their combined resistance, giving a pull-down impedance of about 165Ω to the circuit. Zener diode Z1 provides protection for NETIN by clamping pin 16 to 5.1V.

1.7 Microdrive Control

1.7.1 Seven lines are used by gate array IC1 to control the input and output of data to and from the microdrive. These signals are summarised in the table below.

SIGNAL	FUNCTION	IC PIN NO
ERASE	Control of erase current to microdrive.	35
R/$\overline{W}$	Instructs microdrive to either read or write.	29
COMMS OUT	Microdrive selection. Also selects NET/RS232 when microdrive not in use.	30
COMMS CLK	Microdrive clock.	31
WR PROT	Input which informs IC1 of the status of the write protect microswitch on the selected microdrive.	32
DATA 1	Data from/to microdrive track number 1.	37
DATA 2	Data from/to microdrive track number 2.	38

1.7.2 The implementation of the above signals is described in the following paragraphs.

2. ZX MICRODRIVE (Figure 1.3)

2.1 The ZX microdrive is a 'floppy tape' system used to store and retrieve up to 100 k bytes of information per cartridge. It is connected to the Spectrum via ZX interface 1 and its own flexible ribbon cable, and houses all its own read/write and motor control electronics within its case. Expansion port connectors on each microdrive allow up to 8 devices to be plugged together and connected to one Spectrum computer.

2.2 The microdrive cartridge uses a continuous loop of 2 mm wide video tape. Data is written on two tracks using a standard stereo head arrangement and is written in bytes, one byte to each track. Data is read from the tape in the same way. Software sees the tape as one continuous track since hardware takes care of switching between tracks.

2.3 Although up to 8 microdrives can be connected together and controlled from 1 Spectrum, only 1 can be in use at any instant. The required microdrive and the type of operation, read or write, is selected under software control. During a read operation data is read from the selected microdrive tape. During a write operation the microdrive tape is erased before being written. The erase head is displaced from the write head and is timed by IC1 to sink current before the write head is enabled.

2.4 Microdrives are selected using the COMMS OUT and COMMS CLK signals from IC1. Each microdrive control circuit (IC1 on the microdrive circuit diagram), contains one stage of a shift register (a flip-flop). COMMS CLK is connected to each microdrive and COMMS OUT is routed via the expansion connector to the COMMS IN pin on the next microdrive, which is the input to the shift register. To select a particular microdrive a '1' is shifted into its shift register to give a '1' on its COMMS OUT pin.

2.5 COMMS OUT not only feeds the next microdrive; it is used to select its own IC internal functions and to select the LED, the motor, the erase current and the write protect for the selected microdrive. Therefore, while this signal is low the motor is disabled, the LED is off, no current can flow through the microdrive switch and therefore no erase current can flow.

2.6 Consider the motor drive circuit. A high on pin 20 of IC1 turns on Q1. This pulls the base of Q2 low turning it on and switching power to the motor. Capacitor C10 and resistor R2 time constant ensure that the motor does not cut in too quickly and damage the tape. The red indicator LED D5 is switched on at the same time. With Q2 turned on and the write protect microswitch closed, the erase head current circuit is enabled via pin 6 of the headboard connector. When the erase output is enabled on pin 35 of IC1, transistor Q9 switches on and current flows in the selected microdrive erase head. Diodes D3 and D4 provide protection against reverse currents. Diodes D1, across the erase head, and D2 perform similar functions. The amount of current flowing in the erase head is limited by IC1 and is about 25 mA.

2.7 The write protect signal, WR PROT, on pin 32 of gate array IC1 is normally low. A selected microdrive pulls this signal high when the WR PROT microswitch is closed. When the microdrive cartridge is not present or the write protect flange is broken off this signal is low, informing the user that it cannot write.

2.8 During read/write operations the $R/\overline{W}$ signal on IC1 pin 23 places the selected microdrive in either the read or the write mode, and enables the read or the write amplifiers.

2.9 Data is recorded on 2 tracks using a standard stereo cassette head arrangement and is written in bytes, one byte to one track and the next byte to the other track. It is recovered in the same way. The tape itself is one continuous loop. Since hardware takes care of switching between tracks the software sees the tape as one double-length single track.

2.10 Power to the microdrive circuits has to be filtered and IC2 and capacitors C3 and C4 are used to accomplish this.

2.11 Consider a read cycle. In the read mode the signals appearing in the two read coils inside the heads are differentially amplified through two amplifier chains within IC1. The signals are then converted to digital form to enable logic processing. The outputs from the 2 amplifiers, in digital form are enabled into the DATA 1 and DATA 2 outputs from IC1 on pins 24 and 19. These signals are routed to the interface within the gate array via microdrive edge connector J2.

2.12 The signal recorded on magnetic tape is at the greatest when the rate of change of the signal imposing it was at its fastest. Therefore, when a squarewave has been written, the greatest recovered voltage is obtained on the edge of the pulse. Since the object is to produce a waveform which changes at the peaks of the recovered signal, IC1 contains amplifiers to bring the signal up to the required level, and a peak detect circuit which changes state when the input reaches its greatest level. The peak detector is followed by a hysteresis circuit which ensures that the output does not change on spurious signals.

2.13 The gain of the circuit should not need to be changed, as only one type of high quality video tape is used. The reproduce signal levels may be read across capacitors C1 and C2 and are typically in the order of 400 mV to 500 mV and 250 mV to 350 mV for the low frequency and high frequency signals respectively. In the record mode the modulator in IC1 converts the ones and zeros in the data into FM (frequency modulation) where there is always a transition at the beginning of the bit cell. If the data is a one there is a transition at the beginning and in the middle of the bit cell, which means essentially that the frequency doubles if the data contains ones.

2.14 The gain of the circuit can be adjusted if necessary by changing the ratio of resistors R9 and R8 on pins 15 and 14 of IC1.

2.15 Consider a write cycle. When the $R/\overline{W}$ signal from the gate array goes low the selected microdrive is placed in the write mode. This has the effect of changing DATA 1 and DATA 2 on IC1 from outputs to inputs. These inputs are used to drive current sources for track 1 and track 2. When DATA 1 is high, for example, current is pulled in one direction through the head, when it is low current is pulled in the other direction. Writing is done with an asymmetric write current. Because the erase function is carried out with a d.c. field it is necessary to write 'harder' in one direction than in the other to overcome residual magnetism. Resistors R4 and R5 on pins 11 and 7 of IC1 are chosen to allow this action. Should a different tape be introduced or a different head type be fitted these resistors would also need to be changed.

3. ZX INTERFACE 2

3.1 The ZX interface 2 connects directly to either the ZX interface 1 module or to the Spectrum expansion connector. It provides the interface for any joystick that has a standard 9-way D plug and enables the use of ZX ROM cartridge software. It also enables joysticks to be used with cassette-loaded programs and provides a connector for a ZX printer.

3.2 The interface comprises 1 printed circuit board upon which are mounted a single integrated circuit and all the input/output connectors.

3.3 With the interface 2 connected to either the Spectrum or interface 1 and with a ROM cartridge inserted, the $\overline{\text{ROMCS2}}$ signal disables the Spectrum ROM and enables the Spectrum to interface with the ROM cartridge. The Spectrum CPU then uses its address, data and control busses to access the ROM via the expansion connector.

3.4 The interface 2 ULA is a custom-built CMOS integrated circuit which plugs into the p.c.board mounted socket. Figure 1.4 gives a schematic of the device. Address bits A0, A11 and A12 are used to address the 2 joysticks, with $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$ performing their standard control functions. Lines K1 to K9 receive the control inputs from the 2 joysticks. The functions and connection details are summarised in the table below.

PIN NO.	SK3	SK4	FUNCTION
1	K9	K4	UP
2	K8	K3	DOWN
3	K6	K1	LEFT
4	K7	K2	RIGHT
5	-	-	-
6	K0	K5	FIRE
7	-	-	-
8	0V	0V	COMMON
9	-	-	-

NOTE: K1 to K9 correspond to keyboard keys 1 to 9

The rear edge connector provides connections for a ZX Printer.

4. POWER SUPPLY

The Spectrum power supply is capable of driving the Spectrum, interface 1, interface 2, ZX printer and 8 microdrives at the same time.

