FILE
PM111.

I.O.S.

INTERNAL DOCUMENT 268

THERMISTOR SPAR MONITOR

K.G. Birch and A.P. Haines

[*This document should not be cited in a published bibliography, and is supplied for the use of the recipient only*].

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey GU8 5UB
(042-879-4141)

(Director: Dr. A. S. Laughton, FRS)

Bidston Observatory,
Birkenhead,
Merseyside L43 7RA
(051-653-8633)

THERMISTOR SPAR MONITOR

K.G. Birch and A.P. Haines

INTERNAL DOCUMENT NO. 268

[1985]

INSTITUTE OF OCEANOGRAPHIC SCIENCES
WORMLEY, GODALMING, SURREY GU8 5UB

INDEX

Computer Display System

Introduction

The system was written to allow realtime multichannel graphical presentation of Thermistor Spar data. The channels plotted on the VDU can be selected from within the data frame by software with a maximum of 18 channels at any one time. A hard copy print of the VDU plot can be obtained using a dot matrix printer; however, during plotting periods acquisition of new data is suspended.

System Detailed Description

Data Acquisition

The system described here is based on Acorn BBC Model B, Epson FX80 printer, a purpose-built interface with interrupt driven software.

The data and shift clock derived from the Seadata Logger each drive six buffers connected in parallel IC 1 and IC 2 with the commoned outputs driving an LED in an opto-isolator. The buffers of IC 1 and IC 2 are used in parallel to ensure that enough current is provided to allow the phototransistor to switch at high speed. The output from the opto-isolators is buffered by IC 5a and b to improve the signal rise and fall times. The rising edge of the shift clock is used to trigger a retriggerable monostable IC 7, which acts as a frame detector and remains high for the duration of data input. The shift clock is counted by IC 6, a binary counter, with the Q3 output differentiated to provide a pulse after each eight shift pulses. This pulse is buffered by IC 5c to generate an interrupt strobe for the data into the Computer User Port.

Whilst the shift clock is counted by IC 6 it is also used to clock the data into IC 8, a serial/parallel convertor. The parallel outputs of IC 8 are buffered by IC 5d and IC 6a, b, c, d, e and f and together with the interrupt strobe drive the Computer User Port.

The data is read from the User Port in single bytes under interrupt control and stored in successive memory locations until the complete data frame is acquired. The reading of data from the User Port is controlled by an assembler routine to allow the software to achieve the speed necessary to keep up with the Seadata clock rates in a synchronous mode. The routine automatically establishes synchronisation with the data by use of the internal timer and detects the gap in the data transmissions. Having once established the time frame the software can store the data in the correct channel order.

The final part of the assembler routine .FIN is used to halt data input during the output to a dot matrix printer. The software will accept

any number of 16 bit data words but the number of data words must be correct within the software before the program is used (i.e. CN = number of 16 bit data words).

Plotting Routine

SPARMON draws a time-series graph of all or selected channels of the thermistor spar, the traces proceeding from the left to the right of the screen. At the start of each screen the incoming data is read maxscans% times (usually 3 or 4) and the initial means for all channels are calculated by PROCstat. At this stage if it is first entry to the program the 24 hr time is input within PROCfirst. Axes are then drawn by PROCaxis and plotting may commence. The complete data frame is awaited in the main program whereupon control is passed to PROCdrawgraph which draws traces by connecting the last set of points (lastpt(n)) to the present set (prespt(n)). The very first array of points are neatly spaced out knowing the means; however, the positions of channels can be set in the software by changing the graphics screen coordinate constants in lines 1060-1220. At any time during plotting the vertical and horizontal scales may be changed simply by pressing "M" which causes a branch to PROCmodifyscale. Time ticks are drawn at selected intervals by PROCtick, and labels too by PROClabel. When a screen has been filled, control passes to PROCdump - a 0.1 degree C scale bar is drawn and a screen dump to EPSON dot matrix printer is performed (via a MICROBUFFER). Along with the graphics dump the start-of-screen means and roughly calibrated means are printed; following this the start-of-screen time is dumped. During dumping, data acquisition is halted. The cycle is then repeated with a call to PROCfirst once more and further start-of-screen statistics. Various other small procedures exist for calculating time etc., but these are self explanatory.

Power Supplies

The input buffers, IC1, IC2 and the LEDs in opto-isolators are powered by the logging system with the remainder of the circuit powered by +5 volts from the BBC. The isolation of the two supplies means there is no logging system 0V connected to Mains earth and any differences in voltage levels between the logging system and BBC can be neglected.

