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INTERFACE BETWEEN A MICROCOMPUTER AND THE
ELECTRONIC MODEL FOR TIDES AND STORM SURGES

S. Ishiguro

&

Kathleen Reeves-Wilkin

1982

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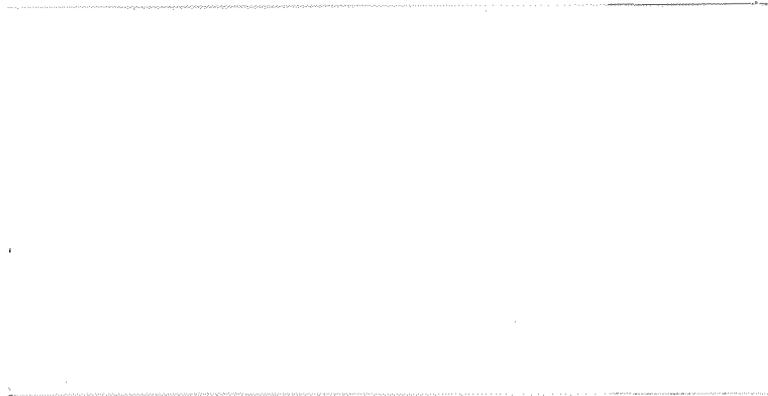
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ELECTRONIC MODEL FOR TIDES AND STORM SURGES

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ABSTRACT

'Electronic Model' is a system for simulating tides and storm surges by solving the dynamic equations at a fast speed without time increments. For processing its input and output data, a standard microcomputer with a floppy-disk unit has been added to the system. This paper describes the designs of hardware and software of the interface between the model and microcomputer.

1. INTRODUCTION

The 'Electronic Model' is a system for simulating tides and storm surges for oceanography. From a mathematical point of view, this can be divided into two parts:

- A Solving a set of tide/surge dynamic equations, and
- B Processing input and output data of A.

A requires a specially developed electronic system like this model, or a large-scale and fast general purpose computer, which is far beyond the capability of a microcomputer or microprocessor.

B can be carried out by a set of purpose-built computing circuits, or a microcomputer containing microprocessors.

In the early stage of this project, some computing circuits including a punched-tape system were developed for B. Since the time when microcomputers became easily available in UK (about 1979), the authors planned to employ a microcomputer for the main part of B, including the replacement of punched tape by floppy disk. The plan was approved in March 1982. This paper describes the designs of the hardware and software of the interface between the electronic model and a microcomputer.

2. REQUIRED CONDITIONS

Fig. 1 shows the scheme of the system (relevant parts to the interface only are shown). The following conditions are required for the interface:

- 1 Commodore Model 8032 has been chosen for the microcomputer, and Commodore Model 2031 for the floppy-disk driving unit. The choice is mainly due to administrative conditions rather than technical.
- 2 The electronic model has 'Input Memory' and 'Output Memory' to and from which the interface is connected. Both the memories can process 8-bit parallel binary numbers between zero and 255 (decimal equivalent), at a speed up to one mega words per second.
- 3 Input data to the model are supplied through
 - a Floppy disks,
 - b Data line to the microcomputer,
 - c Programme in the microcomputer, and/or
 - d Keyboard of the microcomputer.

If it is required to store data, floppy disks are used.

- 4 Output data from the model are displayed on the screen of the microcomputer, and if permanent records are required, the numerical printer, XY plotter, and/or floppy-disk unit are used.

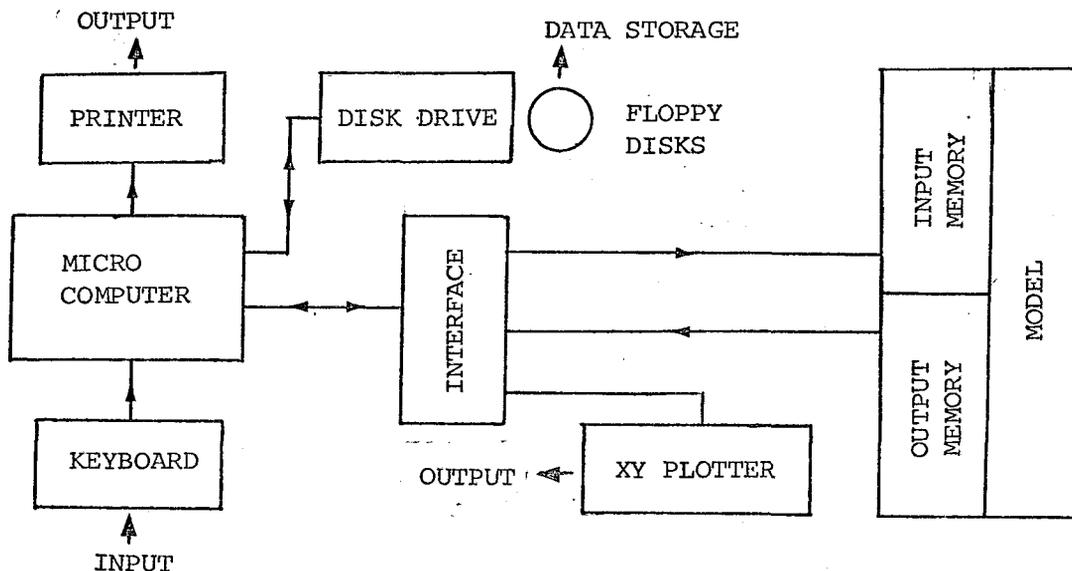


Fig. 1

Scheme of the system around the interface (greatly simplified illustration).

3. DESIGN OF HARDWARE

Fig. 2 shows the circuit diagram of the interface, New BD8. This consists of the following four parts:

- 1 'Output memory' on BD22 → 3-state output circuit, 244(1) → Data bus via CN7 → Microcomputer
- 2 Sequential-code generator, 93(1) & 93(2) → 3-state output circuit, 244(2) → Data bus via CN7
- 3 Microcomputer → Data bus via CN7 → Data holder, 75(1) & 75(2) → 'Input Memory' via CN8
- 4 Microcomputer → Data bus via CN7 → Data holder, 75(1) & 75(2) → DAC, 2N425E(Y) → XY-plotter via SW-XYP, with X-axis output from 93(1) & 93(2), and a pen-lift circuit.

A bidirectional 8-line data bus, and only three control lines (EOI, DAV, ATN) are used for linking the microcomputer and the interface circuit. These control lines are used for some particular signals from the microcomputer to the interface circuit only, and not for the signals originally defined by these symbols.

The Output memory can supply data, when required, at a much higher speed than the microcomputer can access. Therefore, data is available at any time a 'data-request signal' is sent from the microcomputer without a hand-shake procedure. The Input memory can accept data at a much higher speed than the microcomputer can send. Therefore it is enough to send data with 'data-ready signal' any time without a hand-shake procedure. These conditions simplify the design of the interface circuit considerably.

Each part works as follows:

1 Output memory → Microcomputer

Switch SW-SEQ/OFF/ARB is set to ARB. This activates 244(1), and makes BD22/C8 and BD22/N17 controllable (see Appendix 1 for details). A reset signal which is programmed by the microcomputer is sent to BD22/C8 via ATN line. A data-request signal which is programmed by the microcomputer is sent to BD8/N17 via DAV line, for each word of data. The rest of the parts on BD8 do not interfere with the data bus.

2 Sequential-code generator → Microcomputer

This mode of operation is used for testing the data transmission from the interface circuit to the microcomputer. Sequential numbers from 0 to 255 are used as a set of data so that the checking of the test is easy. Switch SW-SEQ/OFF/ARB is set to SEQ. This activates 244(2).

A reset signal which is programmed by the microcomputer is sent to the sequential generator, 93(1) & 93(2), via ATN line. A logic high signal which is programmed by the microcomputer is sent to gate 00/10 via EOI line. The same signal is also sent to gate 00/9 in order to disable 244(1). Data-request signals which are generated by the microcomputer are sent to gate 00/9 via DAV line in order to refresh the number of the code generator.

