OPERATING TEST

of the

ROCKWELL, INC. AIM-65 MICROCOMPUTER

as a

U.S. COAST GUARD AUTOMATIC WEATHER REPORTING STATION

April 1981

School of Oceanography
Oregon State University
Corvallis, Oregon 97331

ORESU-O-81-002

The work reported herein was funded by NOAA Sea Grant under
Contract NA79AA-D-00106 with Oregon State University

INTRODUCTION

This report describes a prototype automatic weather station based upon the Rockwell, Inc. AIM-65 microcomputer and intended for use at U.S. Coast Guard stations in making scheduled reports to the National Weather Service via conventional telephone or teletype circuits.

The system was tested at the Yaquina Bay (OR) Coast Guard Station in February-March 1981 with good results; station interrogation occurred from both So. Beach, OR and Portland, OR during the test using modems, an acoustic coupler, and a terminal.

Provided that suitable sensor outputs are available at a station, the system-with its existing software - could be installed at other Coast Guard coastal facilities for about $2,500 each.

The system enables NWS stations to interrogate a Coast Guard station for weather conditions at any time, whether the Coast Guard communicator's position is on live watch or not. It provides continuous digital weather display to the Coast Guard communicator, for his operational use. It also prints out the weather message whenever interrogated and once each hour.

EQUIPMENT

The system consists of a Rockwell, Inc. AIM-65 microcomputer with BASIC compiler, a tape cassette player for program loading, a sensor interface board mounted within the AIM-65 and an integral sensor connector panel, Fig.1-3 and Appendix A. A computer terminal with RS-232 interface and modem is required to remotely interrogate the AIM-65, Fig. 4.

INSTALLATION

The System should be mounted at a location in the Operations Room convenient to the communicator's panel, to a 110v. 60Hz socket and to either a 20 ma. teletype line or telephone modem with RS 232 interface. Coax cables