Software Description

Line(s)	Function
Main Program:-	
10-20	Select mode, halt screen flicker.
120	Suppress keyboard auto-repeat.
130-160	Dimension arrays, initialise channel name strings.
170-210	Initialise logical variables (-1=TRUE, 0=FALSE).
220	Initialise parameter variables.
230	*LOAD screen dump routine.
250	Sets number of 16 bit data words by CN, and hence the number of bytes to each data frame is calculated.
260-310	Dimension Storage Space for Assembled Machine Code programs, and raw data storage area.
320-340	Start Assembler loop.
350-400	Initialise the storage pointer and data frame flag.
410-450	Set the interval timer.
460-540	WAIT. Detects the absence of interrupts. If an interrupt is detected the timer is reset and the software continues to wait for a gap in the interrupt. This software establishes synchronisation between the processor and the Seadata logger.
550-620	RUPT. This routine is called each time an interrupt is generated. The registers are saved at the start and replaced at the end of interrupt servicing. The User Port data is read and stored in location STORE which is indexed by register X.
630-710	GO. The User Port is set to detect the interrupts and the interrupt vectors are set to point to the routine RUPT.
720	End of the Assembler loop.
730-750	These disable interrupts during printing periods.
810	This resets the data storage pointer.
820	Increment no. of scans for start of screen statistics.
830	Calls initialisation of pointers and flags and then detects synchronisation with data gap in between data frames.
840	Calls routine GO to initiate User Port and interrupt vectors.
860	Waits until correct number of bytes has been acquired, then the display data frame is initiated.

870-880	Check if key "M" has been pressed - if so go to PROCmodifyscale.
890-990	Test number of scans prior to commencing new screen. N.B. Correction: replace '4' with 'maxscans%'.
910	Loop to await next data frame.

PROCdrawgraph:-

970	Switch off text cursor.
990	More graphics cursor to origin.
1000-1030	Collect data from memory and assign to variable x.
1060-1220	Vertically space out data set in the form: height up screen = fixed point + scale multiplier* (x - mean of x at start of screen).
1230	Branch to PROCfirst if start of new screen.
1250	Write inclinometer values at top of screen.
1260-1300	Draw the channels by connecting line between last set of points to the new points.
1310	Increment shift across screen and gap between time ticks.
1330	If due for time tick branch to PROCtick.
1360	Keep this line in if channel labels are required.
1370	If shifted to R.H.S. of screen, branch to screen dumping procedure.

PROCstat:-

1430-1460	Fill x with data from memory.
1470-1480	Calculate mean of x.
1520	Clear screen.

PROCmodify scale:-

1570	Halt data input.
1590	Reset g-cursor to L.H.S. of screen.
1600-1630	Get scale multiplier for vertical scale and x-shift.
1650	If time has been set up, get the start of screen time.

PROCfirst:-

1700	Halt data input.
1720-1740	Assign last set of points to be the present set (as this is start of a screen).
1760-1800	If time has not been set up, get the present time from the user and reset internal clock.
1830	Get start of screen time.
1840	Draw axes on screen.

PROCres:-

1900-1940	Reset to zero all statistics variables.

PROCdump:-

1990	Halt data input.
2000	Join graphics and text cursors.
2020-2040	Draw a scale bar to represent (approximately) 0.1°C.
2050	Enable separation of cursors.
2060	Perform screen dump.
2110	Select print format.
2120-2150	Print start of screen means and calibrated thermistor means.
2160	Change print format.
2170	Print start of screen time.
2180	Halt printing.
2190	Send Form Feed character to printer.
2200	Reset statistics and set up variables for start of screen.

PROCgettime:-

2240	Calculate time in 24 hr clock.

PROCaxis:-

2330-2360	Draw vertical lines.
2370-2420	Draw horizontal ticks for axis.

PROClabel:-

2470-2500	Write odd numbered labels.
2510-2540	Write even numbered labels.