3 Microcomputer → Input memory

Data are generated by the microcomputer, and fed into the data bus. Switch SW-SEQ/OFF/ARB is set to OFF (neutral position) in order to make both 244(1) and 244(2) disable. Data enters into the input memory via CN7, data holder 75(1) & 75(2), and CN8. A logic high signal which is programmed by the microcomputer is sent via EOI line to gate 00/10 and activates it. A data-ready signal which is programmed by the microcomputer is sent to gate 00/9 with each word of the data. This signal holds the word in 75(1) & 75(2) during which time the word is entering into the memory, and also refreshes the memory address. The same data is fed into DAC ZN425E(Y) simultaneously, but this is not intended to be used in this mode of operation.

Data are represented by binary numbers between 0000 0000 and 1111 1110 (decimal 254). The start and end of a set of data are represented by 1111 1111 (decimal 255). This arrangement was started at the time when punched tapes were used. How the start and end codes are detected from the data bus is explained in Appendix 2.

4 Microcomputer → XY plotter

The circuit configuration of this mode of operation is the same as 3, but the programme has been designed to make the data-sending speed slower than 3, so that it can be followed by an XY plotter. DAC ZN425E(Y) is used for this operation in order to obtain an analogue output from the Y output terminal of SW-XYP. The sequential codes are converted into an analogue voltage by DAC ZN425N(X), and used for the X component input (time axis) of the XY plotter. The above ATN and DAV signals are combined by gate 00/11, and used for the Z input (pen lift or drop) of the XY plotter. Z circuit (terminals Z and Z') is isolated by a relay so that an arbitrary voltage can be used for the pen drive.

Fig. 3 shows the physical design of the new BD8. The circuit board has the same dimensions as the previous BD8 (the board for the tape punch circuit) so that this can be replaced by the new board. A large unused area now remains on the board which could be used for any further modifications. Table 1 shows the connections of new BD8.

BD22

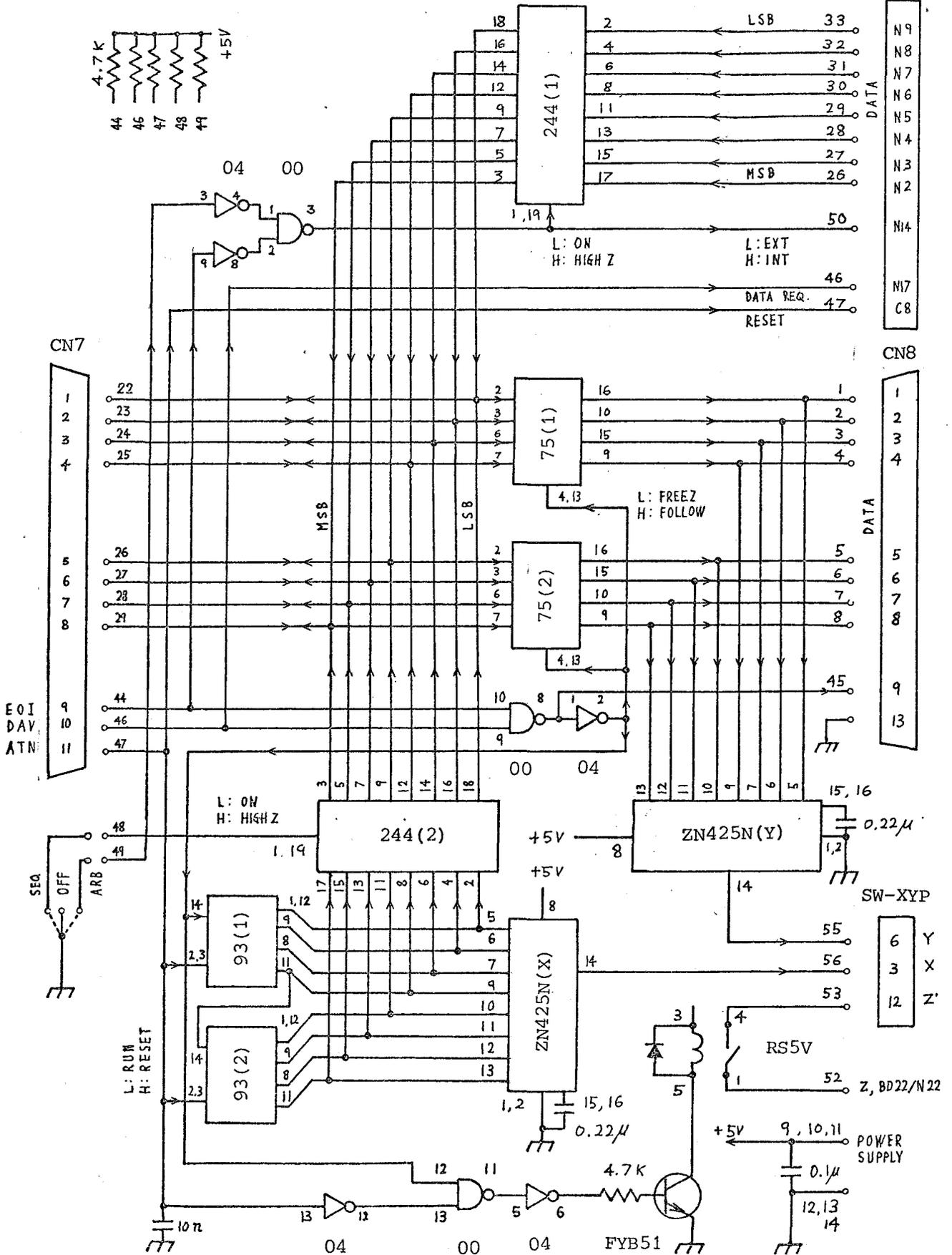


Fig. 2 Circuit diagram of the interface, NEW BD8.

Table 1 Terminal connections of the interface, NEW BD8.

Pin No.	Colour	Function	Connector		Connected to
1	Bn	1(LSB)	CN8/1	CN103/1	BN8/N1
2	R	2	2	2	N2
3	Or	3	3	3	N3
4	Y	4	4	4	N4
5	Gn	5 Data	5	5	N5
6	Be	6	6	6	N6
7	V	7	7	7	N7
8	Gy	8(MSB)	8	8	N8
9	Bk	+5V			
10	"	"			
11	"	"			
12	Gn	Common			
13	"	"			
14	"	"			
15	Gy	8(MSB)	CN7/8	CN7/8	GP1B/16
16	V	7	7	7	15
17	Be	6	6	6	14
18	Gn	5 Data	5	5	13
19	Y	4	4	4	4
20	Or	3	3	3	3
21	R	2	2	2	2
22	Bn	1(LSB)	1	1	1
23					
25					
26	Gy	8(MSB)	—	—	BD22/2
27	V	7	—	—	3
28	Be	6	—	—	4
29	Gn	5 Data	—	—	5
30	Y	4	—	—	6
31	Or	3	—	—	7
32	R	2	—	—	8
33	Bn	1(LSB)	—	—	9
34					
43					
44	Gy/R	EOI	CN7/9		GP1B/5
45	Gy/Be	FH	CN8/9	CN103/9	M1/C22
46	Gy/Bn	DAV	CN7/10	BD22/N17	GP1B/6
47	Gy/Gn	ATN	CN7/11	BD22/C8	11
48	Gy/Bk				
49	Y/R	SW-SEQ/OFF/ARB			
50				BD22/N14	
52	Or/Gn	Z	BD22/N22		
53	Or/Be	Z'	SW-XYP/12		
54	Gn	Common	CN2/14		
55	Or/R	Y	SW-XYP/6		
56	Or/Bn	X	SW-XYP/3		