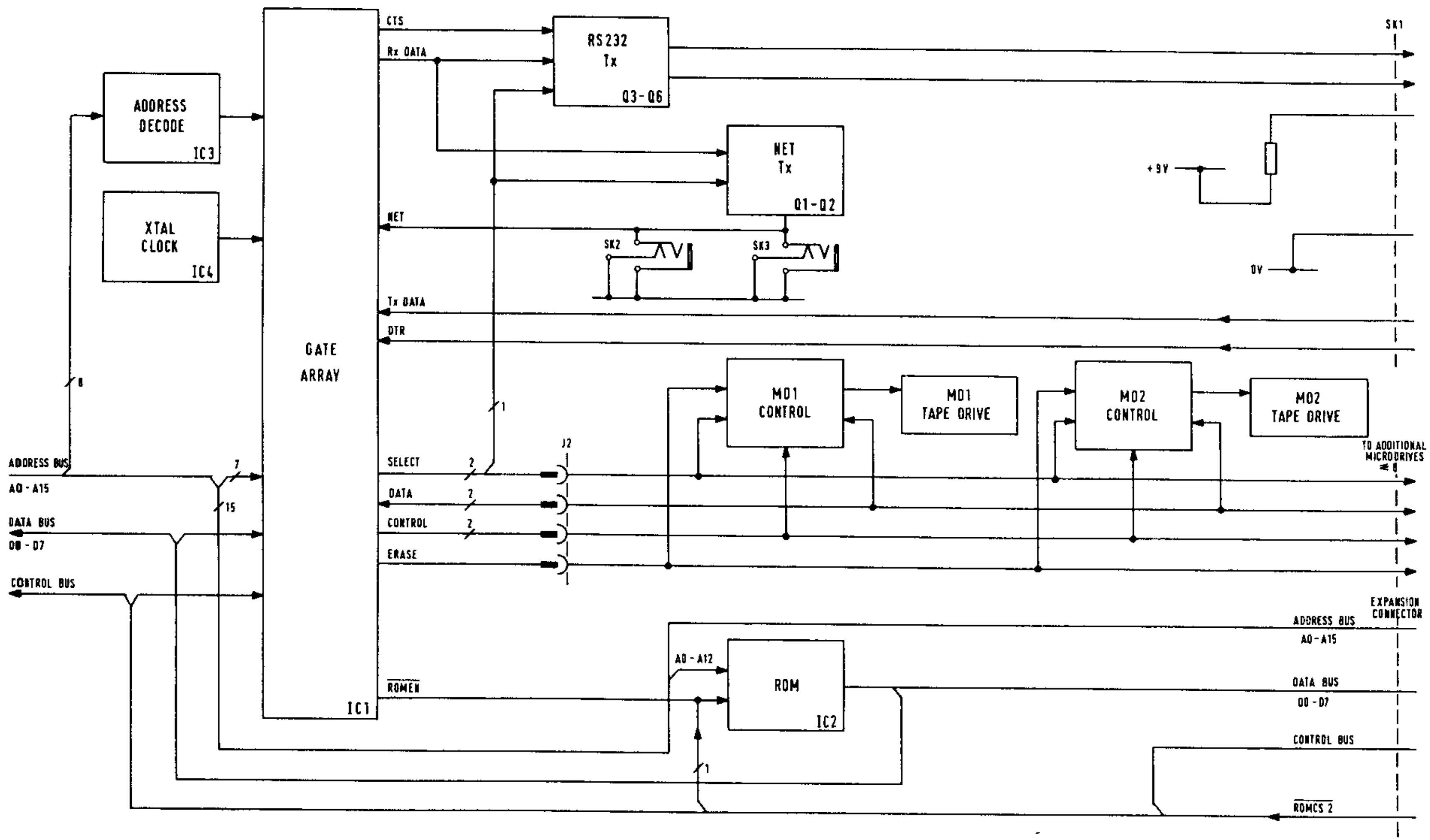
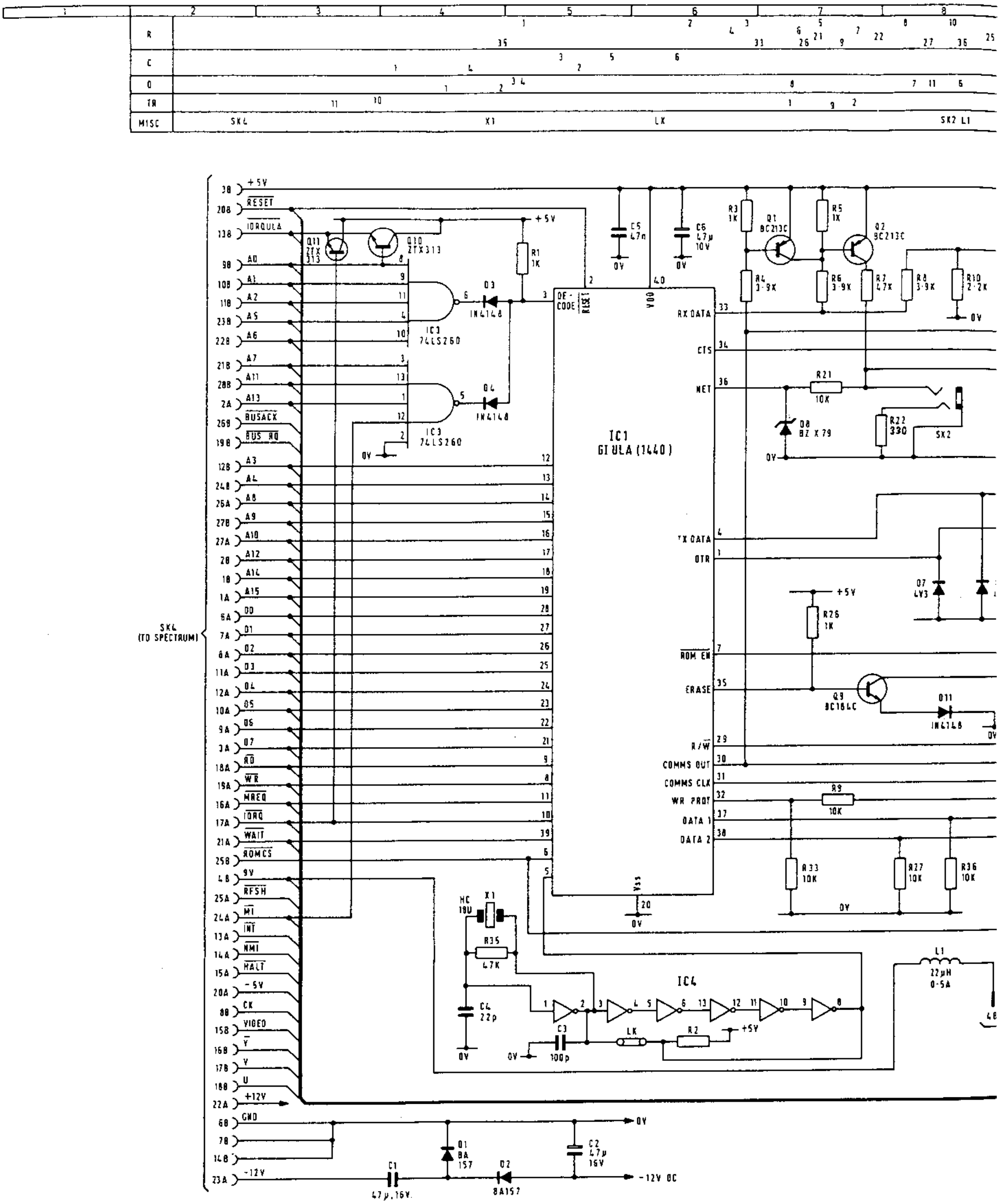
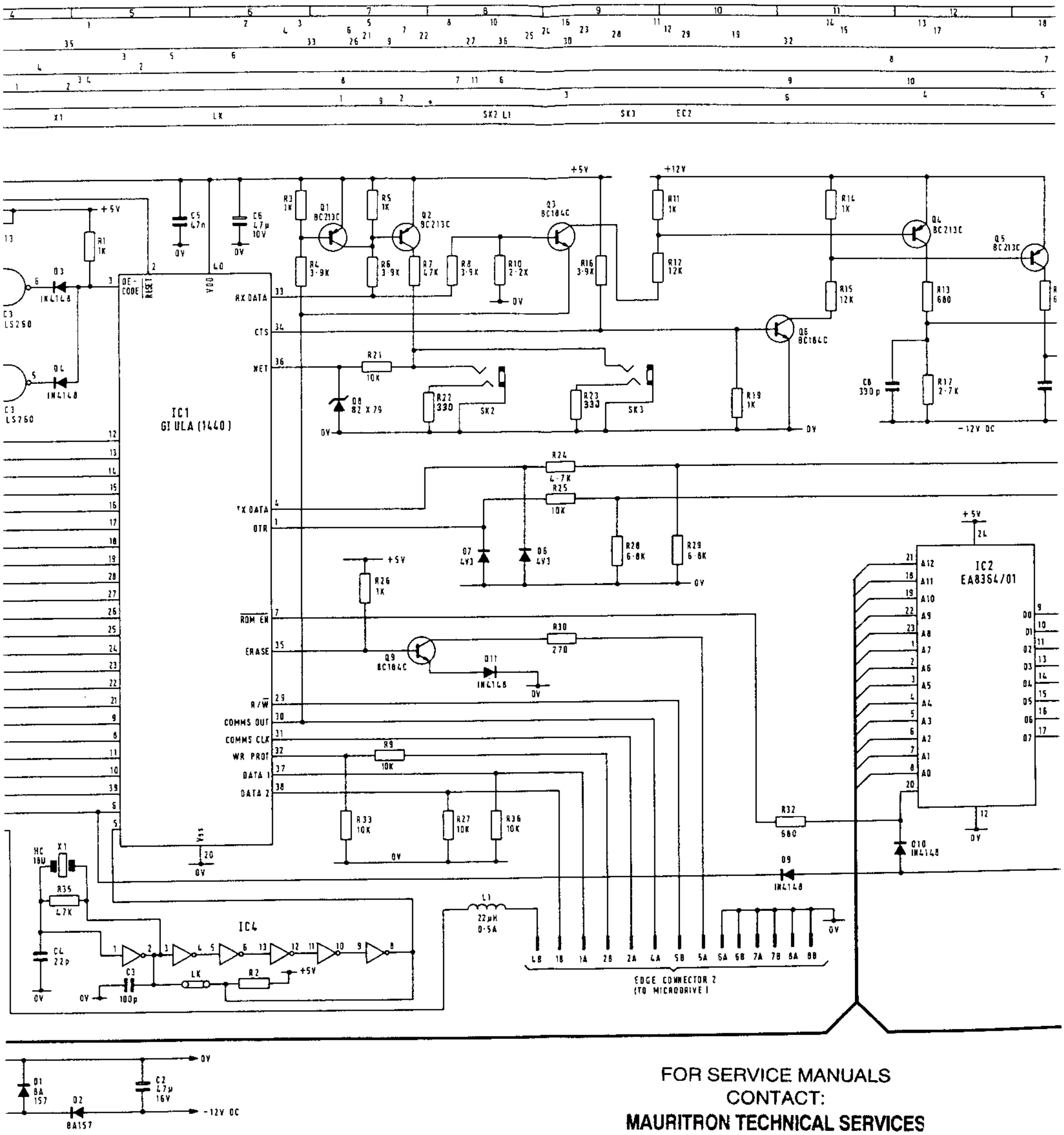
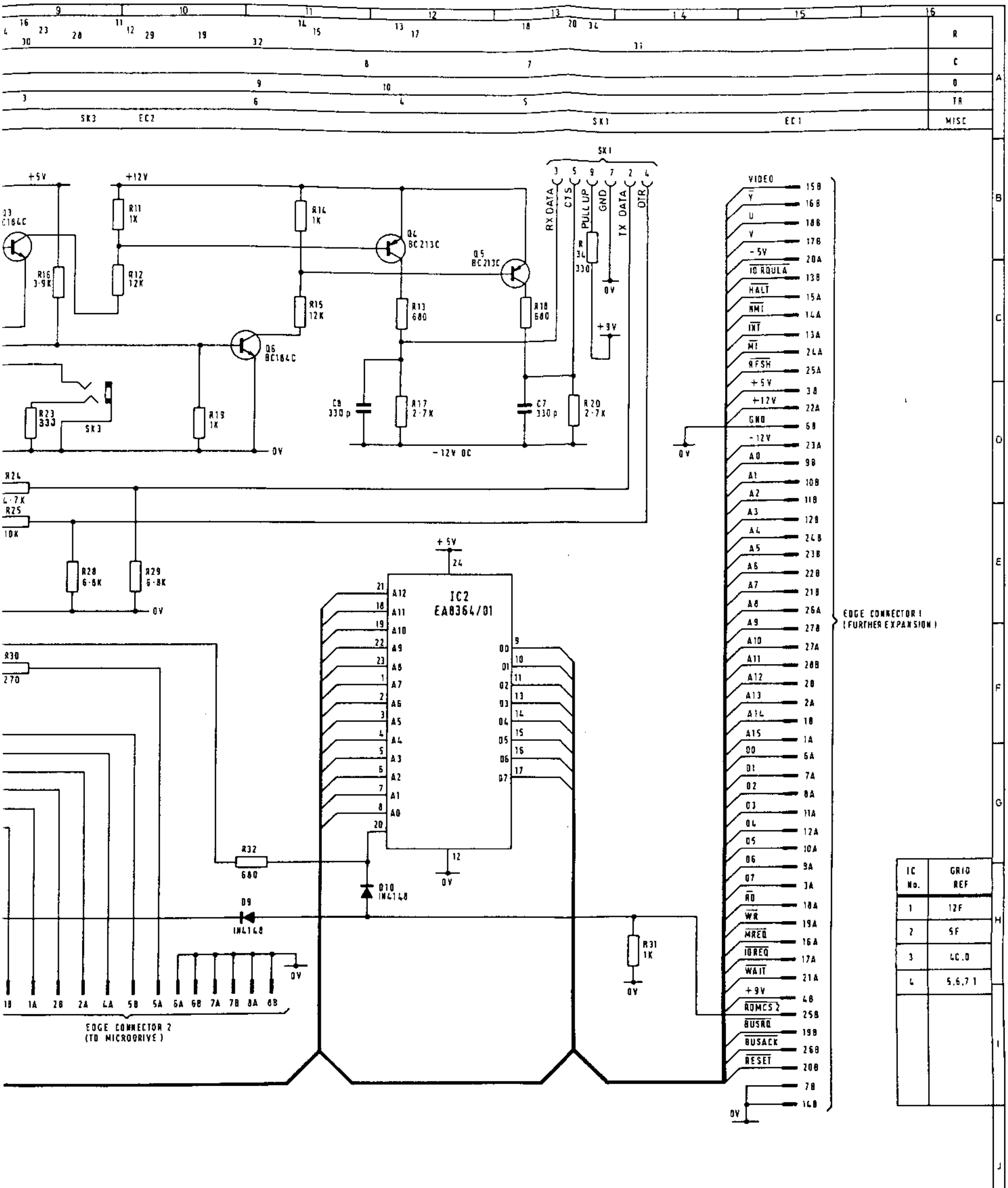