PROCtick:-

2590	Zero the distance between time ticks.
2600-2610	Draw a vertical tick.

Variable List

Variable(s)	Function/Contents
x(18)	Array containing present data set.
xmean(18),ydis(18)	Equivalent variables containing start-of-screen means.
lastpt(18),prespt(18)	Last and present data points.
name$(18)	Array of strings for channel names.
maxscans%	Max. no. of scans for statistics.
xshift%	Screen coordinate shift to right.
nchans%	No. of channels.
ymult	Multiplier to determine vertical scale.
gap%	Distance from last time tick.
indicator%	No. of scans made for statistics.
select$	Character of key pressed.
shift%	Present position across screen.
t1%	1st 2 digits of 24 hr time being input.
t2%	2nd 2 digits of 24 hr time being input.
n1%,n2%	1st and 2nd pair of digits of actual time.
graph%)	
timeset%)	logical control variables.
firsttime%)	

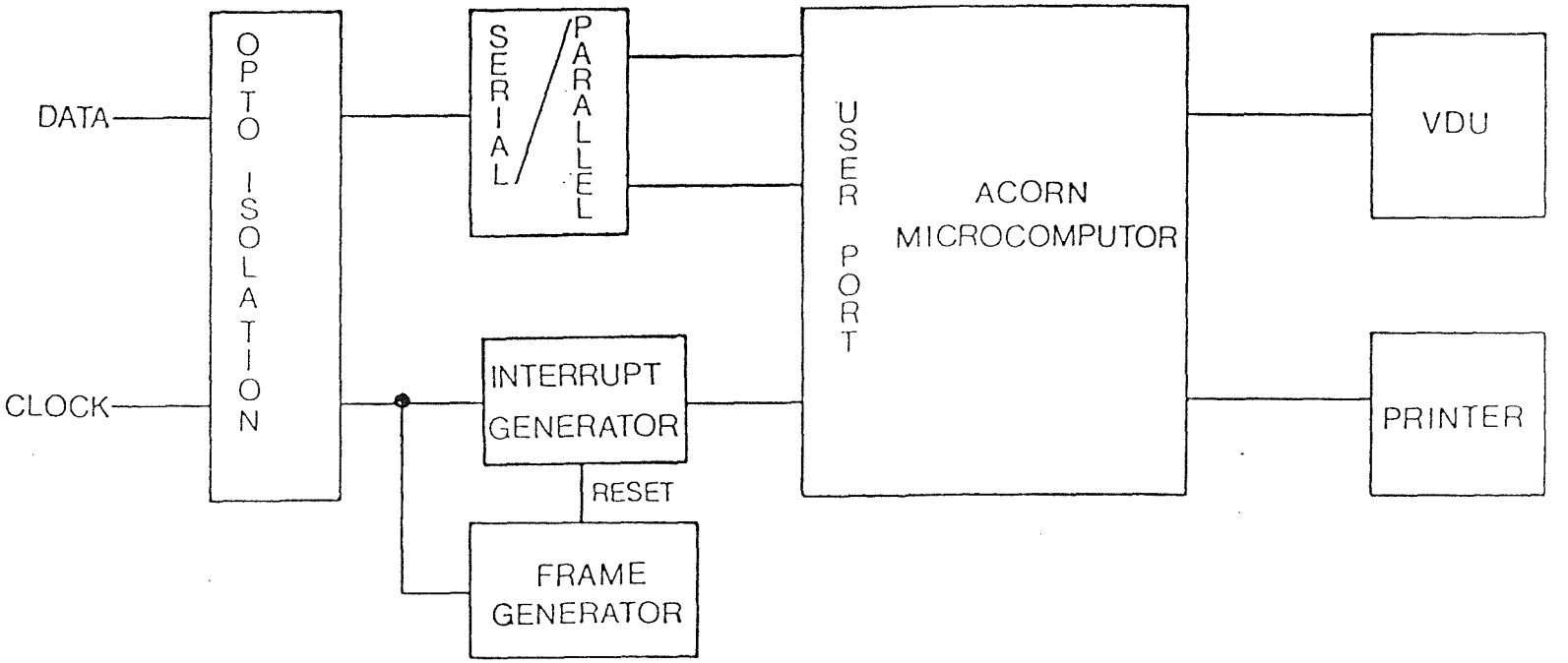
```
 10*TV0,1
 20 MODE4
 30 REM****** PAUL HAINES ********
 40 REM** UNIVERSITY OF SURREY ***
 50 REM***** DEPT.OF PHYSICS *****
 60 REM
 70 REM******* K.BIRCH ***********
 80 REM******* I.O.S.  ***********
 90 REM* APPLIED PHYSICS GROUP ***
100 REM
110 REM NUMBER OF CHANNELS IS SET BY CN
120 *FX11,0
130 DIM
x(18),ydis(18),xsum(18),xmean(18),lastpt(18),prespt(18),yshift%(18),na
me$(18)
140 REM** Initialise variables
150name$(1)="s1 ":name$(2)="s2 ":name$(3)="t1 ":name$(4)="t2
":name$(5)="t3 ":name$(6)="t4 ":name$(7)="t5 ":name$(8)="t6
":name$(9)="t7 "
160name$(10)="t8 ":name$(11)="t9 ":name$(12)="t10":name$(13)="rx
":name$(14)="t11":name$(15)="f+a":name$(16)="p+s":name$(17)="px
":name$(18)="t12"
170 firsttime%=-1
180 timeset%=0
190 graph%=-1
200 shift%=0
210 indicator%=0
220 maxscans%=4:xshift%=4:nchans%=18 :ymult=1:gap%=0
230 *LOAD"DUMPCL"
240REM
250 CN=18
260 NUM=&70
270IRQ2V=&0206
280OSASCI=&FFE3
290OSBYTE=&FFF4
300 DIM STORE 1000
310 DIM INIT 300
320 FOR I%= 0 TO 2 STEP 2
330 P%=INIT
340 [OPT I%
350.INIT  LDA £&00
360       STA &8F
370       STA &8E
380       STA &8D
390       STA &8C ΩRESET POINTERS AND FLAGS
400      STA &8B
410.SYNC  LDA £&00
420       STA &FE64 ΩLOAD LOW BYTE TMER