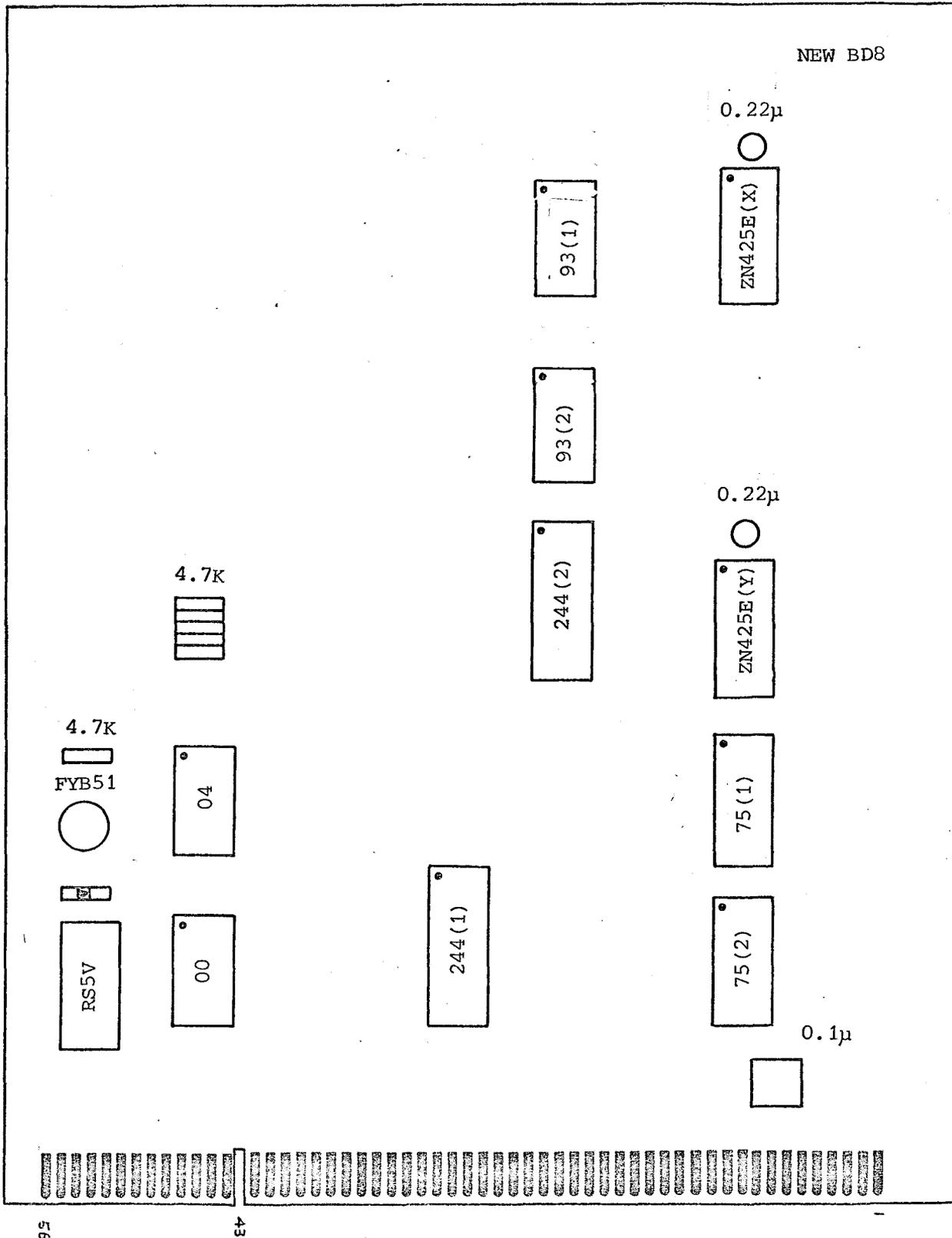


Fig. 3 Physical arrangement of the interface circuit board, NEW BD8 (full scale).

4. COMBINED USE OF INSTRUMENTS

Fig. 4 shows the possible combinations of some instruments related to the interface circuit. The instruments are linked by cables with connectors, since each instrument has to be operated individually or has to be used for other projects. Details of each connector or related board are shown in tables on pages 10 to 11.

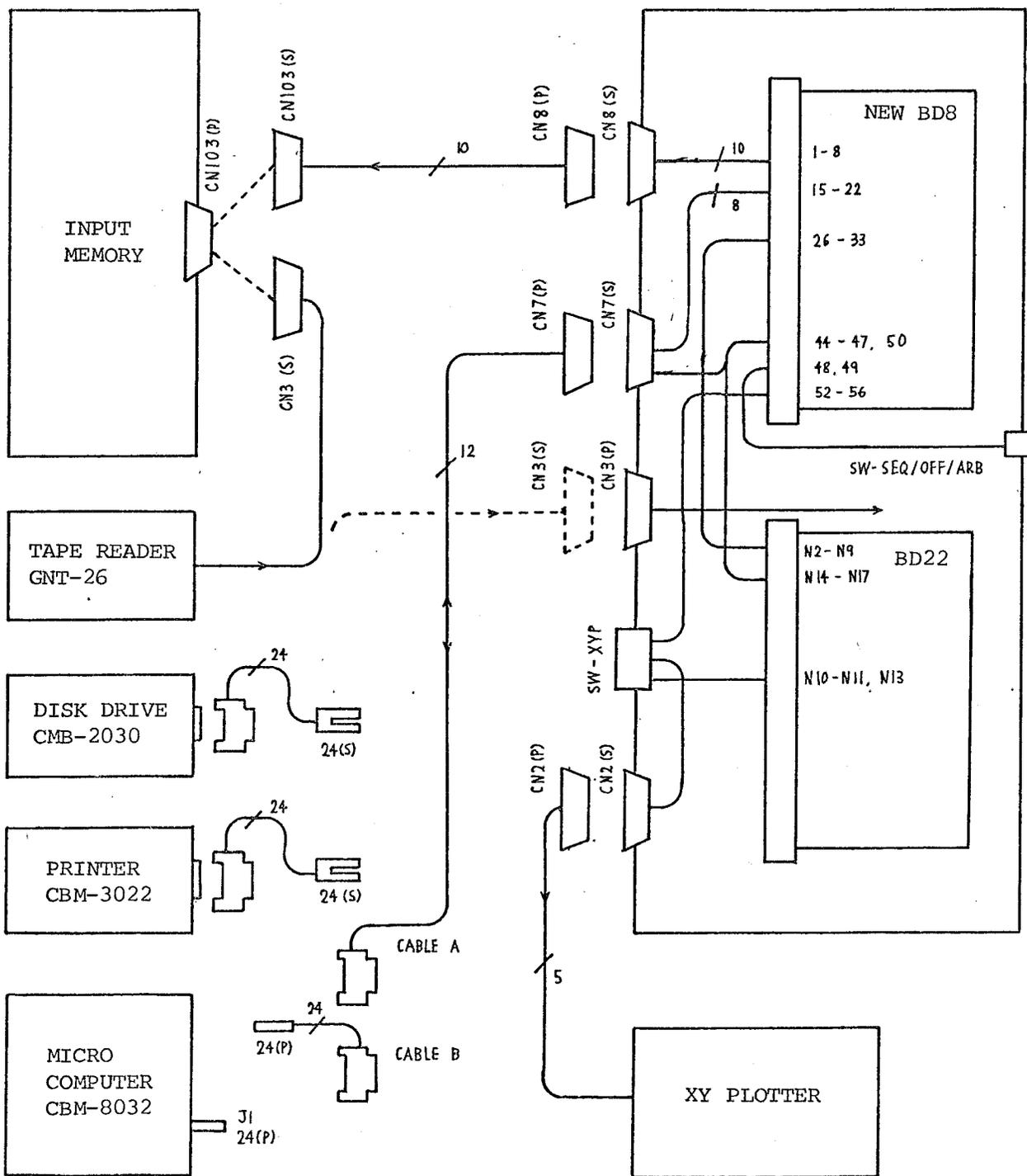


Fig. 4 Possible combinations of some instruments related to the interface, NEW BD8.