FIG 1.1 INTERFACE 1 AND MICRODRIVE BLOCK DIAGRAM



R
C
D
TR
MISC
SK4
X1
LK
SK2 L1
SK4 (TO SPECTRUM)
+5V
RESET
IORQULA
A0
A1
A2
A5
A6
A7
A11
A13
BUSACK
BUS RQ
A3
A4
A8
A9
A10
A12
A14
A15
D0
D1
D2
D3
D4
D5
D6
D7
RD
WR
MREQ
IORQ
WAIT
ROMCS
9V
RFSH
M1
INT
NMI
HALT
-5V
CK
VIDEO
Y
V
U
+12V
GND
-12V
Q11 ZTX313
Q10 ZTX313
R1 1K
D3 1N4148
D4 1N4148
IC3 74LS260
0V
C5 47n
C6 47µ 10V
DE-CODE
RESET
VDD
IC1
GI ULA (1440)
RX DATA
CTS
NET
TX DATA
DTR
ROM EN
ERASE
R/W
COMMS OUT
COMMS CLK
WR PROT
DATA 1
DATA 2
Vss
R3 1K
Q1 BC213C
R5 1K
Q2 BC213C
R4 3·9K
R6 3·9K
R7 47K
R8 3·9K
R10 2·2K
R21 10K
D8 BZ X 79
R22 330
SX2
D7 4V3
R26 1K
Q9 BC184C
D11 1N4148
R9 10K
R33 10K
R27 10K
R36 10K
HC 18U
X1
R35 47K
C4 22p
IC4
C3 100p
LK
R2
L1 22µH 0·5A
C1 47µ,16V.
D1 BA 157
D2 BA157
C2 47µ 16V
-12V DC


IC1
GI ULA (1440)
IC2
EA8364/01
IC4
OE-CODE
RESET
VDD
VSS
RX DATA
CTS
NET
TX DATA
DTR
ROM EN
ERASE
R/W
COMMS OUT
COMMS CLK
WR PROT
DATA 1
DATA 2
SK2
SK3
LK
EDGE CONNECTOR 2
(TO MICRODRIVE)
+5V
+12V
0V
-12V DC