Fig. 1

AIM-65 Microcomputer System

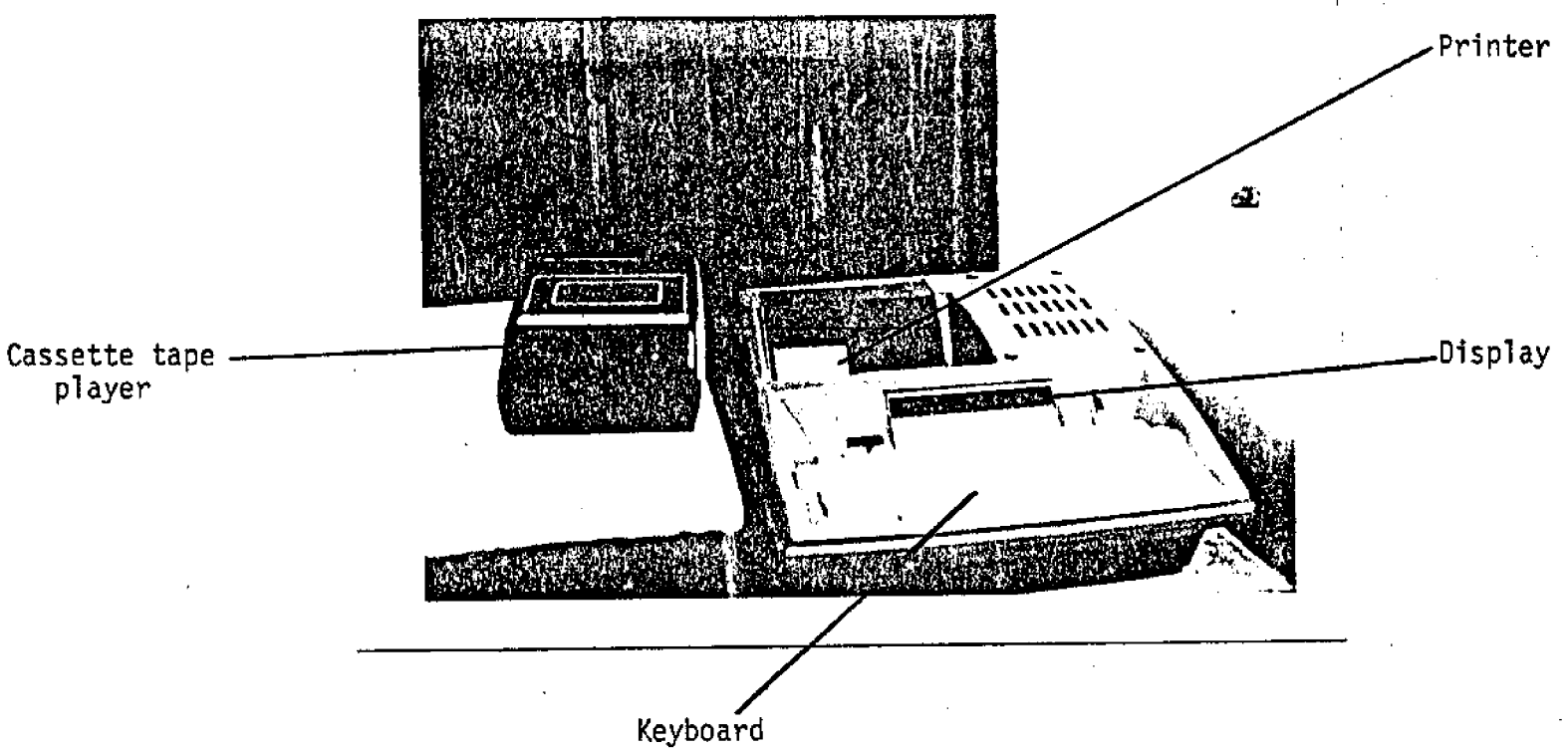


Fig 2a.
Sensor Interface Board

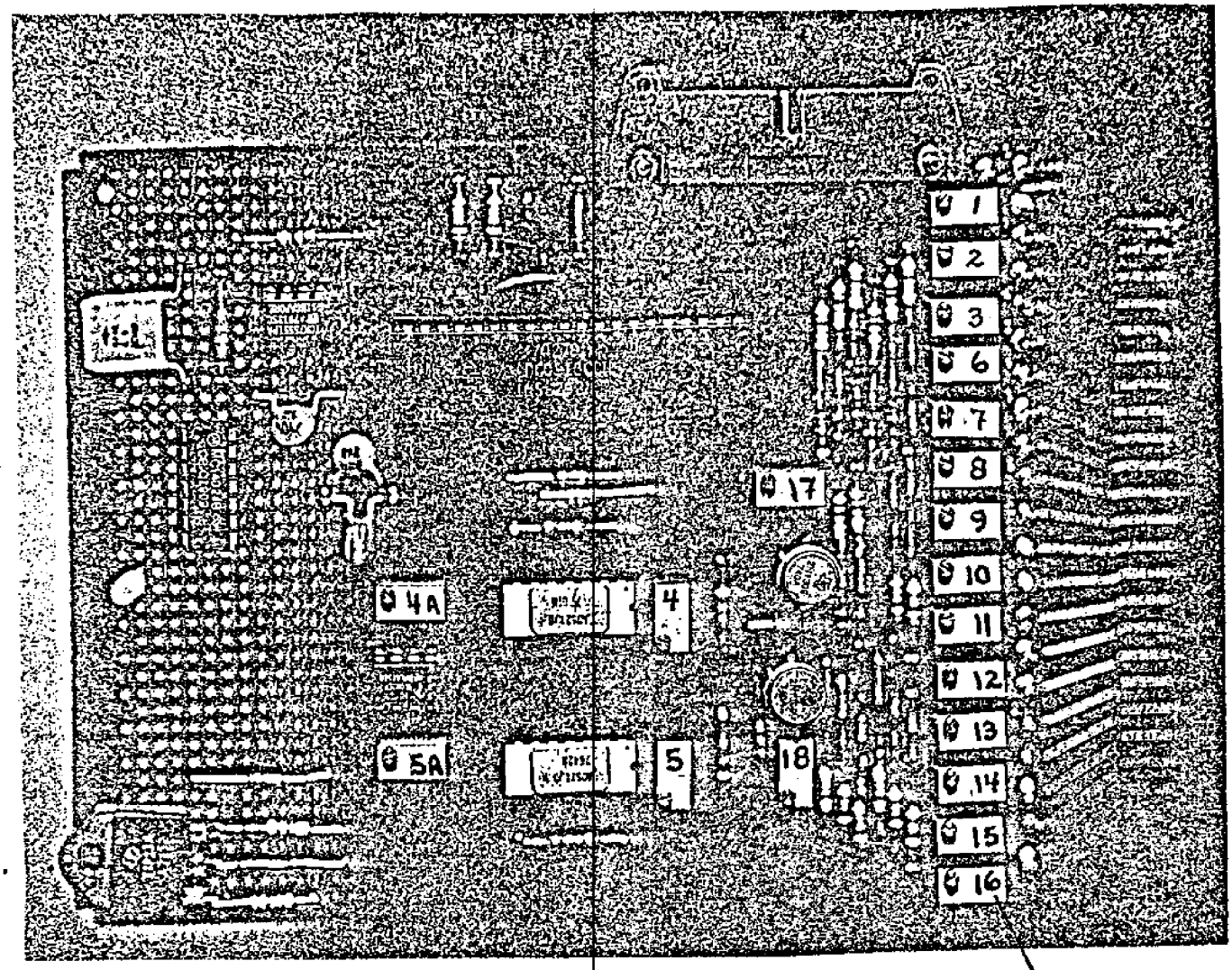


Fig 2b.
Sensor Interface Board Mounted in AIM-65

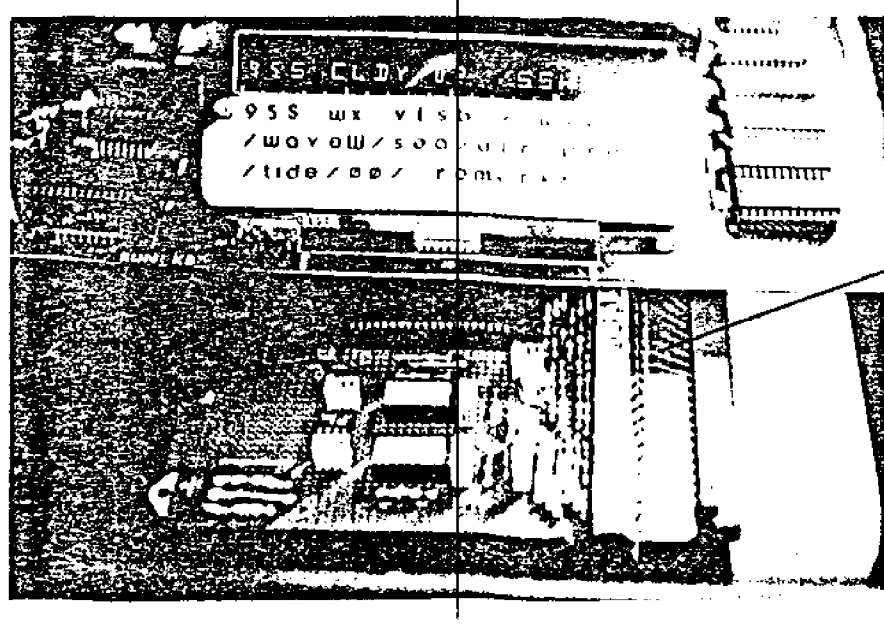


Fig. 3

Back of AIM-65 showing Sensor Connector Panel

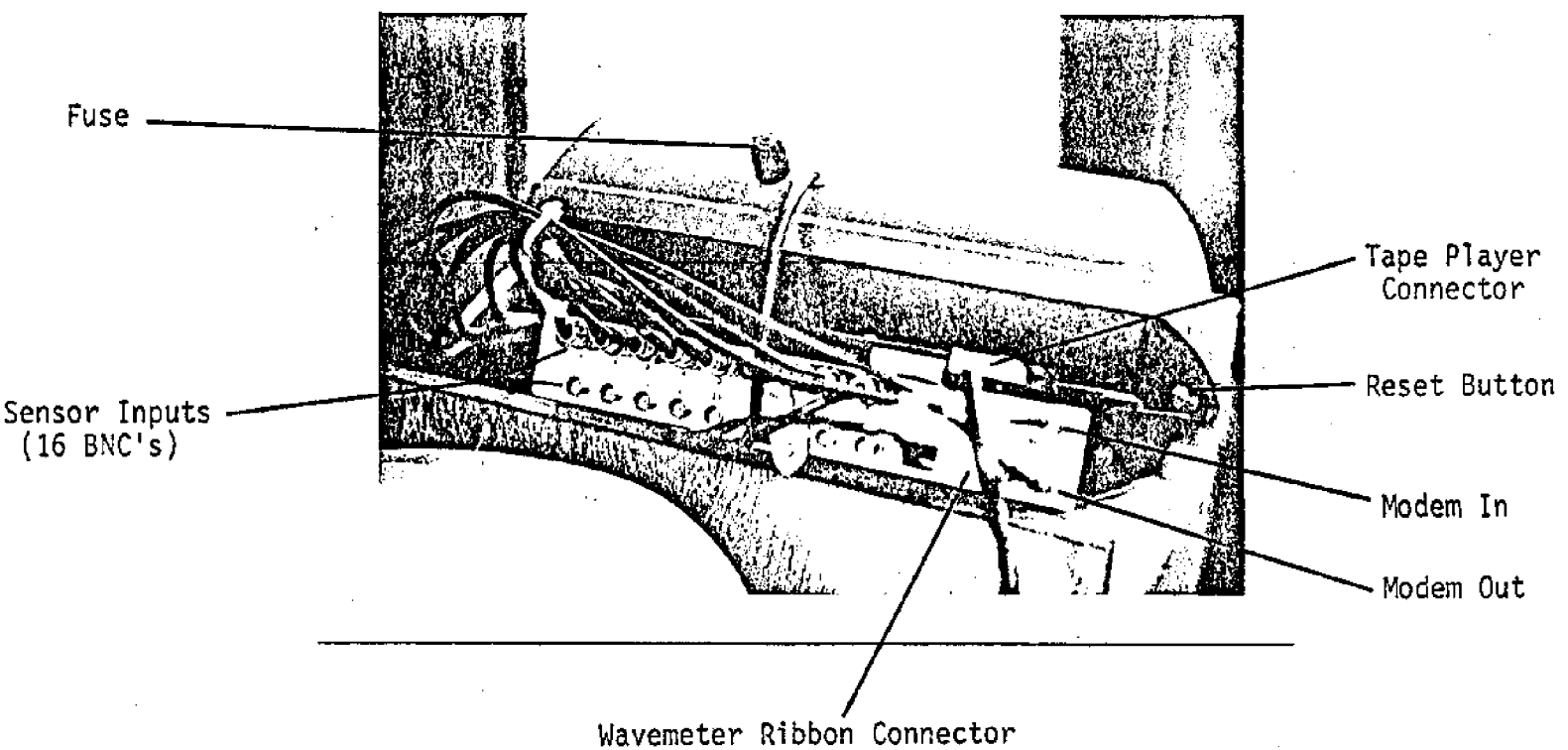
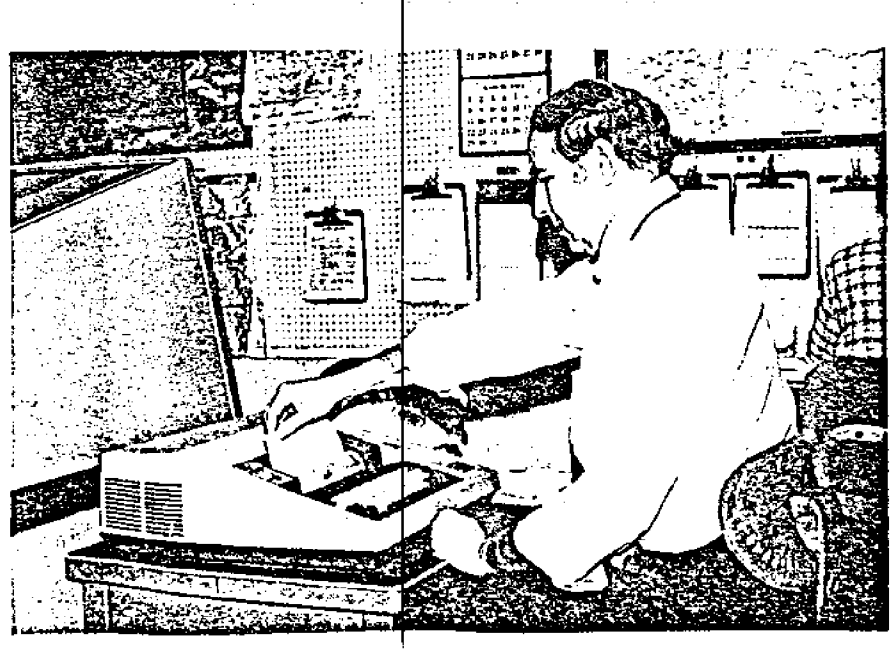