Table 2 Terminal connections related to the interface, NEW BD8

CN2

Pin No.			
1	Bn	SW-XYP/1	X
2	R	SW-XYP/4	Y
3	Or	BD22/N12	Z
4	Y	SW-XYP/10	Z'
5	Be	BD22/N15	CRO X
6	V	BD22/N16	CRO Y
7-13	-		
14	Gn	Common	

CN7

Pin No.			
1	Bn	BD8/22	Data 1
2	R	21	2
3	Or	20	3
4	Y	19	4
5	Gn	18	5
6	Be	17	6
7	V	16	7
8	Gy	15	8
9	Bn/Gy	44	EOI
10	R/Gy	46	DAV
11	Gn/Gy	47	ATN
12	-		
13	Gn	Common	

CN8

Pin No.			
1	Bn	BD8/33	Data 1
2	R	32	2
3	Or	31	3
4	Y	30	4
5	Gn	29	5
6	Be	28	6
7	V	27	7
8	Gy	26	8
9	Be/Gy	45	FH
10-12	-		
13	Gn	Common	

BD22 (Modified parts only)

Pin No.			
N10	Bn	SW-XYP/1	
N11	R	SW-XYP/2	
N12	Or	CN2/3	
N13	Y	SW-XYP/4	
N14	Gy/R	BD8/44	EOI
N17	Gy/Bn	BD8/46	DAV
C8	Gy	BD8/47	ATN

SW-XYP

Pin No.			
1	Bn	BD22/N10	X
2	Bn	CN2/1	
3	Or/Bn	BD8/N56	
4	R	BD22/N11	Y
5	R	CN2/2	
6	Or/R	BD8/N55	
7-9	-		
10	Y	BD22/N13	Z*
11	Y	CN2/4	
12	Or/Be	BD8/N53	

SW-XYP

1	2	3
4	5	6
7	8	9
10	11	12

Pin view

Cable A

IEEE488 Connector		CN7		Connected to	
Pin No.					
1	Bn	1	Bn	BD8/22	Data 1
2	R	2	R	21	2
3	Or	3	Or	20	3
4	Y	4	Y	19	4
5	Gn	9	P	BD8/44	EOI
6	Be	10	Bk	46	DAV
7	V	-			
8	Gy	-			
9	W	-			
10	W/Be				
11	W/Bn	11	D-Be	BD8/47	ATN
12	Screen	24			
13	W/Or	5	Gn	BD8/18	Data 5
14	W/Y	6	Be	17	6
15	W/Gn	7	V	16	7
16	W/Gn	8	Gy	15	8
17	W/V	-			
18	W/Gy	25	} W	Common	
19	W/Bn/Be	25			
20	W/R/Be	25			
21	W/Or/Be	25			
22	W/Y/Be	25			
23	W/Gn/Be	25			
24	W/Be/Be	25			

5. DESIGN OF SOFTWARE

Software for interface NEW BD8 has been developed as follows:

PROG D1	Interface → Screen (Test)
PROG D2	Model → Screen (Operational)
PROG D3	Screen → Disk (Operational)
PROG D4	Disk → Screen (Operational)
PROG D5	Screen → Printer (Operational)
PROG D6	Screen → Model (Basic form)
PROG D7	Screen → Model (Test, 2 channels)
PROG D8	Screen → Model (Test, 144 channels)
PROG D9	Screen → XY plotter (Operational)
PROG D20X	Uniform wind field in X direction
PROG D20Y	Uniform wind field in Y direction
PROG D20J	Uniform pressure-gradient field in X direction
PROG D20K	Uniform pressure-gradient field in Y direction

Some of the programmes are for testing the performances of the interface circuit including the microcomputer, disk, printer and model. Others are for actual operations. All the programmes are stored on a floppy disk. If a waveform can be expressed mathematically, only a formula (or formulas) is stored on the disk and the waveform is generated for each operation, rather than storing the whole amount of data for the waveform.

The total number of data in a section of some programmes can be varied if required. In this chapter, 256 is used for these examples.

A switch, SW-SEQ/OFF/ARB (on the front panel of the control cabinet) should be operated, in addition to the microcomputer keyboard. Instructions for the operation of this switch are given in each programme.

PROG D1 INTERFACE → SCREEN (TEST)

A programme for testing the transmission of data from interface BD8 to the microcomputer screen, by using sequential numbers.

Set SW-SEQ/OFF/ARB to SEquential.

After the programme is run, if sequential numbers 0 to 255 are displayed on the screen, the transmission is perfect.

Programme	Comments
<pre> 10 POKE 59456,0 20 FOR N=0 TO 255 30 A=PEEK(59424) 40 POKE 5000+N,A 50 B=PEEK(5000+N) 60 PRINT B; 70 POKE 59427,60 80 POKE 59427,52 90 NEXT 100 POKE 59456,4 110 STOP </pre>	<pre> ATN → L Counter Read data received from data bus Store data in screen memory Read data from screen memory Display data on screen DAV → H) Next data-request signal DAV → L - ATN → H - </pre>

PROG D2 MODEL → SCREEN (OPERATIONAL)

A programme for transferring an arbitrary waveform from the model to the microcomputer screen in an actual operation.

Model → Output memory

Select SW-BIP/MON, BIPolar or Monopolar depending on the waveform.
 Set SW-INT.C/EXT.C to EXTERNAL Clock (generated in the Input Memory).
 Set SW-MAGNIF to 1, 2, 5, 10, or 20, depending on the amplitude of the waveform.
 Set SW-WRITE/PLOT to WRITE. Press the red button near the switch.
 Monitor the waveform on a CRO.

Output memory → Microcomputer

Set SW-SEQ/OFF/ARB to ARBITRARY.
 Select SW-96/256 depending on the length of data.
 Load PROG D2 to the microcomputer. Then fix the maximum number in Line 30.

Programme	Comments
10 POKE 59409,52 20 POKE 59456,0	EOI → L ATN → L
30 FOR N=0 TO 255 40 A=PEEK(59424) 50 POKE 5000+N,A 60 B=PEEK(5000+N) 70 PRINT B;	Counter (Maximum 255) Read data on data bus. To screen memory Read data on screen memory Display data on screen
80 POKE 59427,52 90 POKE 59427,60 100 NEXT	ADV → L) ADV → H) Next data-request signal -
110 POKE 59409,60 120 POKE 59456,4 130 STOP	EOI → H ATN → H -

PROG D3 SCREEN → DISK (OPERATIONAL)

A programme for transferring data on the microcomputer screen to a disk, in an actual operation.

Set SW-SEQ/OFF/ARB to OFF.

Programme	Comments
<pre> 10 DOPEN#1,"DATAFILE",W 20 FOR I=5000 TO 5255 30 M=PEEK(I) 40 PRINT#1,M 50 NEXT 60 DCLOSE#1 70 STOP </pre>	<pre> Open sequential file on disk to write Screen memory address in loop Get contents of 1st memory address Store contents on disk Get number from next address Close sequential file — </pre>

PROG D4 DISK → SCREEN (OPERATIONAL)

A programme for transferring data from a disk to the microcomputer screen, in an actual operation.

Set SW-SEQ/OFF/ARB to OFF.

Programme	Comments
<pre> 10 DOPEN#1,"DATAFILE",R 20 FOR I=0 TO 255 30 INPUT#1,I 40 POKE 5000+I,I 50 N=PEEK(5000+I) 60 PRINT N; 70 NEXT I 80 DCLOSE#1 90 STOP </pre>	<pre> Oper sequential file on disk to read Counter for 255 words Get 1st word from disk - 1st word to screen memory Display word to check - Close sequential file on disk - </pre>

PROG D5 SCREEN → PRINTER (OPERATIONAL)

A programme for transferring data from the microcomputer screen to the printer, in an actual operation.

Set SW-SEQ/OFF/ARB to OFF.

Programme	Comments
10 OPEN 2,4 20 CMD 2 30 FOR I=5000 TO 5255 40 M=PEEK(I) 50 PRINT#2,M; 60 NEXT 70 CLOSE 2 80 STOP	Open channel to printer - Screen memory address in loop Read contents in memory Print contents in memory - Close channel to printer -

PROG D6 SCREEN → MODEL (BASIC FORM)

A programme for transferring data from the microcomputer screen to the 'Input Memory' of the electronic model.

Set SW-SEQ/OFF/ARB to OFF.

Programme	Comments
10 POKE 59409,60 20 POKE 59426,255	EOI → H Start signal '255'
30 FOR I=5000 TO 5255 40 M=PEEK(I) 50 PRINT M; 60 POKE 59426,M	Loop to get 256 words from memory Get word from screen memory address Display 1st address contents to check Transfer contents to data bus
70 POKE 59427,52 80 POKE 59427,60 90 NEXT I	DAV → L) Data-ready signal DAV → H) Next number from memory
100 POKE 59426,255 110 POKE 59426,0 120 STOP	End signal '255' Return to zero -

Data transferred into the 'Input Memory' can be seen on a CRO through its monitoring terminals. Press the red button on the memory panel to start the reading of the memory contents.