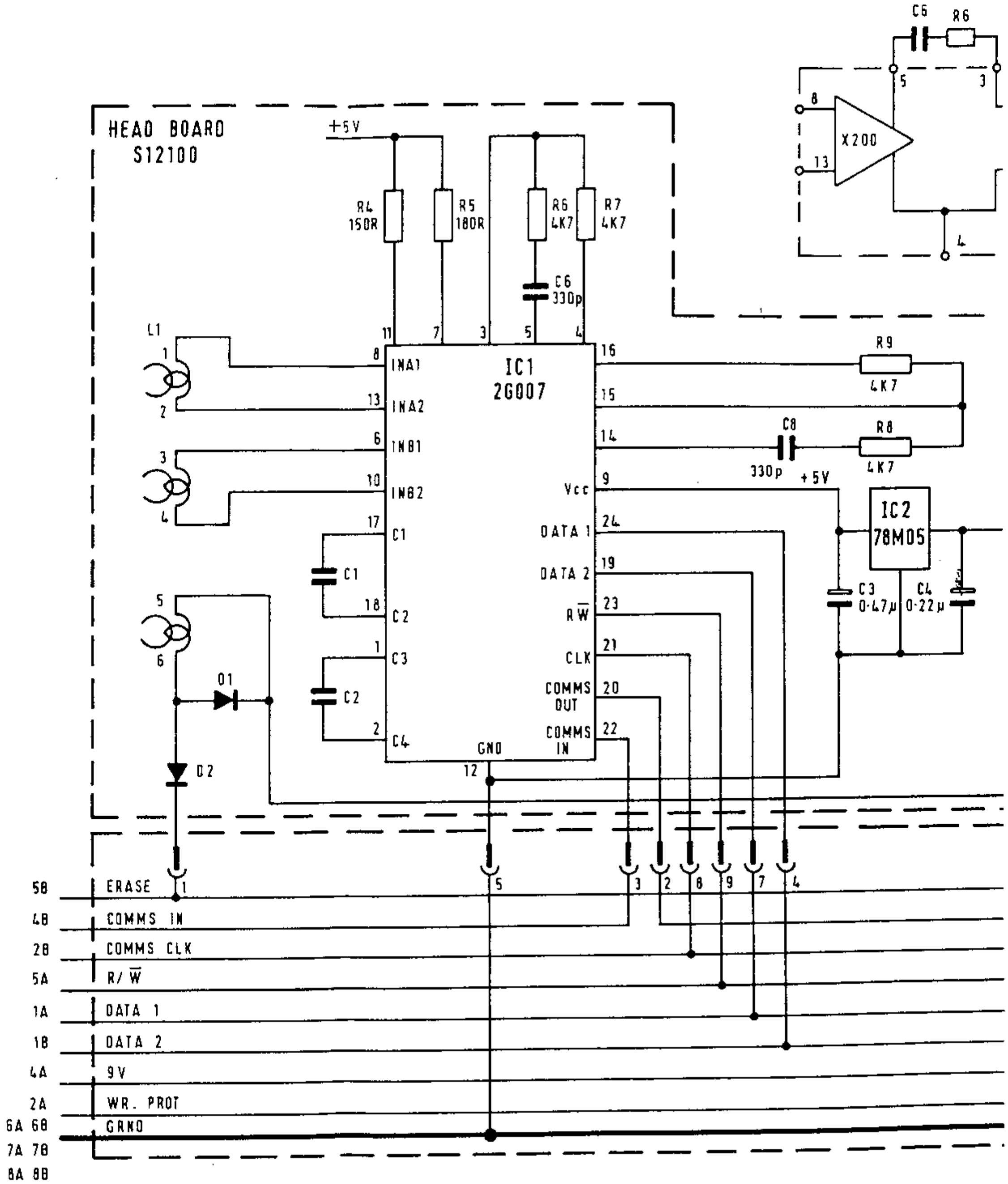


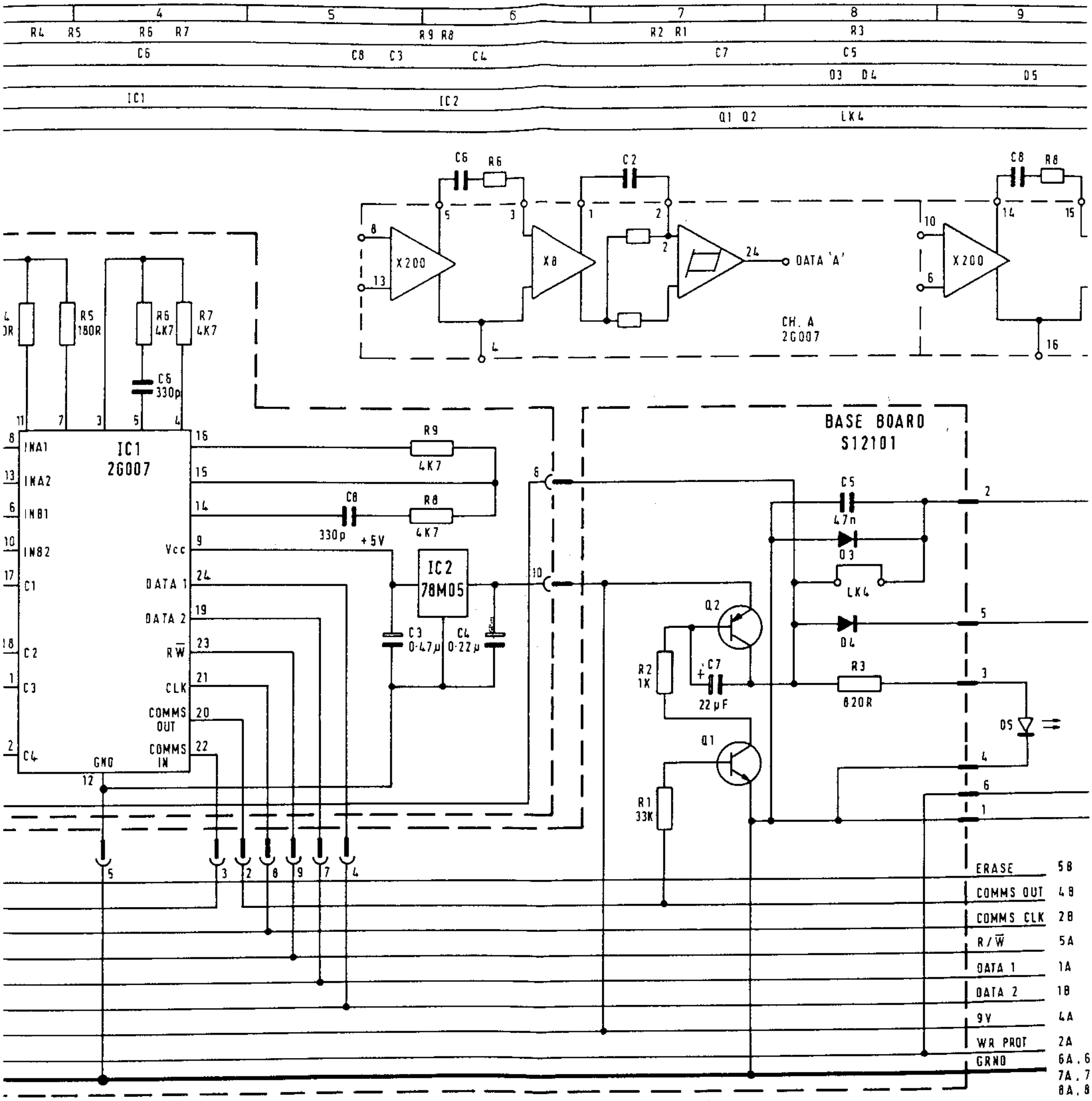
INTERFACE 1 FIG. 1·2

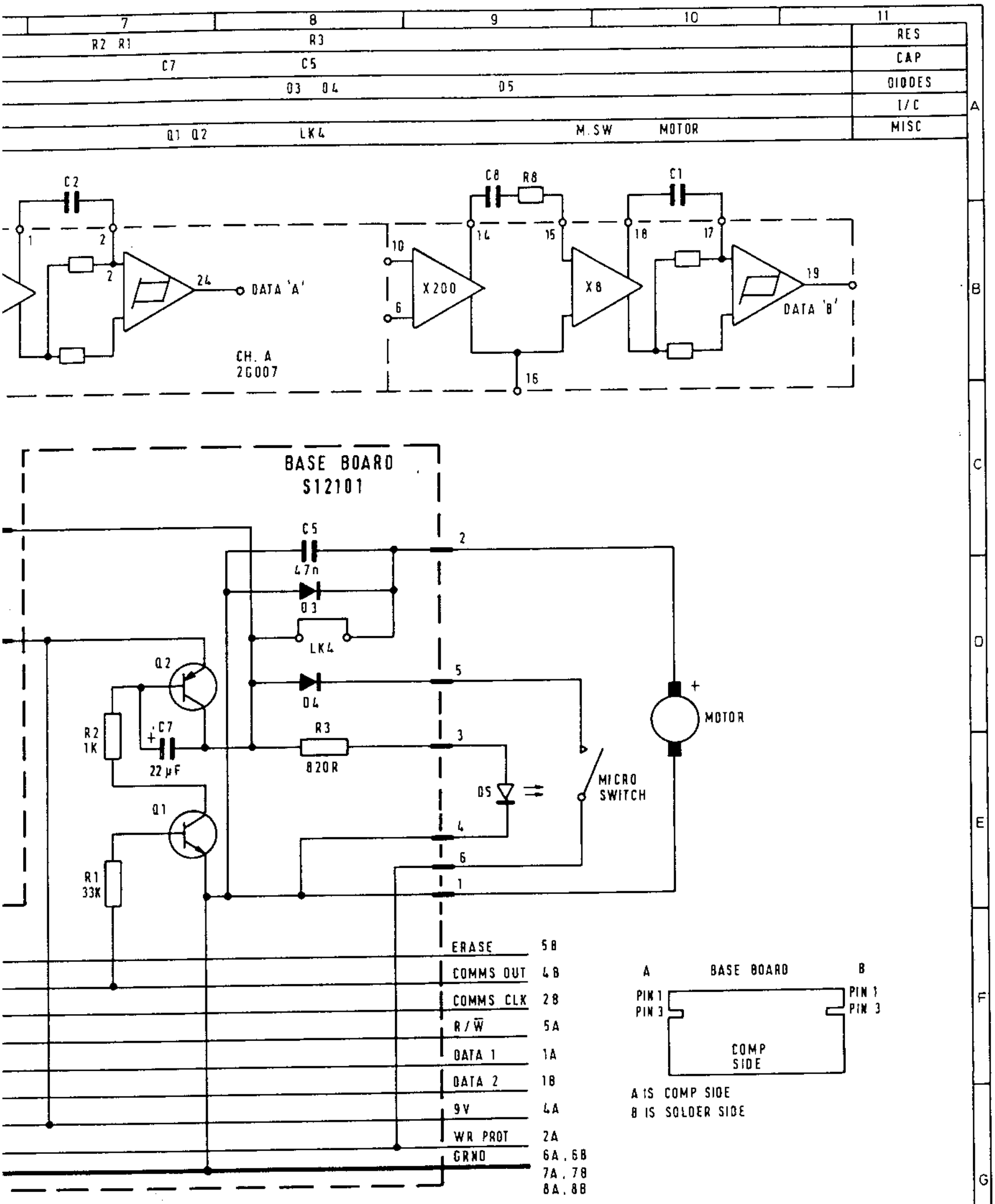
CIRCUIT DIAGRAM DSK 12860

ISSUE 4

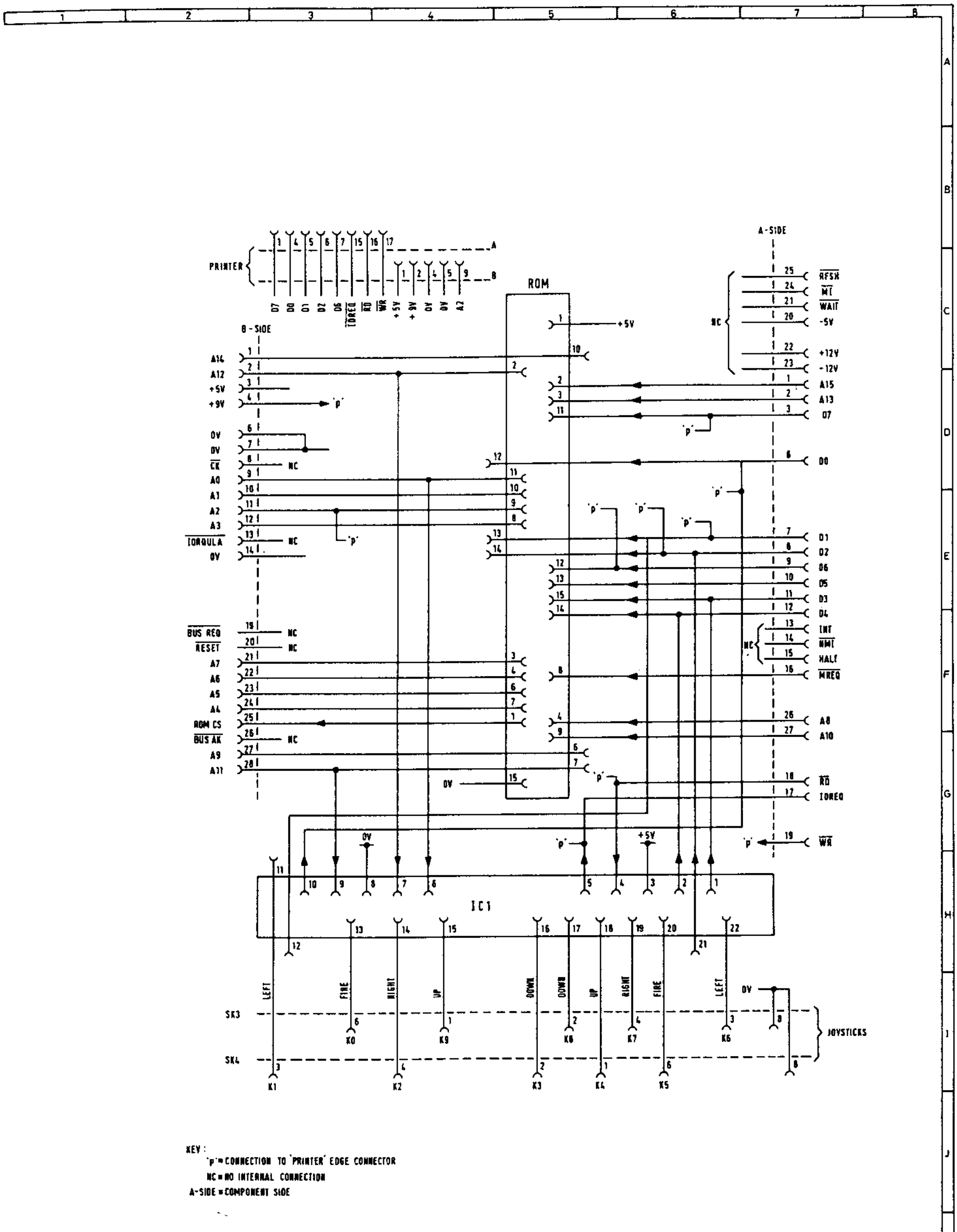
	1	2	3	4	5	6
RES			R4 R5	R6 R7		R9 R8
CAP			C1 C2	C6	C8 C3	C4
DIODES		D2 D1				
I/C				IC1		IC2
MISC		L1				