Fig. 4a

NWS Forecaster Dialing Number of AIM-65 System

Fig. 4b

Forecaster Receiving Message from AIM-65



from each weather sensor (BNC male fittings) are plugged into the sensor connector panel according to the channel sequence:

Channel 1 Wind direction

2 Wind speed

3 Wave height (OSU Mod. SW-1D)

4 Sea water temperature (OSU Mod. TW-1A)

5 Air temperature (OSU Mod. TA-1A)

6 Barometer (future)

7 Tide (OSU Mod. SL-1A)

8 Radiometer (not used in this test)

The ribbon cable from the OSU-developed digital wavemeter "period" output is connected to a special connector; it provides wave-period data in BCD form at 0, +5v. levels.

The program loading regimen is listed in Table I, the program listing is shown in Appendix B.

OPERATION

The output format of the weather message is shown below; "weather/visibility," "barometric pressure" and "remarks" groups are entered manually (barometric pressure could be automatic if a suitable sensor were available at the station):

Group 1	95S	CDY 02	/	SW 15		
	(ID)	(WX. VIS.)		(WIND)		
Group 2	/0810W	/ 042	/	058	/	3012
	(WAVE)	(SEA TEMP.)		(AIR TEMP)		(BARO.PRESS.)
Group 3	/064	/04	/SMALLCRAFT	/YAQ		
	tide	(ΔT)	(Remarks)	(ID)		

The AIM-65 displays each group on a 20 character LED display consecutively on command; it also prints out all groups upon interrogation and once each hour, for record purposes.

The following is a sample message printout from the AIM-65 printer.

```
95S CDY02   /SSW24
/1108W/045/049/3010
/079/00/GALE WNG
```

The following is a sample interrogation received on a remote terminal.

95S CLDY02 / SW18/0713W/054/053/2966/089/00/NO WARNINGS /YAQ

Table II lists the operating sequence. Note that the operating program must be re-loaded from cassette storage in the event of a power interruption, since the AIM-65 internal memory storage is volatile (program loading by cassette tape would be replaced by a PROM chip in the AIM-65 for operational installations).

OPERATING RESULTS AT YAQUINA BAY C.G.S.

Routine operation of the system by Coast Guard personnel was satisfactory after about 1/2 hour training using a cue card (Table II). Interrogation from remote terminals was completely reliable; the interrogation sequence is listed in Table III. No system electronic failures (other than weather sensors) occurred during the two-month test period.

ACKNOWLEDGEMENTS

The AIM-65 automatic weather reporting station and its programming were developed by Walter Dillon and John Clardy under the direction of Dr. Roderick Mosecar. Installation, test and evaluation were performed by Clayton Creech with electronic assistance by David Zopf. All are associated with the OSU School of Oceanography. The generous assistance and cooperation of the Yaquina Bay Coast Guard Station, 13th Coast Guard District, is appreciated.

TABLE I

WEATHER INFORMATION TRANSMISSION STATION
Program Loading Instructions

ACTION	RESPONSE
Turn on power	Printer prints "ROCKWELL AIM 65" Display shows ∠
Place program tape in cassette unit	
Type 5	Display = "MEMORY SIZE?"
Type 3200 (RETURN)	Display = "WIDTH?"
Type (RETURN)	Printer prints "2670 BYTES FREE AIM 65 BASIC V1.1" Display shows ^AIM 65 BASIC V1.1
Hold down CTRL key and depress and release PRINT key	Printer is off Display shows "OFF"
Type LOAD (RETURN)	Display shows "IN="
Type T (this indicates "tape")	Display shows "IN=T F="
Type WETHR (this is file name)	Display shows "IN=T F=WETHR T="
Type 1 (RETURN) (1 is tape unit #1)	Display shows "IN=T F=WETHR T=1"
Depress PLAY bar on cassette unit	Display will show parts of program listing as tape is being read. When ^ is displayed, Basic program has been loaded.
Depress STOP on cassette unit	Display shows ^
Type ESC key	Display shows ∠
Type L	Display shows "IN="
Type T (for tape)	Display shows "IN=T F="
Type WETHR (file name)	Display shows "IN=T F=WETHR T="
Type 1 (RETURN) (for tape unit #1)	Display shows "IN=T F=WETHR T=1"
Depress PLAY bar on cassette unit	Display does not change until program reading begins, then display shows: "LOAD F=WETHR BLK= XX" After program is read from tape, display shows ∠
Depress STOP bar on cassette unit REWIND tape and remove tape cassette from unit	
Type 6	Display shows ^6>
(Aim 65 is now back in Basic and ready to run the system)	
Type RUN (RETURN)	Diplay shows "WX/VSB?"

NOTES:

Program turns off printer and tape unit motor. These cannot be turned on while program is operating.