PROG D7 SCREEN → MODEL (TEST, 2 CHANNELS)

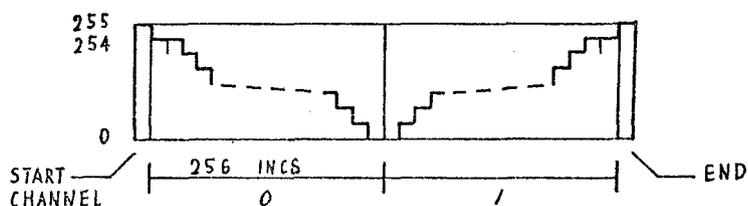
A programme for testing the performance of the interface and input memory, by using a standard waveform for Memory channels 0 and 1.

Set SW-SEQ/OFF/ARB to OFF.

Programme	Comments
10 POKE 59409,60	EOI → H
20 FOR H=255 TO 254 STEP -1 30 PRINT H; 40 POKE 59426,H 50 POKE 59427,52 60 POKE 59427,60 70 NEXT H	Start signal '255', and data 254 Display number on screen Number to data bus DAV → L) DAV → H) Data-ready signal -
80 FOR I=254 TO 0 STEP -1 90 PRINT I; 100 POKE 59426,I 110 POKE 59427,52 120 POKE 59427,60 130 NEXT I	Sequential numbers 254 to 0 -
140 FOR J=0 TO 254 150 PRINT J; 160 POKE 59426,J 170 POKE 59427,52 180 POKE 59427,60 190 NEXT J	Sequential numbers 0 to 254 -
200 FOR K=254 TO 255 210 PRINT K; 220 POKE 59426,K 230 POKE 59427,52 240 POKE 59427,60 250 NEXT K	Data 254, and end signal '255' -
260 POKE 59426,0 270 STOP	Data bus to zero -

Press the red button on the input memory panel, for displaying the waveform on a CRO.

Waveform



PROG D8

SCREEN → MODEL (TEST, 144 CHANNELS)

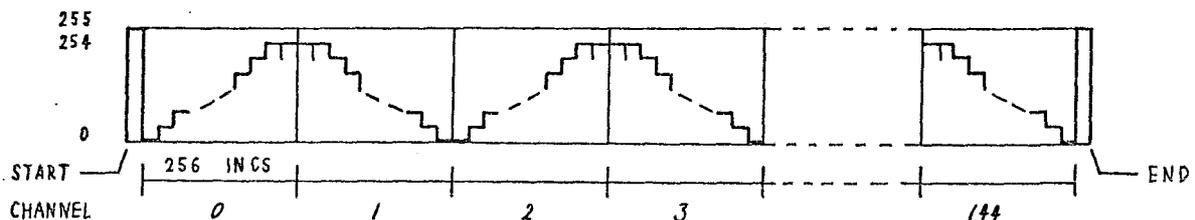
A programme for testing the performances of the interface and input memory, by using a standard waveform for memory channels 0 to 143.

Set SW-SEQ/OFF/ARB to OFF.

Programme	Comments
10 POKE 59409,60 20 S=0	EOI → H Set counter to zero
30 POKE 59426,255 40 POKE 59427,52 50 POKE 59427,60	Start signal '255' to data bus DVA → L) DAV → H) Data-ready signal
60 FOR B=0 TO 253 70 POKE 59426,B 80 POKE 59427,52 90 POKE 59427,60 100 NEXT B	Set up loop Number to data bus DAV → L) DAV → H) Data-ready signal -
110 FOR C=1 TO 4 120 POKE 59426,254 130 POKE 59427,52 140 POKE 59427,60 150 NEXT C	Set up loop Number to data bus DAV → L) DAV → H) Data-ready signal -
160 FOR E=253 TO 0 STEP -1 170 POKE 59426,E 180 POKE 59427,52 190 POKE 59427,60 200 NEXT E	Set up loop Number to data bus DAV → L) DAV → H) Data-ready signal -
210 S=1+S 220 IF S<72 GOTO 60 230 POKE 59426,255 240 STOP	Increment counter Test counter End signal '255' to data bus -

This programme does not display data on the microcomputer screen, hence the cursor disappears from the screen, until the whole process is completed. The data can be monitored as an analogue waveform by a CRO through the monitor terminals of the input memory. After the process has been completed, press the red button on the input memory panel in order to turn the memory into a read mode.

Waveform



PROG D9 SCREEN → XY PLOTTER (OPERATIONAL)

A programme for transferring data from the microcomputer screen to an XY plotter, in an actual operation.

Set SW-SEQ/OFF/ARB to OFF.
Set SW-XYP to MICROCOMP.

Programme	Comments
0 FOR A=0 TO 254 2 POKE 5000+A,A 4 NEXT A	} Sequential numbers to test } main programme below line 10
10 POKE 59459,4 20 POKE 59456,0 30 POKE 59409,60	ATN → H) ATN → L) Reset ADC EOI → H
40 FOR I=5000 TO 5255 50 M=PEEK(I) 60 PRINT M; 70 POKE 59426,M	Loop to get 256 words from memory Get word from memory address Display 1st address to check Transfer contents to data bus
80 POKE 59427,52 90 POKE 59427,60	DAV → L) DAV → H) Data-ready signal
100 FOR C=1 TO 50 110 NEXT C 120 NEXT I 130 POKE 59426,0 140 STOP	For reducing processing speed - Next number from memory Return to zero -

Replace programme lines 0 to 4 by an appropriate programme for an actual operation.

Choose the last number in programme line 90 for an appropriate speed for the XY plotter used.

There is no control on BD8 for the magnification of X and Y outputs. Use controls on the XY plotter, if required.

The input resistance of the XY plotter must be one meg ohms or higher.

PROG D20X UNIFORM WIND FIELD IN X DIRECTION
PROG D20Y UNIFORM WIND FIELD IN Y DIRECTION
PROG D20J UNIFORM PRESSURE-GRADIENT FIELD IN X DIRECTION
PROG D20K UNIFORM PRESSURE-GRADIENT FIELD IN Y DIRECTION

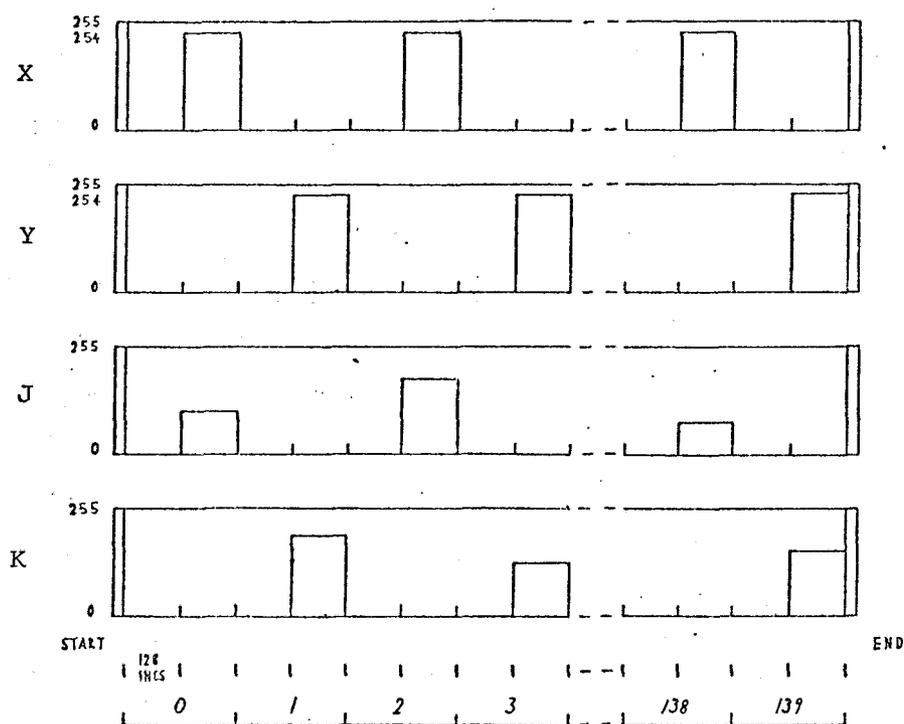
(ALL OPERATIONAL)

A set of programmes used for the computation of storm surges due to two uniform wind fields in orthogonal directions (X and Y), and two uniform pressure-gradient fields in orthogonal directions (J and K). Note, J and K are the same directions as X and Y respectively, but the different symbols are used in order to indicate that they are pressure-gradient fields.