430       LDA £&80
440       STA &FE65 ΩLOAD HIGH BYTE TIMER
450       LDA &FE60 ΩRESET INTERRUPT FLAG
460.WAIT  LDA £&10
470       BIT &FE6D
480       BNE SYNC ΩDETECT CB1 TIMER RESET
490       LDA £&40
500       BIT &FE6D
510       BVC WAIT ΩDETECT TIME OUT 35 mSEC
```

```
520       LDA £&30
530       STA &8F ΩSET DATA R4QUIRED FLAG
540       RTS
550.RUPT  PHA:TXA:PHA:TYA:PHAΩSAVE REGISTERS
560       LDA &8E              ΩLOAD STORAGE PTR
570       TAX                  ΩINTO X REG
580       LDA &FE60            ΩREAD INPUT PORT
590       STA STORE,X          ΩSTORE DATA
600       INC &8E
610.FINAL PLA:TAY:PLA:TAX:PLA ΩRESTORE REGISTERS
620       RTI
630.GO    LDA £&97:LDX £&6C   ΩSELECT PCR ON USER VIA
640       LDY £0:JSR OSBYTE   ΩSET UP TO DETECT H-L TRANS.
650       LDA £&97:LDX £&6E   ΩSELECT IER ON USER VIA
660       LDY £&6F:JSR OSBYTE ΩDISABLE ALL BUT CB1 INTERRUPTS
670       LDA £&97:LDX £&6E   ΩSELECT IER ON USER VIA
680       LDY £&90:JSR OSBYTE ΩENABLE CB1 INTERRUPTS
690ΩCHANGE IRQ2 VECTORS TO POINT TO ABOVE ROUTINE
700       LDA £RUPT MOD 256:STA IRQ2V
710       LDA £RUPT DIV 256:STA IRQ2V+1
720       RTS                  ΩBACK TO BASIC
730.FIN LDA£&97:LDX £&6E
740        LDY£&10:  JSR OSBYTEΩDISABLES INTERRUPTS
750         RTS
760]NEXT I%
770 *FX15,1
780 CLS
790:
800 REM** Start of main loop
810?&8E=0
820 indicator%=indicator%+1
830 CALL INIT
840 CALL GO
850 @%=08
860IF ?&8E>CN*2-1  THEN 870ELSE 860
870select$=INKEY$(0)
880 IFselect$="M"THEN PROCmodifyscale:PROCaxis
890 IFindicator%<4THENgraph%=0ELSEgraph%=-1
900 IFgraph%THEN PROCdrawgraph ELSE PROCstat
910 GOTO 810
920 END
930:
940DEF PROCdrawgraph
950 REM** Get data from memory, work
960 REM** out coords, plot.
970VDU23,1,0;0;0;0;
980wait%=0
990MOVE0,0
1000 F=(nchans%*2)-1
1010 FOR I%=0TO F STEP2
1020 x((I%DIV2)+1)=?(STORE+I%)*256+?(STORE+I%+1)
1030 NEXT
1040 REM** ydis is mean obtained from
1050 REM** PROC stat
1060 prespt(16)=543+(x(17)-43676)
1070 prespt(17)=1023-(x(15)-30875) /44
1080 prespt(18)=903+(x(16)-30743)/44
1090 prespt(1)=843+ymult*(x(3)-ydis(3))
```