The program can be halted by typing the F1 key. This will cause a "Break in (line no.)" to be displayed. Typing CONT (RETURN) will cause the program to begin execution from where it left off when the F1 key was depressed.

If RUN (RETURN) is typed, the program starts at the beginning and all manual data must be re-entered (see operating instructions). Old manual data cannot be retrieved, because the RUN command scrubs it. In addition, if the program is stopped in order to turn on the printer (CTRL PRINT) and CONT is typed, the printer will be turned off (by the Program) after the next MODEM interrogate has been serviced. If RUN is typed after turning printer on, then the printer will be turned off immediately as the program begins to run.

If program does not seem to be operating, or seems to operate improperly, first try the following:

Push the RESET button (left side-panel, at the rear).
Type 6 then RUN (RETURN).
Re-enter manual data as requested by display.
If possible, request an interrogate from the MODEM.

If program still does not seem to run properly, then turn off AIM 65, wait a few seconds, turn it back on and reload the program from cassette tape.

In case of a power failure, the program must be reloaded from cassette tape after power is restored and is stable.

NOTE:

Since this is an experimental device, the printer on the AIM 65 has been programmed to print the weather data whenever interrogated by the MODEM; this print out is identified by the word MODEM preceeding the weather data.

The printer will also print the information groups which are displayed to the operator. This printout has no identifier, and occurs at regularly timed intervals.

TABLE II

ROUTINE OPERATION

1. Printer will print all 3 groups
   a. Once each hour
   b. Whenever computer called by a remote terminal

DO THE FOLLOWING STEPS AT LEAST EVERY 3 HOURS!

2. Roll through display of all 3 groups by succusively pressing space bar, remembering contents of weather, visibility, pressure, and remarks sections.

3. To change contents of manual entry parameters, press C key

4. Display shows WX/VSB?
   a. Enter weather conditions and visibility in miles (8 characters allowed)
      ex: CDYRØ2 for cloudy, with rain and 2 miles
   b. Press F3 key
   c. Press RETURN for no change

5. Display shows BAROMETER?
   a. Enter current pressure reading (leave out decimal point)
      ex: 3019 for 30.19 inches
   b. Automatically advances after 4th digit typed
   c. Press RETURN for no change

6. Display shows REMARKS?
   a. Type weather warnings, equip malfunctions, etc. (12 characters allowed)
   b. Press F3 key
   c. Press RETURN for no change

7. Display shows group 1 information

8. Cycle through groups 2 and 3 by pressing space bar to make sure information is correct. If incorrect, go to step 3.

9. Parameters not entered manually are updated every 20 seconds (display flickers). The keyboard will be temporarily disabled when an update occurs.

TABLE III

Interrogation Sequence

1. Turn on terminal and acoustic coupler or modem.

2. Set terminal for 300 baud.

3. Turn terminal selector switch from LOCAL to LINE.

4. Dial (503) 265-8220

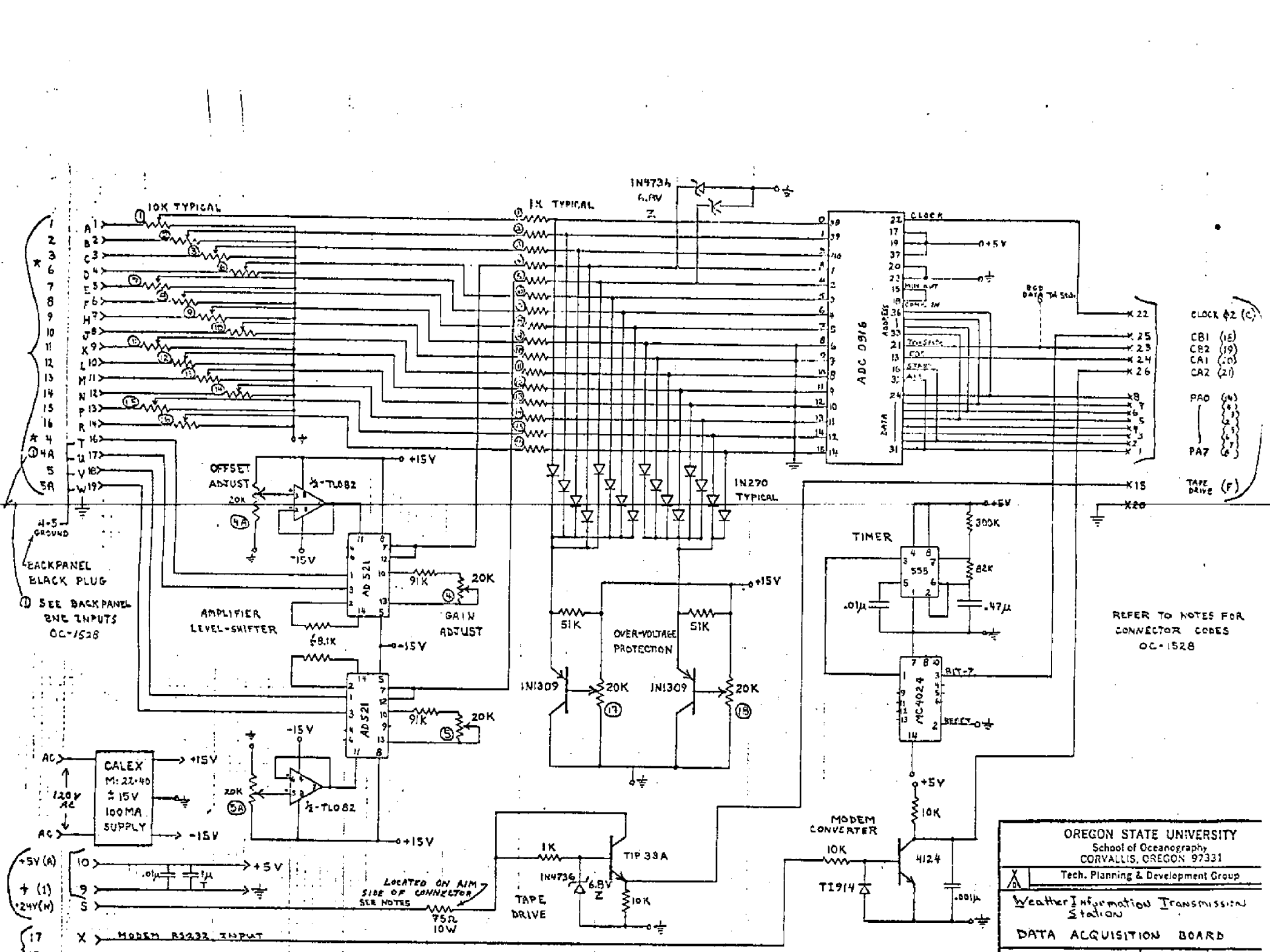
5. When carrier tone is heard, place handset in coupler or press data button on modem.