X and Y have a uniform pulse height (254) in their programmes. J and K have different pulse heights in each section depending on each geographical position in the sea area. The value of each pulse in J and K is given in the DATA lines in the programme. The physical meaning of the whole set of programmes and how the values are determined have been described in a separate paper.

The values in this set of programmes represent the values for the North Sea area including the sea around the north part of Scotland. Should the area to which a wind or pressure field is applied be smaller than this area, the values representing the outside of the smaller area should be zero in the programme.

Waveforms



PROG D20X

Programme	Comments
10 S=0 20 POKE 59409,60	Set counter to zero EOI → H
30 K=255 40 POKE 59426,K 50 PRINT K;	Start signal '255' To data bus Display on screen
60 A=0 70 FOR L=1 TO 128 80 POKE 59426,A 90 POKE 59427,52 100 POKE 59427,60 110 PRINT A; 120 NEXT L	- Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
130 B=254 140 FOR P=1 TO 128 150 POKE 59426,B 160 POKE 59427,52 170 POKE 59427,60 180 PRINT B; 190 NEXT P	- Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
200 FOR C=1 TO 256 210 POKE 59426,A 220 POKE 59427,52 230 POKE 59427,60 240 PRINT A; 250 NEXT C	Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
260 S=1+S 270 IF S<4 GOTO 80 280 POKE 59426,K 290 PRINT K; 300 STOP	Increment counter Test counter End signal '255' to data bus Display on screen -

PROG D20Y

Programme	Comments
10 S=0 20 POKE 59409,60	Set counter to zero EOI → H
30 K=255 40 POKE 59426,K 50 PRINT K;	Start signal '255' To data bus Display on screen
60 A=0 70 FOR L=1 TO 384 80 POKE 59426,A 90 POKE 59427,52 100 POKE 59427,60 110 PRINT A; 120 NEXT L	- Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
130 B=254 140 FOR P=1 TO 128 150 POKE 59426,B 160 POKE 59427,52 170 POKE 59427,60 180 PRINT B; 190 NEXT P	- Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
200 S=1+S 210 IF S<2 GOTO 70 220 POKE 59426,K 230 PRINT K; 240 STOP	Increment counter Test counter End signal '255' to data bus Display on screen -

PROG D20J

Programme	Comments
10 DATA 051,060,098,114,149,075,110,130,131,126, 20 DATA 076,114,126,127,208,090,088,078,190,238, 30 DATA 080,070,067,215,059,041,055,055,225,045, 40 DATA 044,039,072,039,036,019,063,077,024,016, 50 DATA 115,060,063,116,070,014,039,027,115,094, 60 DATA 021,031,038,070,031,019,032,026,033,164, 70 DATA 020,166,218,113,069,076,074,064,000,000, 80 DATA 000,000	
100 S=0 110 POKE 59409,60	Set counter to zero EOI → H
120 K=255 130 POKE 59426,K 140 PRINT K;	Start signal '255' To data bus Display on screen
150 A=0 160 FOR L=1 TO 128 170 POKE 59426,A 180 POKE 59427,52 190 POKE 59427,60 200 PRINT A; 210 NEXT L	- Set up loop Number to data line DAV → L) Data-ready signal DAV → H) Display on screen -
220 READ B 230 FOR P=1 TO 128 240 POKE 59426,B 250 POKE 59427,52 260 POKE 59427,60 270 PRINT B; 280 NEXT P	Read data value Set up loop Number to data bus DAV → L) Data-reading signal DAV → H) Display on screen -
290 FOR R=1 TO 384 300 POKE 59426,A 310 POKE 59427,52 320 POKE 59427,60 330 PRINT A; 340 NEXT R	Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
350 S=S+5 360 IF S<4 GOTO 220 370 POKE 59426,K 380 PRINT K; 390 STOP	Increment counter Test counter End signal '255' to data bus Display on screen -

PROG D2OK

Programme	Comments
10 DATA 051,080,098,114,149,075,110,130,131,126, 20 DATA 076,114,126,127,208,090,088,078,190,238, 30 DATA 080,070,067,215,059,041,055,055,225,045, 40 DATA 044,039,072,039,036,019,063,077,024,016, 50 DATA 115,060,063,116,070,014,039,027,115,094, 60 DATA 021,031,038,070,031,019,032,026,033,164, 70 DATA 020,166,218,113,069,076,074,064,000,000, 80 DATA 000,000	
100 S=0 110 POKE 59409,60	Set counter to zero EOI → H
120 K=255 130 POKE 59426,K 140 PRINT K; 150 A=0	Start signal '255' To data bus Display on screen -
160 FOR L=1 TO 384 170 POKE 59426,A 180 POKE 59427,52 190 POKE 59427,60 200 PRINT A; 210 NEXT L	Set up loop Number to data bus DAV → L) Data-ready signal DAV → H) Display on screen -
220 READ B 230 FOR F=1 TO 128 240 POKE 59426,B 250 POKE 59427,52 260 POKE 59427,60 270 PRINT B; 280 NEXT F	Read data value Set up loop Number to data bus DAV → L) DAV → H) Display on screen -
290 S=1+S 300 IF S<4 GOTO 160 310 POKE 59426,K 320 PRINT K; 330 STOP	Increment counter Test counter End signal '255' to data bus Display on screen -

6. CONCLUSION

The interface (hardware and software) between the electronic model and microcomputer has been developed in a short period, and some parts of the model system have been replaced by the microcomputer. This has improved the efficiency of handling the input and output of the system. The data transferring rate through the interface is not the possible maximum at the moment, but is quite sufficient. The rate can be improved if required, without changing the hardware design.

Appendix 1 TIMING ARRANGEMENT IN BD22

The interface circuit BD8 (shown in Fig. 2) is connected to BD22 through which the output of the model is taken. Details of BD22 have been described in IOS Internal Document 85 (1980). Minor modifications have been carried out to BD22 in order to combine it with the newly designed BD8 in 1982, as shown in Fig. A1(a) and A1(b).

BD22 is essentially an ADC plus a memory. However, the timing arrangement of BD22 is rather complex as shown in Fig. A2 (greatly simplified illustration, but the new modifications are included). This is due to the following conditions:

- 1 The write rate and start/end signals of the memory on BD22 should be synchronized with those of the 'Input Memory' when an approximate timing (order of seconds) of the start is commanded manually by a push button.
- 2 The memory on BD22 should have three clock rates for reading:
 - a fast rate for a CRO,
 - b medium rate for the microcomputer, and
 - c slow rate for a XY plotter.
- 3 Without any external clocks, BD22 should work with its own two clocks, with fast and slow rates.

The timing control of BD22 shown in Fig. works as follows: Manual switch SW1 selects the sources of the write clock, EXT (clock 1 in the Input Memory) or INT (clock 2 within BD22). Manual switch SW2 selects Write or Plot mode of the memory on BD22, with the start command by SW START. Only when SW START is pressed, pulses from the pulse synthesizer passes through gate 00(3)/8. Details of the pulse synthesizer, through which the operation of the model is linked to BD22, are described in IOS Internal Document 160 (1982). The output of gate 00(3)/8 sets FF 00(1)/6 and controls the electronic switch 51/8, either Write or Read mode. The output of 51/8 enters into the sequential code generator and other circuits, through selector 157/4, until the FF is reset. This reset signal is given when the generator completes a sequence of codes, up to 96 or 255 depending on the setting of SW3. The sequential generator is reset by a pulse through selector 157/7, before it starts.