4 5 6 7 8 9
R4 R5 R6 R7 R9 R8 R2 R1 R3
C6 C8 C3 C4 C7 C5
D3 D4 D5
IC1 IC2
Q1 Q2 LK4
C6 R6 C2 C8 R8
X200 X8 X200
DATA 'A'
CH. A
2G007
R5 180R
R6 4K7
R7 4K7
C6 330p
IC1
2G007
INA1 INA2 INB1 INB2 C1 C2 C3 C4
Vcc DATA 1 DATA 2 R/W CLK COMMS OUT COMMS IN GND
R9 4K7
C8 330p
R8 4K7
+5V
IC2
78M05
C3 0·47µ
C4 0·22µ
BASE BOARD
S12101
C5 47n
D3
LK4
D4
R3 820R
D5
Q2
Q1
R2 1K
C7 22µF
R1 33K
ERASE 5B
COMMS OUT 4B
COMMS CLK 2B
R/W 5A
DATA 1 1A
DATA 2 1B
9V 4A
WR PROT 2A
GRND 6A, 6
7A, 7
8A, 8



MICRODRIVE FIG. 1·3
CIRCUIT DIAGRAM CSK 10626



INTERFACE 2 - CIRCUIT DIAGRAM

FIG. 1.4

SECTION 2

DISASSEMBLY/ASSEMBLY

1. INTRODUCTION

1.1 This section details the disassembly procedures for the two interfaces and the microdrive. In general the assembly procedure is the reverse of disassembly although certain precautions are included where considered necessary. The only tool required is a small cross-head screwdriver.

CAUTION

This equipment contains CMOS integrated circuits. All surfaces and handling devices must be properly earthed in order to avoid damage resulting from electrostatic discharge.

2. ZX INTERFACE 1

2.1 Turn the interface upside-down and remove 5 cross-head screws securing the top cover to the base. Lift the base clear and place on one side. Remove two 5/8in self-tapping screws used to secure the interface to the Spectrum and turn the interface right-side up on a clean work surface. Remove the 2 cross-head screws securing the printed circuit board to the top cover and while restraining the edge connector, ease the top cover clear.

2.2 Assembly is the reverse of disassembly remembering to replace the 5/8in self-tapping screws in the recesses provided BEFORE fitting and securing the base.

3. ZX MICRODRIVE

3.1 Using a small blade screwdriver, carefully lift one corner of the adhesive cover trim. Having partially separated the trim from the cover remove it completely and discard. Remove two cross-head screws previously obscured by the trim and after releasing a tongue positioned along the back edge, separate the top cover from the base.

NOTE: The LED affixed to the cover is connected to the base p.c.board via flying leads. These prevent the cover and base being separated entirely.

3.2 To renew the motor assembly or components on either p.c.board it is advisable to separate the base from the head chassis and base p.c.board by preceeding as follows. Remove 2 cross-head screws securing the base p.c.board to the base and a further cross-head screw, accessible on the underside of the microdrive, securing the base to the head chassis.

CAUTION

Having removed the base, take care not to place excess strain on the flex cables linking the head and base p.c.boards.

Do not attempt to separate the head p.c. boards from the head chassis, as the read/write head alignment is critical. Special tools are needed to re-align this assembly.

3.3 Assembly is the reverse of disassembly taking care not to trap the flying leads between the head p.c.board and the base. After replacing the top cover, fit a new adhesive trim.

4. ZX INTERFACE 2

4.1 Turn the interface upside-down and remove 4 cross-head screws. After lifting the base clear, the p.c.board is easily separated from the top cover.

4.2 Assembly is the reverse of disassembly taking care to orientate the p.c.board correctly.

SECTION 3

SYSTEM TEST

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4	ZX Interface 2	3.3

1. INTRODUCTION

1.1 The use of the following test procedures is strongly recommended after carrying out unit repairs, thus ensuring that a once defective unit is completely operational before return to the owner. The procedures may also be used effectively during fault diagnosis (Section 4).

1.2 In each instance, where the list of test equipment specifies a ZX Spectrum, or ZX Interface 1 or a ZX Microdrive, use a workshop serviceable unit, NOT one returned by the customer.

2. ZX INTERFACE 1

2.1 The following are a number of tests to verify the operation of the various functions of the ZX Interface 1 unit. The Interface 1 should be connected to a known good ZX Spectrum or Spectrum + and a known good ZX Microdrive.

(a) After switch-on, key in:

PRINT p [ENTER],

which should give the message 'Variable not found'.

Then key in:

RUN [ENTER]

The message 'Program finished' should appear. This indicates that the paging mechanism is working, the ROM is functional, IC2 and IC3 are functional, and that (at least) parts of the ULA and most of the connections to the Spectrum are good. If the message 'OK' appears, this means that the ZX Interface 1 is not functioning or not connected.

(b) Key in **CAT 1 [ENTER]**.

If the red LED on the microdrive lights and the motor spins briefly, this indicates that pins 29-32, 37 and 38 of the ULA are functioning properly.

(c) To test the RS232 and NET ports, plug into the RS232 port a D connector with pins 2 and 3 shorted together, and pins 4 and 5 shorted together. Then run the following program:

```
  2 PRINT "RS232 TEST: ";
 10 OUT 239,255: OUT 247,1
 20 IF IN 247<128 THEN GO TO 99
 30 OUT 247,0
 40 IF IN 247>127 THEN GO TO 99
 50 PRINT "PASS 1; ";
 70 GO SUB 200
 80 IF NOT d THEN GO TO 99
 85 OUT 239,239: GO SUB 200
 87 IF d THEN GO TO 99
 90 PRINT "PASS 2": GO TO 100
 99 PRINT "FAIL": STOP
100 PRINT "  NET TEST: ";
120 OUT 239,254: OUT 247,1
130 LET d=IN 247: IF INT (d/2)<>d/2 THEN GO TO 99
140 OUT 247,0
150 LET d=IN 247: IF INT (d/2)=d/2 THEN GO TO 99
160 PRINT "PASS": STOP
200 LET d=IN 239: FOR i=7 TO 4 STEP -1: IF d>=2^i THEN LET d=d-2^i
220 NEXT i: LET d=(d>7): RETURN
```


The first part of the RS232 test checks the data send/receive, and the second part checks the DTR function. If the RS232 function still does not work despite passing these two tests, the ULA must be functioning and the voltage levels between the ULA and the RS232 socket should be checked.

(d) **Clock Test:** Try formatting a cartridge in the ZX Microdrive. If the screen border remains black during the first part of the format, this indicates a clock problem in the Interface 1, and the crystal circuit should be examined.

3. ZX MICRODRIVE

3.1 There are some basic tests that can be carried out using the following program. This should be run with the microdrive unit connected to a known good system.

```
  6 LET d=1
  7 PAPER 7: CLS
 90 BORDER 0: INK 2: PRINT AT 5,2;"Microdrive/Interface1 tester"
100 LET a$="A": FOR i=1 TO 8: LET a$=a$+a$: NEXT i
101 PRINT #0; INK 6;" WRITE TEST"
105 OPEN #4;"m";d;"Text"
110 PRINT #4;a$
120 CLOSE #4
125 PRINT #0; INK 5;" READ  TEST"
130 OPEN #4;"m";d;"Text"
140 INPUT #4;b$
150 IF a$<>b$ THEN  PAPER 0: INK 7: CLS : PRINT "WRITE FAILURE": STOP
160 CLOSE #4
165 PRINT #0; INK 4;" ERASE TEST"
170 ERASE "m";d;"Text"
175 CLS
180 PAPER 0: INK 7: CLS : PRINT "DRIVE OK"
190 PAUSE 0: STOP
```

With a blank cartridge inserted in the Microdrive, the above program performs a simple exercise of the 'write', 'read' and 'erase' functions.

3.2 An indication of another class of problem can be gained from the screen during the format operation. If the screen remains white during the third stage of the format, this is a sign of noise on the write line. In this case, the motor alignment, the Microdrive ULA, or the voltage regulator should be checked.

3.3 The waveforms at either end of C1 and C2 are significant for fault diagnosis.

Key in:

OUT 239,252: OUT 239,254 [ENTER]

to set the ZX Microdrive spinning. Look at the waveform, ensuring that the oscilloscope lead is earthed on the body of the regulator. There should be packets of oscillating voltage (one long, two short), separated by quiet areas. The oscillating voltage should be about 0.5V peak-to-peak, but the important thing is that it should be consistent, and not vary. The other important parameter is the noise level in the quiet patches. This should not be more than 25mV. The best way to check waveforms is to compare with those on a known good unit.

4. ZX INTERFACE 2

4.1 The most practical test for the ZX interface 2 is a functional check using a suitable ROM cartridge (e.g. Space Raiders) and a pair of industry-standard joysticks.