6. Message is printed on terminal.

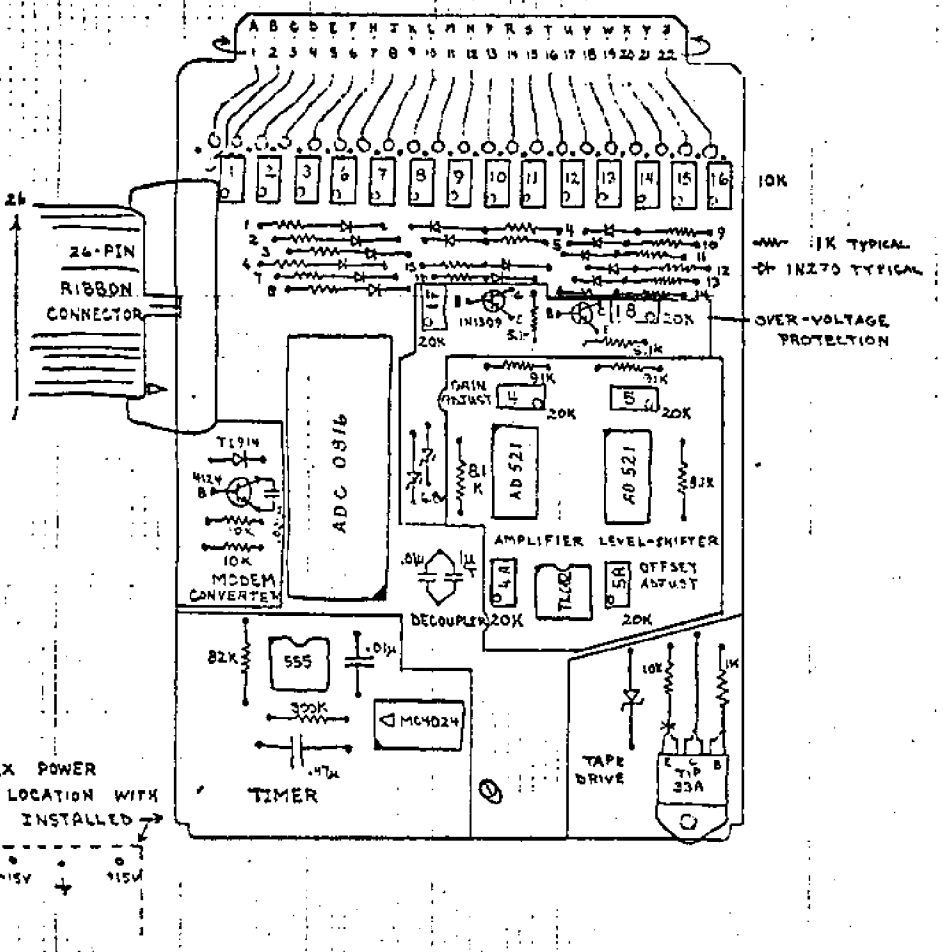
7. Hang-up by replacing handset on phone cradle or pressing talk on modem.

Appendix A

CIRCUIT DIAGRAMS


10K TYPICAL
1K TYPICAL
1N4734
6.2V
Z
ADC 0916
CLOCK
+5V
BCD DATA TRI STATE
CLOCK φ2 (C)
CB1 (15)
CB2 (19)
CA1 (20)
CA2 (21)
PA0 (4)
PA7 (11)
TAPE DRIVE (F)
1N270 TYPICAL
OFFSET ADJUST
20K
½-TL082
+15V
-15V
AD521
91K
20K
GAIN ADJUST
AMPLIFIER LEVEL-SHIFTER
68.1K
51K
OVER-VOLTAGE PROTECTION
1N1309
TIMER
555
300K
82K
.01μ
.47μ
MC4024
BIT-7
SELECT
REFER TO NOTES FOR CONNECTOR CODES
OC-1528
BACKPANEL BLACK PLUG
SEE BACKPANEL BNC INPUTS OC-1528
H-S GROUND
CALEX
M: 22-40
±15V
100MA
SUPPLY
120V AC
AC
AC
+15V
-15V
+5V (A)
+ (1)
+24V(N)
.01μ
1μ
+5V
LOCATED ON AUX SIDE OF CONNECTOR
SEE NOTES
75Ω
10W
TAPE DRIVE
1K
TIP 33A
1N4736
6.8V
Z
10K
MODEM CONVERTER
10K
4124
T1914
.001μ
+5V
10K
MODEM RS232 INPUT
OREGON STATE UNIVERSITY
School of Oceanography
CORVALLIS, OREGON 97331
Tech. Planning & Development Group
Weather Information Transmission Station
DATA ACQUISITION BOARD

AIM-65
WEATHER BOARD LAY-OUT

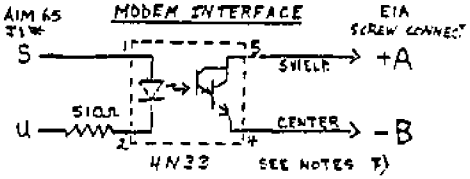


PIN-OUTS

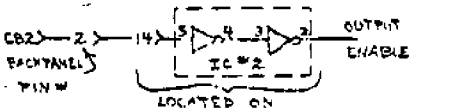
EDGE CONNECTOR

1 - INPUT 1		A - GROUND
2 - INPUT 2		B -
3 - INPUT 3	*	C -
4 - INPUT 6		D -
5 - INPUT 7		E -
6 - INPUT 8		F -
7 - INPUT 9		H -
8 - INPUT 10		J -
9 - INPUT 11		K -
10 - INPUT 12		L -
11 - INPUT 13		M -
12 - INPUT 14		N -
13 - INPUT 15		P -
14 - INPUT 16		R - GROUND
15 - TAPE DRIVE + (P) AIM #1		S - +24V +75Ω INPUT (N) AIM #1
16 - INPUT 4	*	T - GROUND
17 - INPUT 4		U -
18 - INPUT 5	*	V -
19 - INPUT 5		W - GROUND
20 - GROUND (I) AIM #1		X - MODEM INPUT - RS-232 (BNC IN)
21 - -15V } CALEX SUPPLY		Y - GROUND (MODEM) (BNC IN SHIELD)
22 - +15V } CALEX SUPPLY		Z - GROUND (±15V SUPPLY)

MODEM INTERFACE



WAVEMETER INTERFACE



RIBBON CONNECTOR

PIN # - AIM-65 (#1 ✻)			
1 - PA7 (8)		14 - N/C	
2 - PA6 (7)		15 -	
3 - PA5 (6)		16 -	
4 - PA4 (5)		17 -	
5 - PA3 (2)		18 -	
6 - PA2 (3)		19 -	
7 - PA1 (4)		20 -	
8 - PA0 (14)		21 -	
9 - GROUND (1)		22 - CLOCK Φ2 (C)	
10 - +5V (A)		23 - CB2 (19)	
11 - N/C		24 - CA1 (20)	
12 -		25 - CB1 (18)	
13 -		26 - CA2 (21)	

OREGON STATE UNIVERSITY
School of Oceanography
CORVALLIS, OREGON 97331

Tech. Planning & Development Group

Weather Information Transmission Station

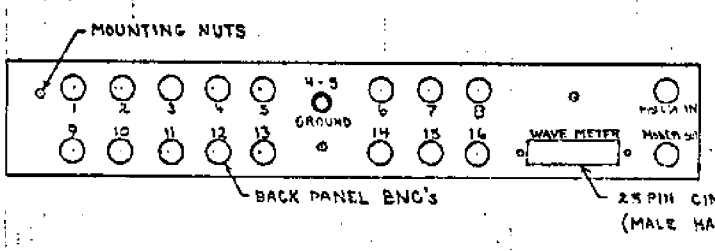
LAY-OUT / PIN-OUT

EB-

DWG NO OC-1527

C. Hardy 1/23/91

BACK PANEL



BNC INPUTS

1 - CH 1 WIND DIRECTION
2 - CH 2 WIND SPEED
3 - CH 3 WAVE HEIGHT
① 4 - CH 4 SEA TEMPERATURE (+, -, GROUND)
② 5 - CH 5 AIR TEMPERATURE (+, -, GROUND)
6 - CH 6 BAROMETER
7 - CH 7 TIDE
8 - CH 8 RADIOMETER
9 - DO NOT USE GROUNDED INTERNALLY
10 -
11 -
12 -
13 -
14 -
15 -
16 -