The microcomputer is linked with BD22 only when selectors 157/4 and 157/7 are switched to the microcomputer side. Such a state occurs only when gate 00/8 on BD8 is activated by SW4 (ARB side) and EOI signal. When the two selectors are switched to the microcomputer side, the read clock is generated by the microcomputer and enters into selector 157/4 through terminal N17; also the reset signal enters into selector 157/7 through terminal C8. Note the write clock and its start/end signals are still taken from the input memory.

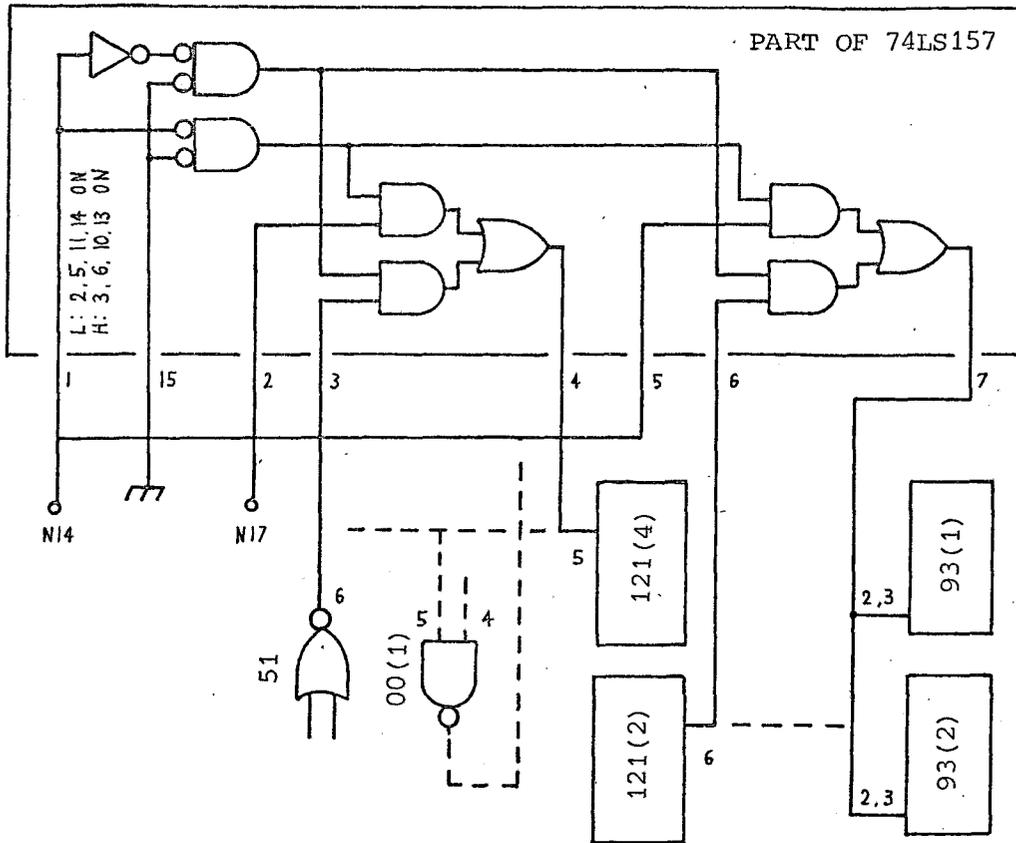


Fig. A1(a)

Modification of BD22 for the interface, NEW BD8.
 Dotted lines show parts removed.
 Solid lines show parts added.

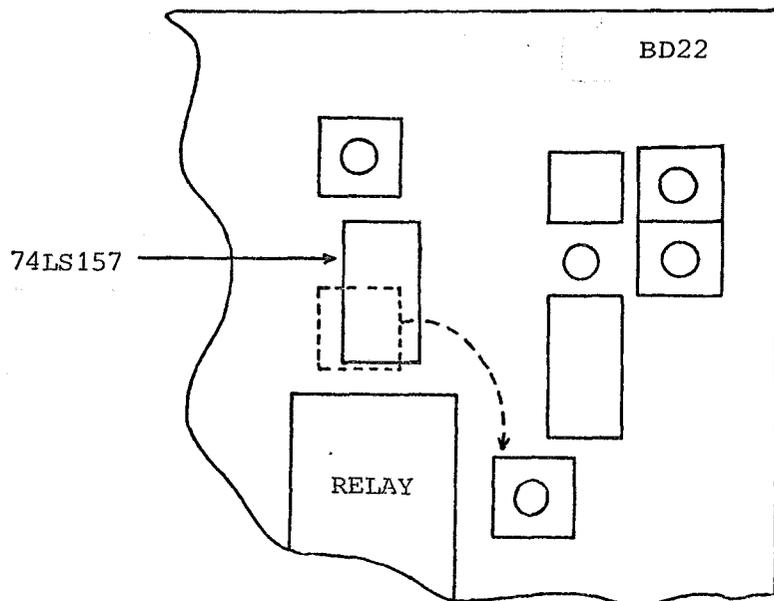


Fig. A1(b)

Physical modification of BD22 for the interface, NEW BD8. The location of a potentiometer has been changed, and 74SL157 has been added.

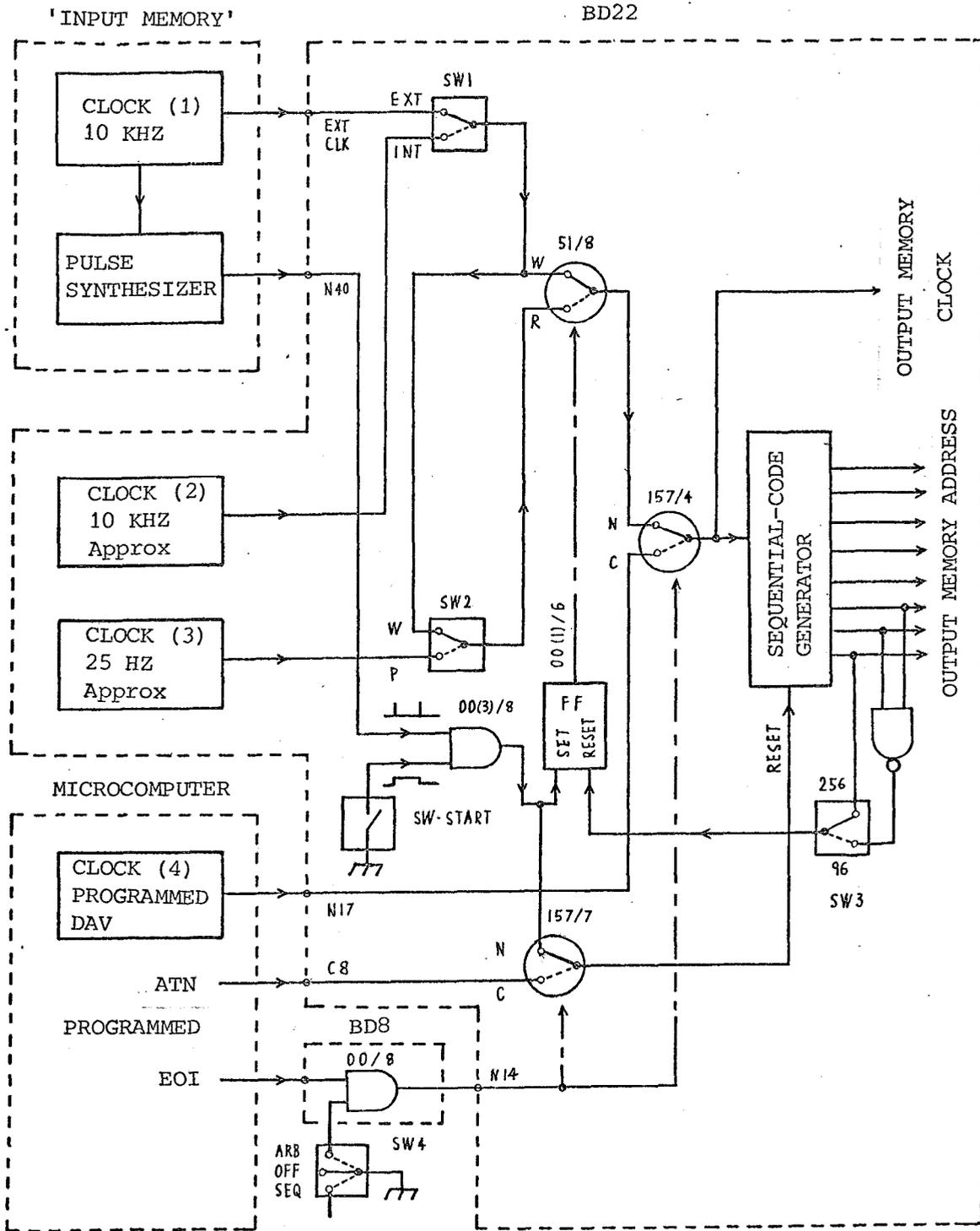


Fig. A2 Timing control scheme of BD22 including the modification for the interface.