4.2 ZX interface 2 is plugged into the ZX Spectrum and the ROM cartridge software RUN in the normal way. Provided the game employs joystick controls it is a simple matter to determine whether the game is running correctly and the UP, DOWN, LEFT, RIGHT and FIRE control switches are operational.

4.3 If the game does not run, suspect the ZX interface 2 p.c.board and/or edge connectors. The same applies if the joysticks are non-operational but also include a check of the 9-pin D-type connectors and possible renewal of the ULA.

SECTION 4

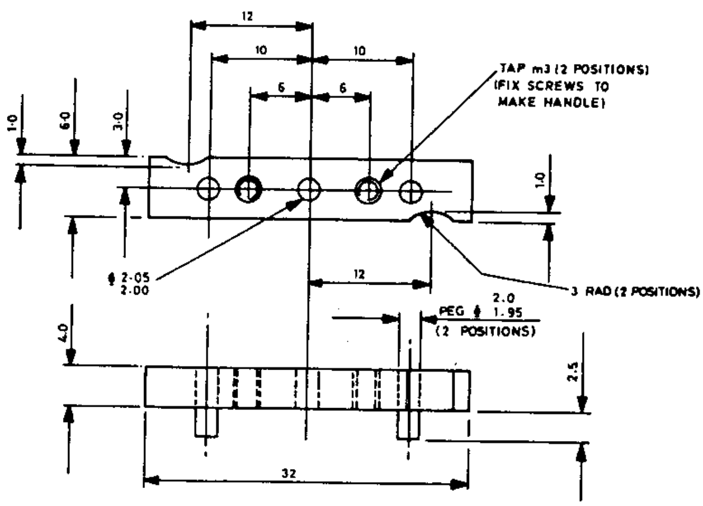
FAULT DIAGNOSIS AND REPAIR

Sub-Section	LIST OF CONTENTS	Page No.

1. INTRODUCTION

1.1 Section 4 is intended as a guide to the fault diagnosis and repair of the ZX interface 1, ZX microdrive and ZX interface 2. It is assumed that the service engineer has a reasonable knowledge of electronic theory, servicing and fault-finding techniques and has access to the test equipment and tools required to carry out the task. The following items of test equipment and materials is the minimum recommended:

(a) Oscilloscope with rise time 0.02 S/cm
(b) Oscilloscope probe (X10)
(c) Multimeter, general purpose
(d) Head cleaner (Open market)
(e) Motor location jig as shown:



NOTE: DIMENSIONS IN MILLIMETRES

MOTOR LOCATION JIG

1.2 For details of how the ZX interfaces 1 and 2 and the ZX microdrive connect to the Spectrum and for Spectrum operating procedures, refer to the relevant manuals which accompany each unit.

2 MODIFICATION HISTORY

2.1 **ZX Interface 1.** A small number of the EPROM version of the ZX interface 1 were produced. This version is characterised by a socket-mounted EPROM in the IC2 position and by IC3 and IC4 mounted pickaback fashion.

CAUTION

This version has no keyway on the microdrive edge connector. Take care when connecting a keyway-less ribbon connector, otherwise a short-circuit could occur.

2.2 Where Q3, Q6 and Q9 are Ferranti type BC184P, these are inserted in the opposite orientation to the pcb legend.

2.3 **ZX Microdrive.** A number of modifications have been introduced on the microdrive. These modifications and the reasons for their implementation are summarised below:

(a) A 22μF capacitor C7 has been added across Q2 base to collector. This allows the motor to build up to running speed, rather than change from rest to speed immediately with the possibility of damage to tape. This modification should be checked for and if necessary fitted retrospectively.

(b) Capacitors C1, C2, C6, and C8 have been changed from polystyrene to ceramic axial, purely for convenience of production. The value of C1 and C2 has also been changed from 150 pF to 220 pF. This value change should be checked for and if necessary fitted retrospectively.

(c) A 47nF capacitor has been added between pins 9 and 12 of IC1. This is a decoupling capacitor which prevents high frequency interference.

(d) The microswitch positioning peg has been moved 1/2 mm towards the base edge. In early issues, the microswitch moving arm can be bent by rough use, causing incorrect switch operation.

(e) The ratchet roller, ratchet and ratchet-spring (Fig 4.1) have been replaced by two rollers, one rubber and one plastic, which operate more simply and economically. The ratchet is designed to stop a loop forming in the tape as the roller is turned mechanically by the action of inserting the cartridge. In the drive position the cartridge disables the ratchet.

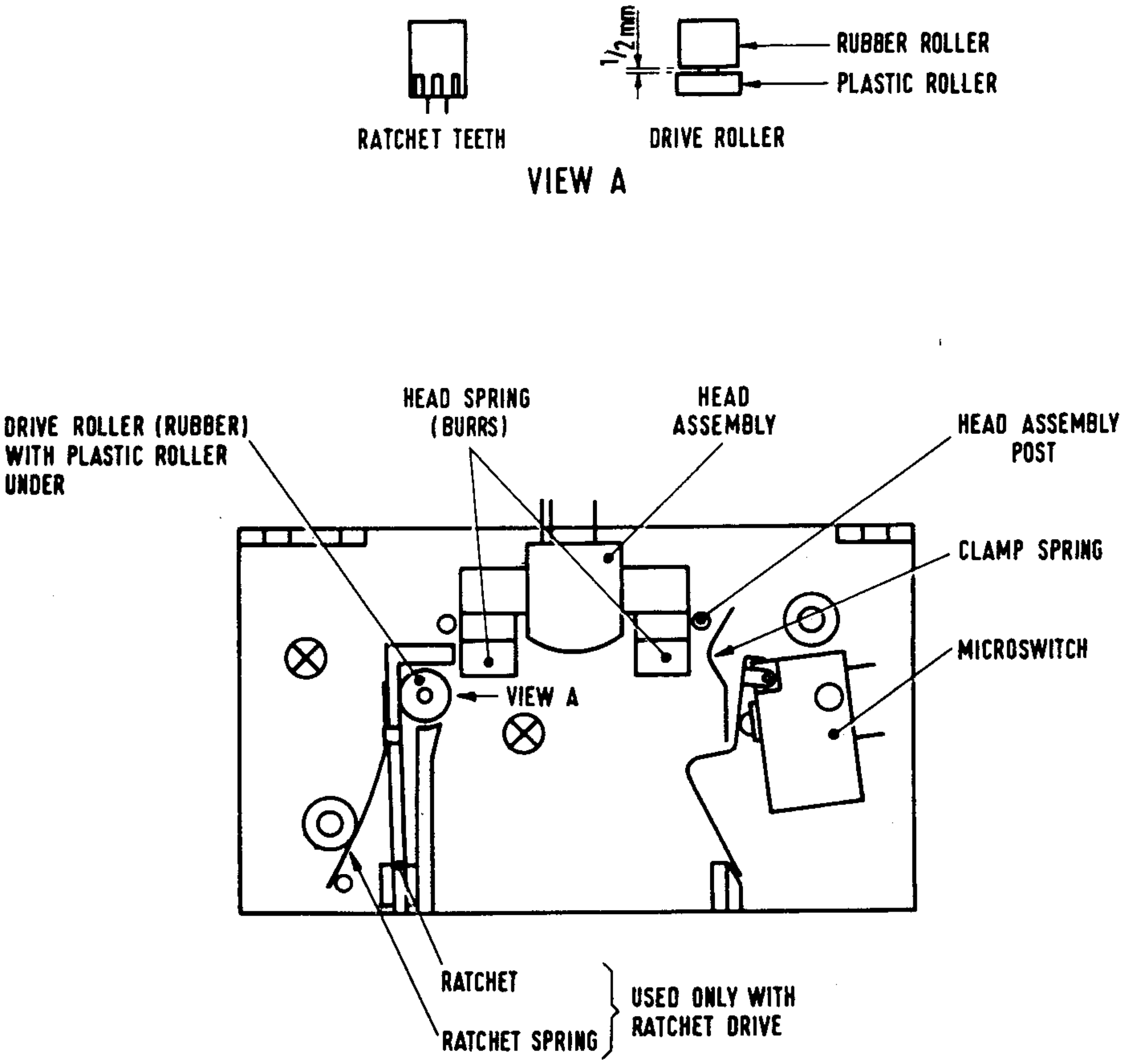


FIG 4.1 HEAD CHASSIS

(f) A harder material has been used for the clamp spring. It has been found that the original material did not retain its spring and sometimes required to be bent back to its original position.

(g) Where Q1 is Ferranti type BC184P, this transistor is inserted in the opposite orientation to the pcb legend.

2.4 **ZX Interface 2.** No problems have to date arisen with this unit.

3. FAULT DIAGNOSIS

3.1 Techniques

3.1.1 In a closed loop system such as a computer, because of the inter-dependence of numerous component parts, fault diagnosis is not necessarily straight-forward. In addition, because of the high speed cyclic operation, interpretation of any waveforms on control, data and address lines as being valid depends to a large extent on practical experience of the system.

3.1.2 Since the number of discrete components is limited it is possible that the major source of faults will be within integrated circuits. However before any IC is changed, waveforms and levels in the circuit must be checked. Experience has shown that the best method of initially checking waveforms and levels can be to compare with the same point in a known serviceable board. The following pages provide a basic fault-finding procedure and a list of possible faults along with suggested remedies.

3.1.3 As a matter of course the suspect board should be inspected for obvious faults such as burnt-out components or raised tracks. Edge connector pins should also be cleaned either with an eraser or an appropriate cleansing agent, applied with a small stencil brush and wiped clean with lint-free cloth. Pin connections should be inspected for damage.

3.1.4 Suspect units should be connected into the test system using workshop cables and connectors which are known to be serviceable. If a successful test result is obtained then the customer's cable/connector must be faulty.

3.2 Initial Checks

3.2.1 Before power is applied to a suspect unit a check should be made between each power rail and 0V to isolate any short circuits. Check for open circuit between 0V and the pins set out in the following table.