NOTE: DO NOT ATTACH ANY INPUTS TO THESE LINES WITHOUT UNGROUNDING INTERNALLY

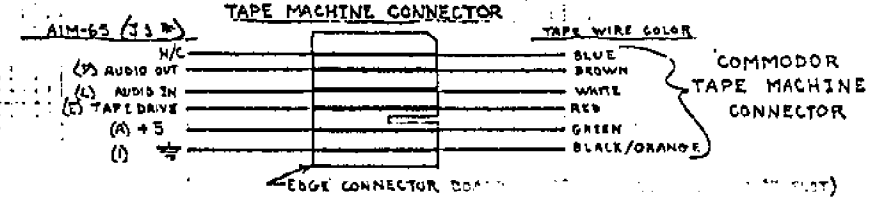
MODEM IN - INPUT RS232 SIGNAL FROM MODEM (CENTER-CF(IN), SHIELD-GROUND)
MODEM OUT - DATA - 20 MA LOOP; 300 BAUD (CENTER - SIGNAL OUT, SHIELD - RETURN)
GROUND - GROUND INPUT FOR CH's 4 & 5

IMPORTANT NOTE — ① ② THE CENTER CONDUCTOR OF THE BNC CONNECTION IS ONE SIDE OF THE ±200MV SIGNAL AND THE SHIELD IS THE OTHER SIDE OF THE SIGNAL, & CIRCUIT GROUND IS CONNECTED TO THE CENTER BLACK PLUG - (4-5 GROUND)

25-PIN CONNECTOR WAVE METER

PIN #	AIM 65 (J1 #)	WAVEMETER #
1	GROUND	23
2	CB2 (19)	14
3	N/C	
4	PB3 (12)	19
5	PB2 (11)	7
6	PB1 (10)	20
7	PB0 (9)	8
8	PB7 (15)	21
9	PB6 (17)	9
10	PB5 (16)	22
11	PB4 (13)	10
12	N/C	
25		

TAPE MACHINE CONNECTOR



NOTES

1) ALL RESISTORS 5%, ¼ W, CAPACITORS CERAMIC UNLESS OTHERWISE NOTED
2) BNC INPUTS 9-16 ARE GROUNDED INTERNALLY AT THE A/D MULTIPLEXER INPUTS
3) 75Ω 10W RESISTOR IN THE TAPE DRIVE CIRCUIT IS LOCATED ON THE AIM 65 POWER SUPPLY HEAT SINK.
4) MODIFACTIONS MADE TO THE AIM 65 INCLUDE:
   A) FILTER ATTACHED TO MAIN INPUT TRANSFORMER AND CONNECTED TO THE INPUT LINE CORD.
   B) ATTACHMENT OF 75Ω 10W RESISTOR TO HEAT SINK
   C) JUMPER OVER J3-12, SEE AIM65 CIRCUITRY, FOR TAPE RECORDER INTERFACE.
   D) MOUNTING HOLES FOR HARDWARE.
   E) WIRE CONNECTIONS ON MAIN TRANSFORMER FOR AC SUPPLY OF CALEX ±15V SUPPLY
   F) WIRE CONNECTION FROM 75Ω RESISTOR CONNECTED TO +12V INPUT OF TB1 ON AIM CIRCUIT BOARD, SEE AIM-65 CIRCUITRY.
5) SHIELDS ON ALL BNC INPUTS ARE GROUNDED EXCEPT:
   BNC # ④ SEE IMPORTANT NOTE TO LEFT
   ⑤ SEE IMPORTANT NOTE TO LEFT
   ⑲ CENTER CONDUCTOR CONNECTED TO AIM65 J1 # U AND THE SHIELD IS CONNECTED TO AIM 65 J1 # S.
6) CONNECTOR SYMBOLS ON OC-1526, DATA ACQUISITION, REFER TO:
   { - BACK PANEL BNC's
   (- AIM-65 J1 CONNECTOR
   ⊏ - DATA ACQUISITION BOARD 26 PIN RIBBON CONNECTOR
   (NOTHING) - DATA ACQUISITION BOARD EDGE CONNECTOR
7) THE MODEM 20MA LOOP ISOLATION CIRCUIT IS LOCATED ON 'MODEM OUT' BNC
8) MODIFICATION TO WAVEMETER: REFER TO OC-1427, 'BANDAID BOARD' IC #2. PINS 3 & 4 TIED TOGETHER. WIRE FROM WAVEMETER BACKPANEL PIN #14 CONNECTS TO PIN 5, INTERNAL RIBBON WIRE #2 CONNECTED TO PIN 2.