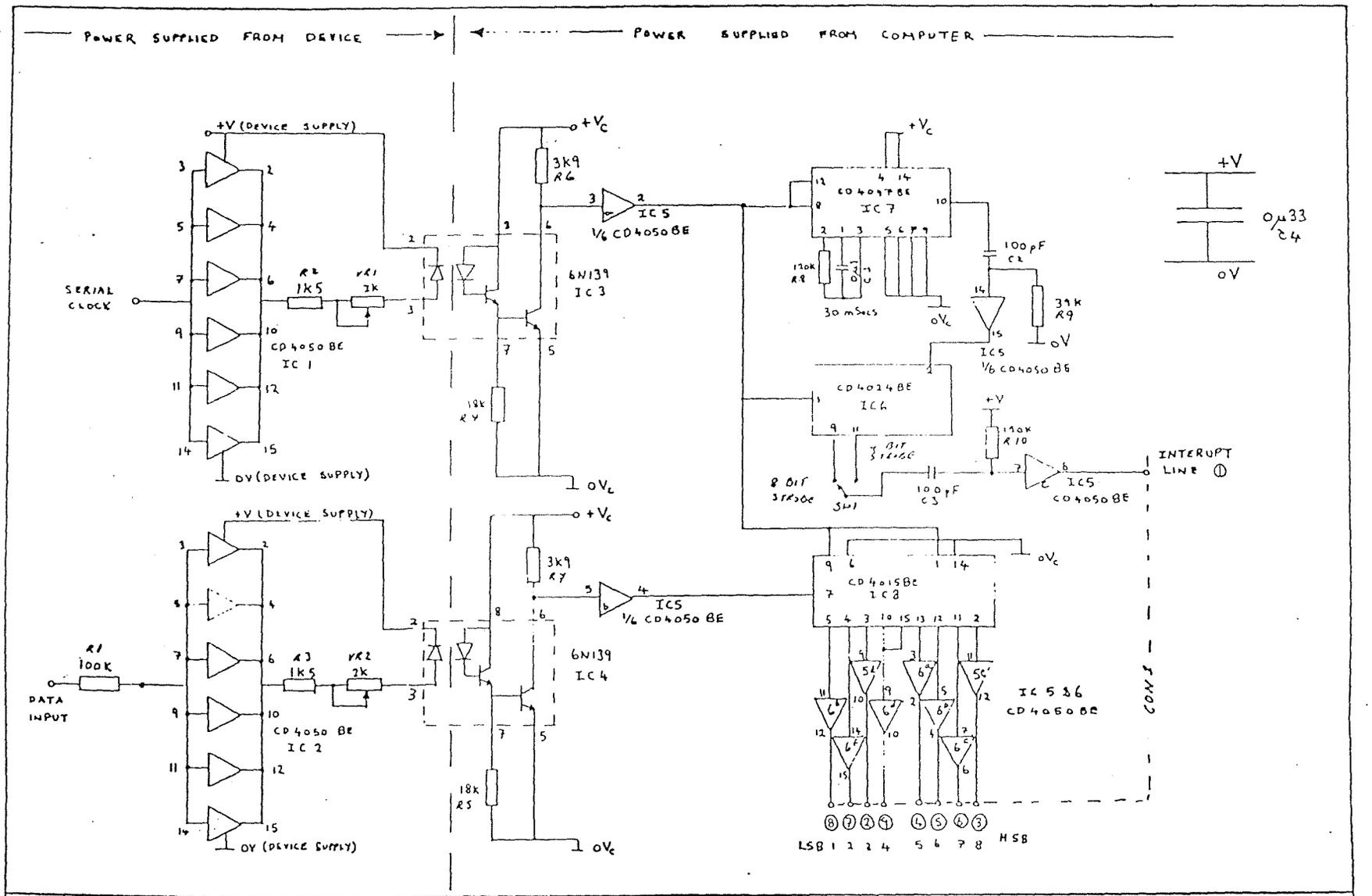
```
 1100 prespt(2)=783+ymult*(x(4)-ydis(4))
 1110 prespt(3)=723+ymult*(x(5)-ydis(5))
 1120 prespt(4)=663+ymult*(x(6)-ydis(6))
 1130 prespt(5)=603+ymult*(x(7)-ydis(7))
 1140 prespt(7)=483+ymult*(x(9)-ydis(9))
 1150 prespt(8)=423+ymult*(x(10)-ydis(10))
 1160 prespt(9)=363+ymult*(x(11)-ydis(11))
 1170 prespt(10)=303+ymult*(x(12)-ydis(12))
 1180 prespt(11)=243+ymult*(x(13)-ydis(13))
 1190 prespt(12)=183+ymult*(x(14)-ydis(14))
 1200 prespt(13)=123+ymult*(x(18)-ydis(18))
 1210 prespt(14)=0+.02*(x(1)-41000)
 1220 prespt(15)=60+.02*(x(2)-41000)
 1230 IFfirsttime%THEN PROCfirst
 1240 REM** Draw the point & values
 1250 PRINTTAB(12,0);"F/A ";(x(15)-30875.36)DIV178.19438;" P/S
";(x(16)-30743.626)DIV174.41068
 1260 FOR I%=1 TO 18
 1270MOVEshift%,lastpt(I%)
 1280DRAWshift%+xshift%,prespt(I%)
 1290 lastpt(I%)=prespt(I%)
 1300 NEXT I%
 1310 shift%=shift%+xshift%:gap%=gap%+xshift%
 1320 REM*** number below=half of number of secs between ticks ****
 1330 IFgap%>=(60*xshift%) THEN PROCtick
 1340 REM** Keep next line in if labels
 1350 REM** are required.
 1360 IF shift%>=400AND shift%<=(401+xshift%) THEN PROClabel
 1370 IFshift%>=1279THEN PROCdump
 1380ENDPROC
 1390:
 1400DEF PROCstat
 1410 REM** Get stats for plot start.
 1420PRINTTAB(14,5);"STAT ANALYSIS"
 1430F=(nchans%*2)-1
 1440FOR I%=0TO F STEP2
 1450num%=(I%DIV2)+1
 1460x(num%)=?(STORE+I%)*256+?(STORE+I%+1)
 1470xsum(num%)=xsum(num%)+x(num%)
 1480xmean(num%)=xsum(num%)/indicator%
 1490ydis(num%)=xmean(num%)
 1500 PRINTydis(num%)
 1510NEXT
 1520CLS:CLG
 1530ENDPROC
 1540:
 1550DEF PROCmodifyscale
 1560 REM** Modify X/Y scales.
 1570 CALL FIN
 1580CLS:CLG
 1590shift%=0:gap%=0
 1600PRINTTAB(10,5);"MODIFY SCALE"
 1610PRINT
 1620INPUT"y-multiplier ",ymult
 1630INPUT"x-shift      ",xshift%
 1640CLS
 1650IF timeset% THEN PROCgettime
 1660ENDPROC
```