Appendix 2 START AND END SIGNALS FOR THE INPUT MEMORY

Data can be fed into the input memory either by a punched-tape reader or the microcomputer with the interface BD8. This arrangement has been used because a number of punched tapes were already made prior to the floppy disk being employed. The input memory is linked with the tape reader or BD8 by 8 parallel data lines and a single timing signal line only. Therefore, the start and end of the data transmission are indicated by 1111 1111 (decimal 255) on the data line (255 is not used for data). Fig. A3 shows the circuit for detecting the start and end signal from the data line. The first 255 is regarded as Start, and the second as End.

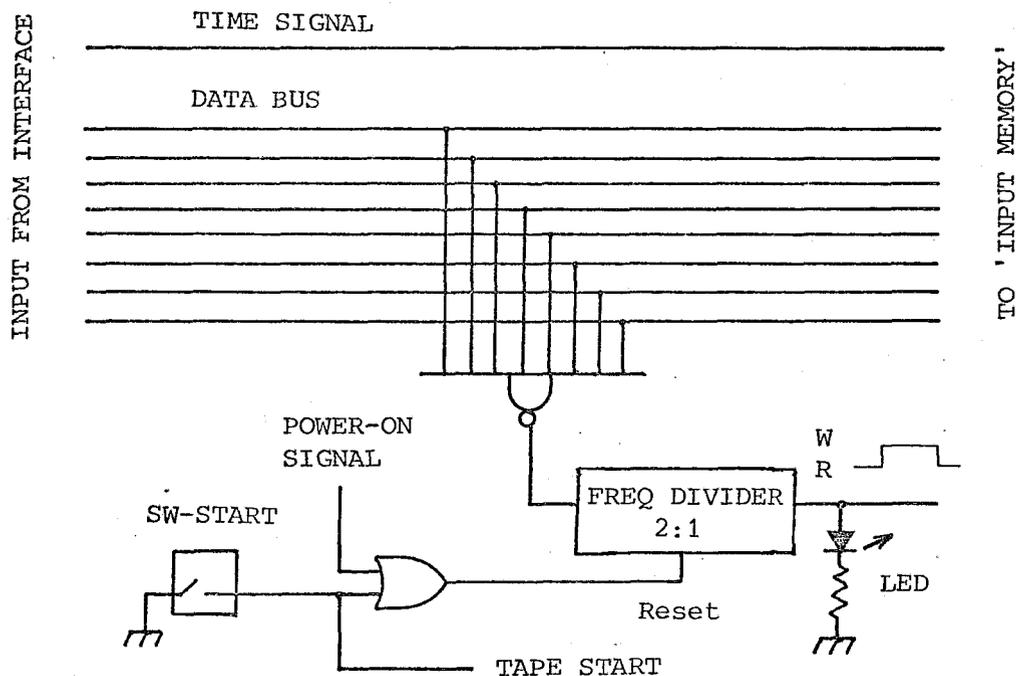
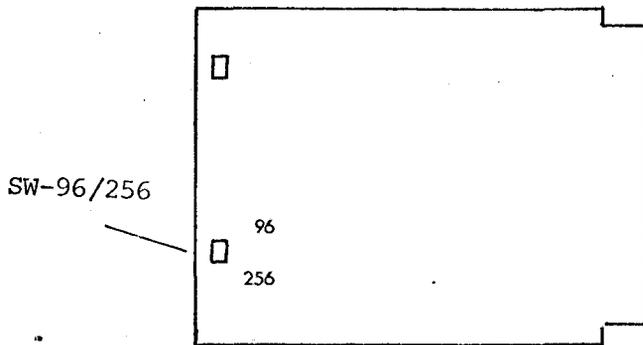
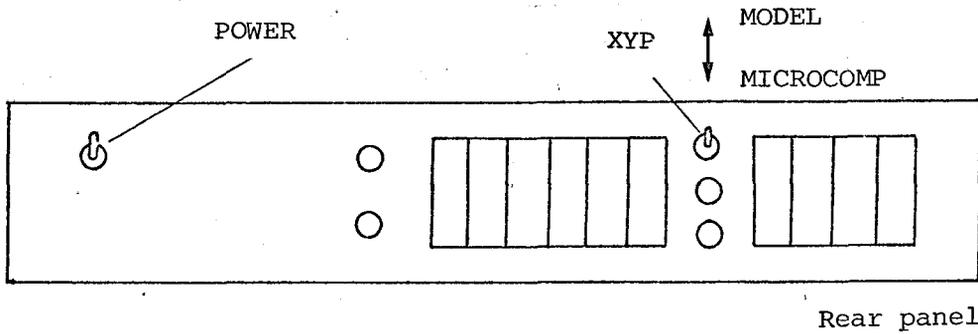
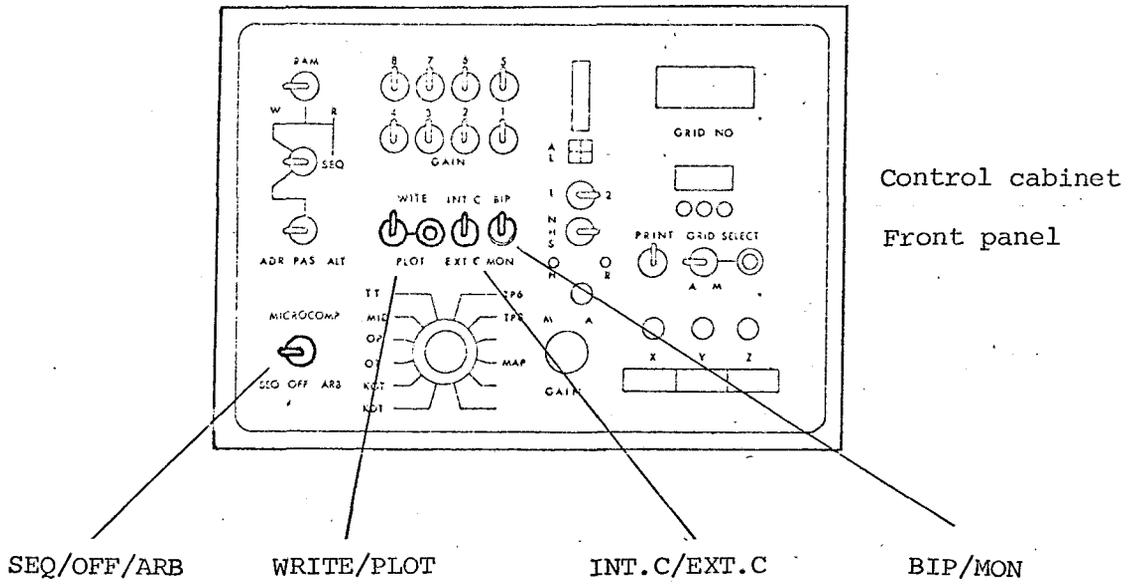
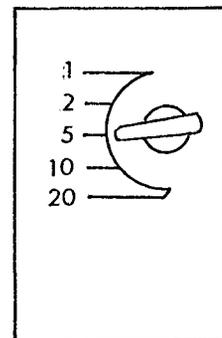


Fig. A3 Circuit for detecting the start and end signals in the 'input memory'.

Appendix 3 LOCATION OF SWITCHES



Component side of BD22



Input-gain control