OREGON STATE UNIVERSITY
School of Oceanography
CORVALLIS, OREGON 97331

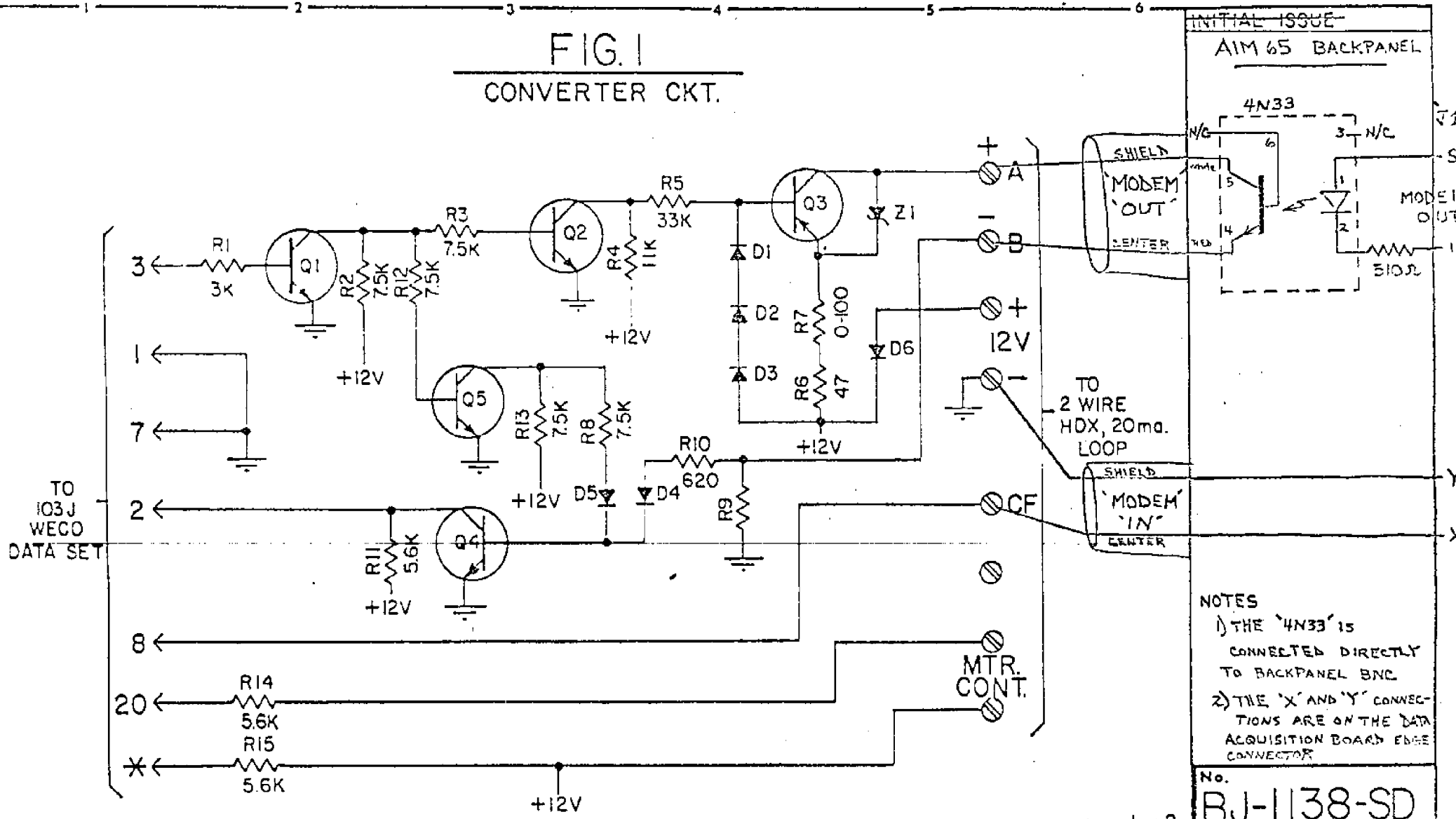
Tech. Planning & Development Group

Weather Information Transmission Station
AIM-65
BACK PANEL / NOTES

J. CLARDY — DWG NO OC-1528

WITS : MODEM - AIM 65 INTERFACE

FIG. 1
CONVERTER CKT.



NOTES
* AVAILABLE TO BE ASSIGED FOR SPECIAL CUSTOMER REQUIREMENTS

INITIAL ISSUE

AIM 65 BACKPANEL

NOTES
1) THE '4N33' IS CONNECTED DIRECTLY TO BACKPANEL BNC
2) THE 'X' AND 'Y' CONNECTIONS ARE ON THE DATA ACQUISITION BOARD EDGE CONNECTOR

No. BJ-1138-SD

Issue 1

BEJED PORTLAND, ORE.

CIRCUIT SCHEMATIC FOR E.I.A. TO LOOP CONVERTER CKT.

By ISD Appr. RFJ Date 9-1-80

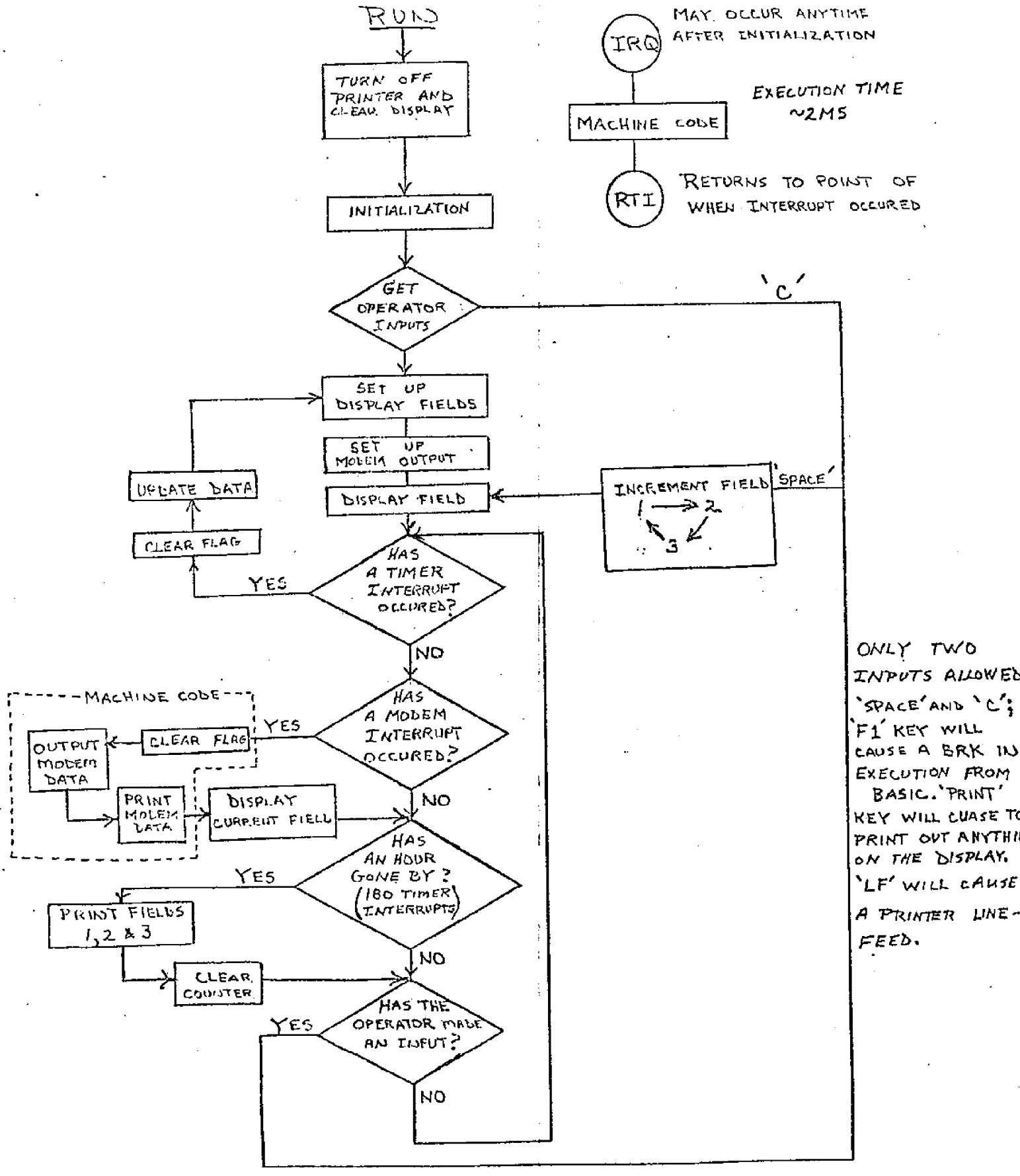
Appendix B

PROGRAM LISTING

Weather Information Transmission Station

WITS

BASIC PROGRAM FLOW

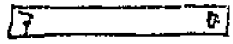
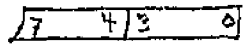
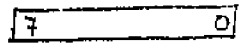


ONLY TWO INPUTS ALLOWED, 'SPACE' AND 'C'; 'F1' KEY WILL CAUSE A BRK IN EXECUTION FROM BASIC. 'PRINT' KEY WILL CAUSE TO PRINT OUT ANYTHIN ON THE DISPLAY. 'LF' WILL CAUSE A PRINTER LINE-FEED.