DEVICE	CONNECTOR	PIN NO.	OV PIN (Ground)	POWER RAIL
ZX Interface 1	SK4	3b 4b 20a 22a	6b 6b 6b 6b	+5 V +9 V -5 V +12 V
ZX Microdrive	Edge conn.	4b	6b	+9 V
ZX Interface 2	Spectrum edge conn.	3b 4b	6b 6b	+5 V +9 V

3.3 ZX Interface 1

3.3.1 With this unit connected to a known serviceable system, apply power. Carry out the checks set out in the table below to establish start conditions.

CAUTION

Do not connect interface 1 with the power ON as damage to inductance L1 and the ULA may occur.

FUNCTION	CIRCUIT REF.	WAVEFORM/VOLTAGE VALUE
On board d.c.power supplies:		
+5 V	IC1 pin 40	5 V d.c. ± 0.25 V - no discernable ripple.
-5 V	Pin 20a of exp. conn.	-5 V d.c.
+12 V	R11	+12 V d.c.
-12 V	R17	- 7 V d.c.
+ 9 V.	R34	+ 9 V d.c.
Clock pulses	IC1 pin 5	8.0 MHz squarewave at +5 V amplitude

3.3.2 Carry out the ZX Interface 1 tests described in Section 3.2, which also gives details of fault diagnosis.

As an additional check, try loading a program from Microdrive. The following table lists possible faults and remedies.

SYMPTOM	REMEDY
Software does not load	(1) Check for low on pin 20 of IC2 and pin 6 of IC1. If high renew IC3. (2) Renew IC2. (3) Renew ULA IC1.
Software does not run and one of the following messages displayed: **File not found** **Microdrive not present**	Renew ULA IC1

3.4 ZX Microdrive

3.4.1 With the ZX microdrive connected to a serviceable system, apply power. Establish that on-board voltages are correct by carrying out the checks set out in the table below:

VOLTAGE	CIRCUIT REF.	VOLTAGE VALUE
+5 V	IC1 Pin: 11 7 9	+5 V +5 V +5 V, no discernible ripple
+9 V	Pin 10 of ribbon connector.	+9 V

3.4.2 Perform the ZX Microdrive tests described in Section 3, para 3.1-3.2. The following table lists possible faults and remedies. For detailed diagnosis, use the test in Section 3, para 3.3, as required.

SYMPTOM	REMEDY
Message **Microdrive not present** displayed	(1) Check and/or replace Q2. (2) Renew IC1.
If program stops during: Write test	 (1) Check R4, R5. (2) Renew IC1.
Read test	(1) Check C1, C2. (2) Renew IC1. (3) Renew whole unit.
Message **Write protect broken** displayed.	Check microswitch
Microdrive does not operate although selected correctly Tape being looped out of cartridge causing jamming Tight cartridge tape Broken tape	(a) Check motor. (b) Check microdrive mechanics for: (i) Burrs on headsprings (check cartridge for scratches). (ii) Weak clamp spring (listen for clicks/-crunch sounds). (iii) Correct the operation of the ratchet/spring assembly. NOTE: If motor has over-heated check for buckled base plate. Renew complete microdrive unit.
Head failure	Renew complete microdrive unit.
LED failure	Renew LED (LED is push-fitted).

3.5 ZX Interface 2

3.5.1 Since the ZX interface 2 comprises one integrated circuit and a number of connectors, fault finding is simple. Connect the unit to a Spectrum and connect a games ROM cartridge, two joysticks and a printer to the unit. Initiate the game and check out all functions. If a fault is found, power-down and replace IC1. Printer faults must be due to discontinuity between input and output, since pin to pin connections are used.

4. REPAIR

4.1 Renewal of components should be carried out using recognised desoldering/heatsinking techniques to prevent damage to the component or the printed circuit board. General points to note are:

(a) The head assembly in the microdrive is the only component which **MUST NOT** be changed.

(b) When replacing the plug-in IC in interface 2 use the correct removal and insertion tools.

(c) When handling ICs take normal anti-static precautions. It is recommended that only a suitably earthed, low power soldering iron be used.

(d) When removing a soldered-in IC, cut each pin and remove the component before individually unsoldering each pin.

(e) After any component has been removed the p.c. board should be examined carefully to ensure that there are no solder 'splatters' which may cause short circuits between tracks or connector pins.

(f) Disassembly/assembly instructions are given in Section 2.

4.2 Actions to take to rectify problems encountered in the mechanical operation of the microdrive are set out in the following paragraphs.

Replace the motor as follows:

(a) Insert the motor and loosely assemble the fixing screws.

(b) Insert the motor location jig to position the motor.

(c) Tighten fixing screws.

NOTES: 1. When renewing the motor also renew the plastic and the rubber drive rollers. If the motor has a combined rubber roller and ratchet, discard complete ratchet assembly and replace with the rubber and plastic roller.

2. The gap between the rubber roller and the plastic roller should be 0.25 millimetre.

(d) Perform the following motor drive test:

(i) With a cartridge inserted and the motor running, push the cartridge gently away from the motor drive roller until tape movement ceases.

(ii) Release the cartridge. It should return under the action of the clamp spring and tape movement restart without any rattling or noise. If this is not the case, then provided that the clamp spring is set satisfactorily, the head spring must be adjusted as follows. (Never adjust new type clamp spring which has a loop below chassis level).

(e) If the motor drive test above indicates that the head spring needs adjusting, this is done as follows:

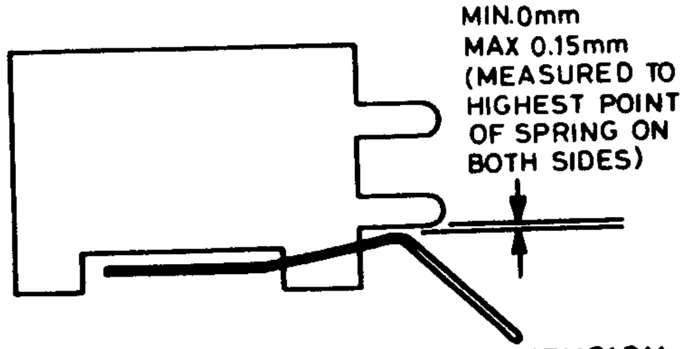
(i) Unscrew the motor and push the head spring downwards on each side of the head to achieve the dimension shown below.

(ii) Replace the motor and set its position with the motor location jig.

4.3 The two problems associated with faulty mechanical operation of the cartridge are burrs on the head springs and a weak clamp spring. Both faults prevent the cartridge from being firmly pushed into the drive position and can cause intermittent operation, tape-spill etc.

4.4 Burrs on the head springs may be filed off using a small flat instrument file. Take care not to damage the drive roller on the motor side.

4.5 The clamp spring may be bent back into position using a pair of bull-nosed pliers. The final position of the spring should be within the diameter of the adjacent head-assembly post.



HEAD SPRING REFERENCE DIMENSION

SECTION 5

PARTS LIST

1. INTRODUCTION

1.1 The following parts tables list only those components considered practicable to renew. The microdrive record/playback is not listed neither are the side, head and ratchet springs.

TABLE 5.1 ZX INTERFACE 1 PCB ASSEMBLY

Circuit Reference	Value	Rating Tolerance	Manufacturer/ Type	Notes
CAPACITORS				
C1,C2	47μF	16V	Electrolytic	Axial
C3	100pF	5%,50V	Ceramic	Axial
C4	22 pF	5%,50V	Ceramic	Axial
C5	47 nF	+80%,-20%,50V	-	Axial
C6	47μF	16V	Electrolytic	Axial
C7,C8	330pF	10%,50V	'Tayo'	Axial
COIL				
L1	22μH	0.41 A	-	-
DIODES				
D1,D2			BA157	Rectifier
D3,D4			1N4148	Signal
D6 to D8	4.3V	500 mV	BZX79C4V3	Zener
D9 to D11			1N4148	Signal

(continued)

TABLE 5.1 ZX INTERFACE 1 PCB ASSEMBLY (Contd)

Circuit Reference	Value	Rating Tolerance		Manufacturer/ Type	Notes
INTEGRATED CIRCUITS					
IC1(ULA)				General Instrument/ LA15-302	
IC2(ROM)				Motorola/ SCH9288 OP	Alternative is Texas TMS4764NLZA 62408
IC3				74LS260	
IC4				Motorola/ 74HCU04N	
RESISTORS					
R1	1K0	0.25W,	5%	Carbon	
R2	-				
R3	1K0	0.25W,	5%	Carbon	
R4	3K9	0.25W,	5%		
R5	1K0	0.25W,	5%	Carbon	
R6	3K9	0.25W,	5%		
R7	47R	0.25W,	5%		
R8	3K9	0.25W,	5%		
R9	10K0	0.25W,	5%		
R10	-				
R11	1K0	0.25W,	5%	Carbon	
R12	12K0	0.25W,	5%		
R13	680R	0.25W,	5%		
R14	1K0	0.25W,	5%	Carbon	
R15	12K0	0.25W,	5%		
R16	3K9	0.25W,	5%		
R17	2K7	0.25W,	5%		
R18	680R	0.25W,	5%		
R19	1K0	0.25W,	5%	Carbon	
R20	2K7	0.25W,	5%		
R21	10K0	0.25W,	5%		
R22	330R	0.25W,	5%		
R23	330R	0.25W,	5%		
R24	4K7	0.25W,	5%	Carbon	
R25	10K0	0.25W,	5%		

(continued)

TABLE 5.1 ZX INTERFACE 1 PCB ASSEMBLY (contd)