```
1670:
1680DEF PROCfirst
1690 REM** Set up start of plot
1700CALL FIN
1710LOCAL I%
1720FOR I%= 1 TO 18
1730lastpt(I%)=prespt(I%)
1740NEXT
1750 REM** First entry- get time
1760 IFtimeset%=0THEN1770ELSE1820
1770 INPUT"TIME (HOURS)";t1%
1780 INPUT"     (MINS )";t2%
1790 timeset%=-1
1800 TIME=0
1810CLG
1820firsttime%=0
1830PROCgettime
1840 PROCaxis
1850ENDPROC
1860:
1870:
1880 DEF PROCres
1890 REM** Reset stats vars.
1900 FOR P%=1 TO 18
1910 xsum(P%)=0
1920 xmean(P%)=0
1930 ydis(P%)=0
1940 NEXT
1950 ENDPROC
1960:
1970DEF PROCdump
1980 REM** Screen dump
1990 CALL FIN
2000VDU5
2010MOVE5,50
2020PRINT"    .1d="
2030MOVE300,40
2040DRAW300+400*ymult,40
2050VDU4
2060CALL &A00
2070CLG:CLS
2080VDU2
2090 REM** Print the stats used at
2100 REM** start of plot and time.
2110@%=&20208
2120PRINTTAB(11);"MEAN";TAB(23);"TEMP"
2130FOR n%=1 TO18
2140PRINTTAB(0);name$(n%);"=
";TAB(11);xmean(n%);TAB(23);xmean(n%)/4000.0 -2.12725
2150NEXT
2160@%=&20002
2170 PRINT:PRINT"TIME :";n1%;n2%
2180VDU3
2190VDU2,1,12,3
2200PROCres:indicator%=0:shift%=-1:firsttime%=-1
2210ENDPROC
2220:
2230DEF PROCgettime
```

```
2240tm%=TIME:m%=tm%DIV6000
2250n2%=(t2%+m%)DIV60:n1%=t1%+INT(n2%)
2260n2%=t2%+m%-INT(n2%)*60
2270IFn1%>=24THENn1%=n1%-24
2280 REM** Time given by n1.n2
2290ENDPROC
2300:
2310 DEF PROCaxis
2320 REM** Draw axes
2330 MOVE 5,5
2340 DRAW 5,1000
2350 MOVE 1277,5
2360 DRAW 1277,1000
2370 FOR S=60 TO 1120 STEP 60
2380 MOVE 0,S
2390 DRAW 25,S
2400 MOVE 1250,S
2410 DRAW 1280,S
2420 NEXTS
2430 ENDPROC
2440:
2450 DEF PROClabel
2460 REM** Label the channels
2470 FOR T=1 TO 13 STEP 2
2480 X=(32-(prespt(T)/32))
2490 PRINTTAB(12,X);T
2500 NEXT T
2510 FOR G=2 TO 12 STEP 2
2520 X=(32-(prespt(G)/32))
2530 PRINTTAB(14,X);G
2540 NEXT G
2550 ENDPROC
2560:
2570DEFPROCtick
2580 REM** Draw time ticks
2590gap%=0
2600MOVEshift%,20
2610DRAWshift%,60
2620ENDPROC
>*SPOOL
```



COMPUTOR DISPLAY- FIGURE 1



8 BIT PARALLEL INTERFACE TO COMPUTER

INSTITUTE OF OCEANOGRAPHIC SCIENCES.

ISSUED TO	DRAWING No. LO.9/
REVISED	DRAWN BY KJB DATE 3/4/84 SHEET No.
	ISSUED FOR ORDER No. FOR UNITS

A3

CIRCUIT DIAGRAM SYMBOL	ELECTRONICS COMPONENT DESCRIPTION				IDENTIFICATION		ALTERNATIVES & REMARKS
	NAME	RATING	GRADE	TYPE	TRADE OR SUPPLIERS NAME	REFERENCE No.	
IC1	INTEGRATED CIRCUIT			CD4050 BE	R.C.A		
IC2	" "			CD4050 BE	R C A		
IC3	" "			6N 139	H P		
IC4	" "			6N 139	H P		
IC5	" "			CD4050 BE	R C A		
IC6	" "			CD4024 BE	R C A		
IC7	" "			CD4047 BE	R.C.A		
IC8	" "			CD4015 BE	R C A		
VR1	POTENTIOMETER	2KΩ	0.5W	375 - 207	DUMLIER	FARNELL CODE 375-207 2K	
VR2	"	2KΩ	0.5W	" "	"	" " " " "	
R1	RESISTOR	10K	¼W	METAL FILM HR25	WELWYN		
R2	"	1K5	"	" " "	"		
R3	"	1K5	"	" " "	"		
R4	"	18KΩ	"	" " "	"		
R5	"	18KΩ	"	" " "	"		
R6	"	3K9	"	" " "	"		
R7	"	3K9	"	" " "	"		
R8	"	120KΩ	"	" " "	"		
R9	"	39KΩ	"	" " "	"		
R10	"	150KΩ	"	" " "	"		
C1	CAPACITOR	0.1	10%	MKS2	WIMA	FARNELL CODE 143-680	
C2	"	100pF	10%	81232 /100 INV	STC		

REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE

SCADATA - COMPUTER INTERFACE

INSTITUTE OF OCEANOGRAPHIC SCIENCES

ELECTRONICS COMPONENTS FOR DRG. No. I.O.S./

COMPILED BY KJS DATE 9/4/85 SHEET No. 1

ISSUED FOR ORDER No. FOR UNITS

CIRCUIT DIAGRAM SYMBOL	ELECTRONICS COMPONENT DESCRIPTION				IDENTIFICATION		ALTERNATIVES & REMARKS
	NAME	RATING	GRADE	TYPE	TRADE OR SUPPLIERS NAME	REFERENCE No.	
C3	CAPACITOR	100pF	10%	81232 /C0G 100V	S.T.C		
C4	"	0·33μF	10%	MKC 4	WIMA		
CON 1	PCB CONNECTOR	20 WAY	IDC	ITT-CANNON - G		R.S. COMPONENTS STK No 467-346	
CABLE	RIBBON CABLE	20 WAY				— " — 360-122	DIRECT CONNECTORS ARE MOUNTED ON RIBBON CABLE TYE
CON 2	RIBBON CABLE MTD	20 WAY				— " — 467-209	INTERFACE PLUGS DIRECTLY
CON 3	" " "	20 WAY				— " — 467-285	INTO BBC USER PORT
SW1	SWITCH	SPCO		ULTRA MINATURE		— " — 334-224	

REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE	REMARKS	ISSUE	DATE

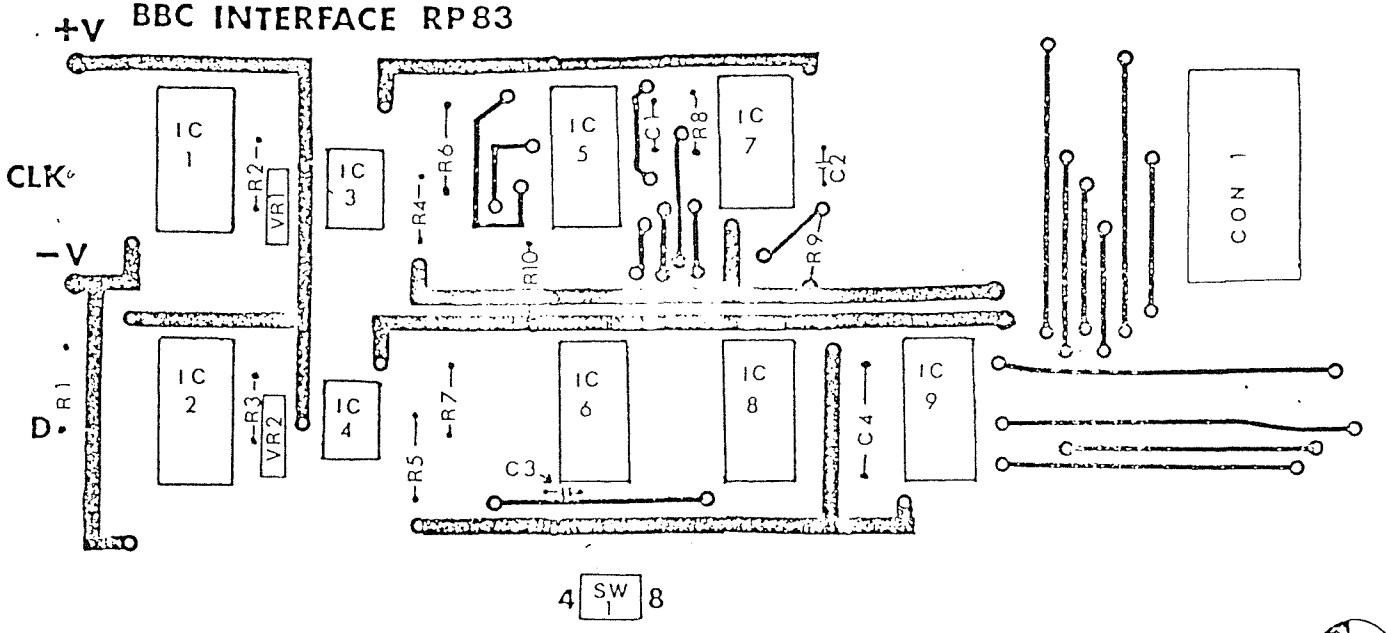
SEADATA – COMPUTER INTERFACE

INSTITUTE OF OCEANOGRAPHIC SCIENCES

ELECTRONICS COMPONENTS FOR DRG. No. I.O.S./

COMPILED BY KGB DATE 10/1/85 SHEET No. 2

ISSUED FOR ORDER No. FOR UNITS


BBC INTERFACE RP83
+V
CLK
-V
D
R1
IC 1
IC 2
R2
R3
VR1
VR2
IC 3
IC 4
R4
R5
R6
R7
IC 5
IC 6
C1
C3
R8
R10
IC 7
IC 8
C2
R9
C4
IC 9
CON 1
4
SW 1
8