Circuit Reference	Value	Rating Tolerance	Manufacturer/ Type	Notes
RESISTORS (contd)				
R26	10K0	0.25W, 5%	Carbon	
R27	NOT USED			
R28	6K8	0.25W, 5%		
R29	6K8	0.25W, 5%		
R30	270R	0.25W, 5%		
R31	1K0	0.25W, 5%	Carbon	
R32	680R	0.25W, 5%		
R33	10K0	0.25W, 5%		
R34	330R	0.25W, 5%		
R35	47K0	0.25W, 5%		
R36	10K0	0.25W, 5%		
TRANSISTORS				
Q1			BC213C	
Q2			BC213C	
Q3			Motorola BC184,BC184B or BC184C *	
Q4			BC213C	
Q5			BC213C	
Q6			Motorola BC184,BC184B or BC184C *	
Q7	NOT USED			
Q8	NOT USED			
Q9			Motorola BC184,BC184B or BC184C *	
Q10			Ferranti ZTX313	Alternative
Q11			Ferranti ZTX313	is BC183L
(NOTE: Q11 fitted on later boards only)				
* Ferranti BC184P permitted exceptionally.				
MISCELLANEOUS				
SK1			ITT Common, Pye/ 9-way 'D' socket	
SK2			Tuda/3.5mm jack socket	
X1	8.0MHz	1% nominal	G English/HC18U	

TABLE 5.2 ZX INTERFACE 1 CASE ASSEMBLY

Item	Description	Manufacturer/Type
Cover	-	Kenure/S12110
Base	-	Kenure/S12111
Screw (2 off)	C'sk, 4.2 mm x 5/8 in lg	Plastite
Screw (2 off)	C'sk, 4.2 mm x 3/8 in lg	Plastite
Screw (5 off)	C'sk, 4.2 mm x 1/2 in lg	Plastite
Ribbon Cable	Interface 1 to Microdrive	Varelco
Jack Cable	3.5 mm jack ends x 2 m lg	Able

TABLE 5.3 ZX MICRODRIVE HEAD BOARD ASSEMBLY

Circuit Reference	Value	Rating Tolerance	Manufacturer/ Type	Notes
RESISTORS				
R4	150	0.25W, 5%	Carbon	-
R5	180	0.25W, 5%	Carbon	-
R6 to R9	4K7	0.25W, 5%	Carbon	-
CAPACITORS				
C1	220 pF	2.5%	Ceramic	Axial
C2	220 pF	2.5%	Ceramic	Axial
C3	0.47μF	50 V	Electrolytic	Axial
C4	0.22μF	50V	Electrolytic	Axial
C6	330 pF	2.5%	Ceramic	Axial
C7	NOT USED			
C8	330pF	2.5%	Ceramic	Axial
C9	NOT USED			
C10	48nF	+80%,-20%,50V	Tayo	Axial
DIODES				
D1	-	-	1N4148	Signal
D2	-	-	1N4148	Signal
INTEGRATED CIRCUITS				
IC1 (ULA)		Ferranti/ ULA2G007		
IC2	5V	78M05	Regulator	

TABLE 5.4 ZX MICRODRIVE BASE BOARD ASSEMBLY

Circuit Reference	Value	Rating Tolerance	Manufacturer/ Type	Notes
RESISTORS				
R1	33K0	0.25W, 5%	Carbon	-
R2	1K0	0.25W, 5%	Carbon	-
R3	820	0.25W, 5%	Carbon	-
R10	-	-	-	Link
CAPACITORS				
C5	47nF	+80%,-20%,50V	-	Axial
C7	22μF	-	Electrolytic	Axial
DIODES				
D3	-	-	1N4148	Signal
D4	-	-	1N4148	Signal
TRANSISTORS				
Q1 *	-	-	Motorola BC184, BC184B or BC184C	-
Q2	-	-	Ferranti ZTX551	-

* Ferranti BC184P permitted exceptionally.

TABLE 5.5 ZX MICRODRIVE HEAD CHASSIS ASSEMBLY

Item	Description	Manufacturer/Type
Head Assembly.	This component must not be changed.	
Motor	9V,2400 rpm, clockwise rotation	Mabuchi EG-500AD-9F
Drive Roller Plastic Roller	Smooth wall	RE components
Microswitch	-	Burgess
Screw (2 off)	C'sk,4 mm,Posidrive	M2.5
Screw (1 off)	Pan hd, 2.28 mm x 3/8 lg	Plastite

TABLE 5.6 ZX MICRODRIVE CASE ASSEMBLY

Item	Description	Manufacturer/Type
Cover	-	Kenure S12090
Base	-	Kenure S12095
Cover Trim	Spectrum Logo	James Cook S12095
LED	Red	G English/LN28PP(T)
Inner Flex	5 way x 1 in flex cable	Dean
Outer Flex	5 way x 1 1/2 in flex cable	Dean
Connector	7 way daisy-chain	Pye S12102
Screw (4 off)	Pan hd,4.2 mm x 1/4 in lg	Plastite
Screw (1 off)	Pan hd,4.2 mm x 1/2 in lg	Plastite
Screw (2 off)	C'sk,4.2 mm x 3/8 in lg	Plastite

TABLE 5.7 ZX INTERFACE 2

Item	Description	Manufacturer/Type
IC1 (ULA)	Integrated Circuit	MCE HT62001
SK1	28-way edge connector	Pye
SK2	15-way edge connector	Pye
SK3,SK4	9-way 'D' type connector	ITT Cannon
Upper case	-	Canton-Hill SRC126
Lower case	-	Canton-Hill SRC127
Case lid	-	Canton-Hill SRC128
Screw (4 off)	C'sk,2.9 mm x 13 mm lg	Plastite

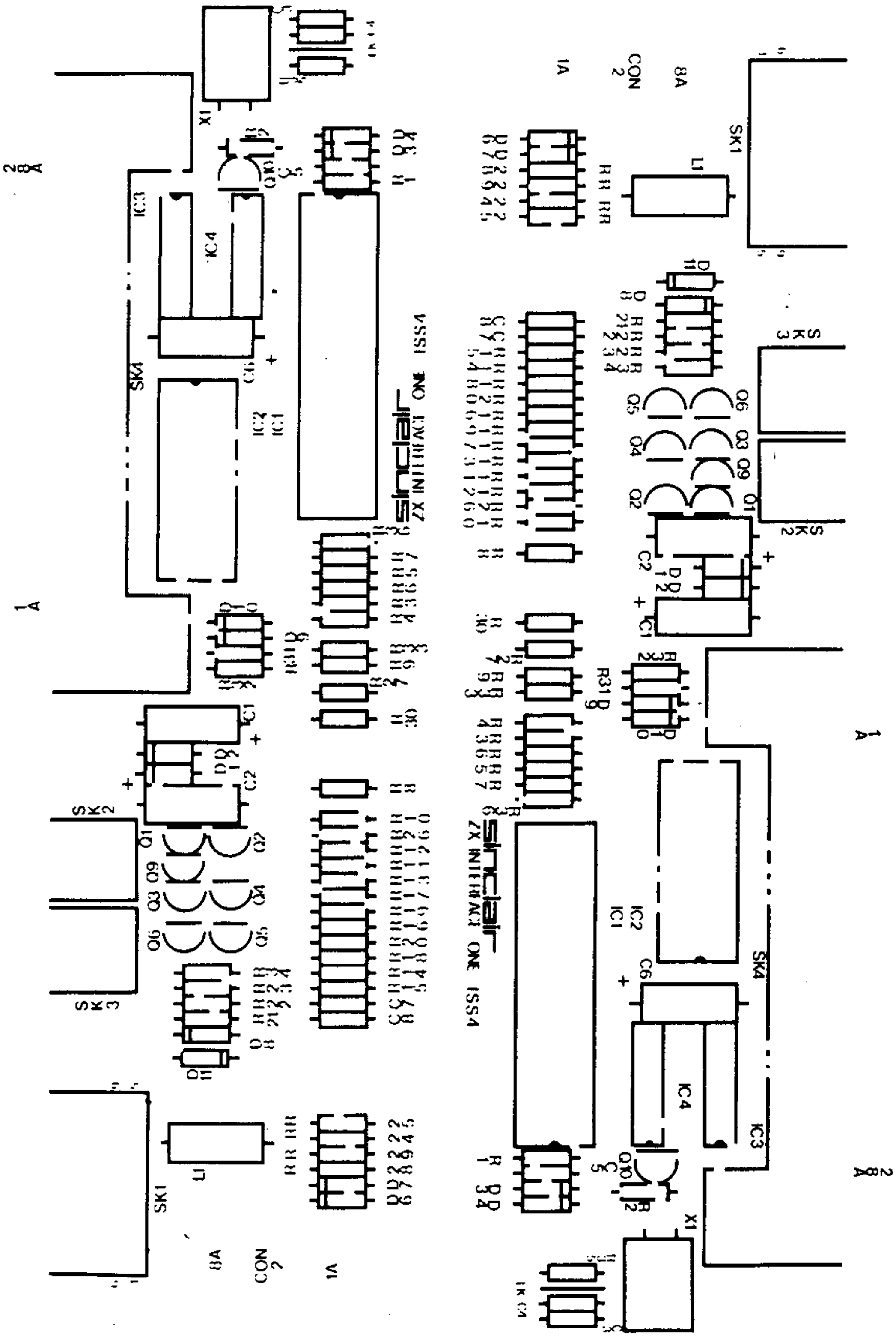


FIGURE 5.1 ZX INTERFACE 1 BOARD LAYOUT

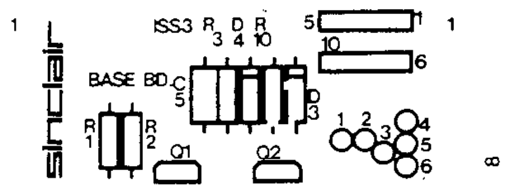


FIGURE 5.2 ZX MICRODRIVE - BASE BOARD LAYOUT

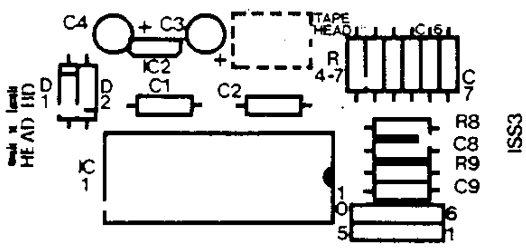


FIGURE 5.3 ZX MICRODRIVE - HEAD BOARD LAYOUT