Weather Information Transmission Station
WITS

Memory Map

Pointers, Flags and Memory Allocations

Address Dec	Address Hex		
4095	ØFFF		- LENGTH OF MODEM STRING
4094	ØFFE		- DATA FLAG (BITS 0-3) MODEM FLAG (BITS 4-7)
4093	ØFFD		- TIMED-PRINT FLAG
To	ØFFF	OUTPUT (MODEM) STRING BUFFER	
4020	ØFB4		
4018	ØFB2	Chan Address	- SENSOR COUNTER
4017	ØFB1	SENSOR DATA BUFFER	18 - DATA LOCATIONS
4000	ØFA0		
3576	ØDF8	MACHINE CODE PROGRAMS	374 - BYTES OF CODE
3202	ØC82		
3200	ØC80	BASIC PROGRAM	2000+ - BYTES OF CODE
530	Ø212		

USR(x) FUNCTION VECTORS

- ØDD3 TAPE/PTR OFF
  POKE 4,211 : POKE 5, 13
- ØC85 ML Initialization
  POKE 4,133 : POKE 5, 12
- ØD6Ø MODEM XMIT
  POKE 4,96 : POKE 5, 13

BASIC LANGUAGE PROGRAM

The software which controls the operation of WITS is composed of programs written in machine code and in high-level Basic. Aim 65 Basic is used to accomplish the following functions:

- Provide initialization of variables and of pointers for USR function (Lines 5 through 25).
- Provide operator prompts to the alphanumeric display for manual entry of data. (Lines 30-40).
- Provide for manual entry, correction, and changes of data entered from the built-in keyboard. (Subroutine 500)
- Operate the alphanumeric display for presentation of weather data. (Lines 115-155)
- Operate the built-in 20-column printer for hourly printout of weather data. (Lines 132-133)
- Do the required calculations to convert each sensor's digitized value to "engineering" units. (Lines 45-85; Subroutines 200, 300, 400)
- Form the engineering units into "strings" of particular length and format (see example of display in Operating Instructions) and store the strings in a memory array. (Lines 90-105)
- Obtain the ASCII value of each string character and store it in a separate "output buffer" in memory (for use by the MODEM machine-code output routine). ($ubroutine 600)
- Form the difference between minimum and maximum values from the Radiometer sensor, and periodically reset the values used for the min and max comparisons. (Subroutine 400)
- Test flags in memory to determine whether to update data, output to modem, or output to built-in printer. Flag testing is done only in the data display "loop" so that interference with the operator will not occur. (Lines 128-133).

The following VARIABLES are used:

A	Starting address of digitized-data memory buffer. See Line 10.
D	Index for reading Data statements. See Line 210.
F	Used to clear lower 4 bits of memory flag at 4094; these bits indicate a data update. See Line 45.

L Length of strings for loading "output buffer" for MODEM output. See Line 600.

M Utility variable: maximum characters for manual entry; variable base address for MODEM output memory buffer. See Lines 30, 35, 600, 615.

N Utility: Character counter for manual entry; index for MODEM buffer memory address. See Lines 520, 605.

P Decimal value of wave period (from BCD conversion) See Line 72.

Q Value of memory flag for timed printout. See Line 132.

S "Group" counter for display of weather data. See Lines 120, 145.

T Value of tide data word. See Line 300.

W Subscript variable for wind direction array. See Lines 215, 220.

Z Dummy for USR function (to access machine code). See Line 5.

HI Upper 4 bits of BCD wave period data word.

LO Lower 4 bits of BCD wave period data word (for BCD to decimal conversion). See Line 70.

MN Value for comparison with Radiometer minimum. See Lines 20, 405.

MS Counter for number of samples of Radiometer. See Lines 20, 425.

MX Value for comparison with Radiometer maximum. See Lines 20, 410.

C1 through C8 designate data words for analog sensor channels one through eight. Variations of Cn are as follows:

Cn = 8-bit data word
Cn% = integer value of a calculation on Cn.
Cn$ = String variable for Cn or Cn%.

For an example, see Lines 50, 55.

K1, K2, K3, K4 constants used in conversion to "engineering" units. See Line 25.

T% Integer value of calculation on T (Tide). See Line 300.

ROCKWELL AIM 65

"WETHR"

BASIC CODE- 2/81

```
LIST
 5 POKE4,211:POKE5,1
3:Z=USR(0)
 6 PRINT" ":PRINT
 8 POKE4,133:POKE5,1
2:Z=USR(0)
 10 DIMWX$(4):DIMWD$
(16):A=4000
 15 SL$="/":ID$="955
 ":V$="          ":R$=
"          "
 20 MS=0:MN=70:MX=30
:POKE4,96:POKE5,13
 25 K1=.391:K2=.0784
:K3=.156:K4=.0156
 30 S=1:M=8:A$=V$:PR
INT"WX/VSB? ";:GOSUB
500:V$=B$
 35 M=4:A$=C6$:PRINT
"BAROMETER? ";:GOSUB
500:C6$=B$
 40 M=12:A$=R$:PRINT
"REMARKS? ";:GOSUB50
0:R$=B$:GOTO90
 45 F=PEEK(4094):POK
E4094,FAND240:GOSUB2
00
 50 C2%=(PEEK(A+1)*K
1)+.5:C2%=C2%+100
 55 C2$=STR$(C2%):C2
$=RIGHT$(C2$,2)
 60 C3%=(PEEK(A+2)*K
2)+.5:C3%=C3%+100
 65 C3$=STR$(C3%):C3
$=RIGHT$(C3$,2)
 70 P=255-PEEK(A+16)
:LO=FAND15:HI=FAND24
0
 72 HI=HI/1.6:P=HI+L
O:P=P+100
 73 P$=STR$(P):P$=RI
GHT$(P$,2)
 75 C4%=(PEEK(A+3)*K
3+30)+.5:C4%=C4%+100
0
 78 C4$=STR$(C4%):C4
$=RIGHT$(C4$,3)
 80 C5%=(PEEK(A+4)*K
1)+.5:C5%=C5%+1000
 82 C5$=STR$(C5%):C5
$=RIGHT$(C5$,3)
 85 GOSUB300:GOSUB40
0
 90 WX$(1)=ID$+V$+SL
$+C1$+C2$
 95 WX$(2)=SL$+C3$+P
$+"W"+SL$+C4$+SL$+C5
$+SL$+C6$
 100 WX$(3)=SL$+C7$+
SL$+C8$+SL$+R$
 105 WX$(4)=SL$+"YA0
"
 110 GOSUB600
 115 K$=""
 120 PRINTWX$(S)
 125 GETK$
 128 IF(PEEK(4094)AN
D15)<>0THEN45
 130 IF(PEEK(4094)AN
D240)<>0THENZ=USR(0)
:PRINTWX$(S)
 132 O=PEEK(4093)
 133 IFO>100THENPRIN
T!WX$(1):PRINT!WX$(2
):PRINT!WX$(3):POKE4
093,0
 135 IFK$=""THEN125
 140 IFK$="C"THEN30
 145 IFK$=" "THENS=S
+1
 150 IFS<4THEN120
 155 S=1:GOTO115
 200 RESTORE:DATA"
S",SSW," SW",WSW,"
W",WNW," NW",NNW
 205 DATA"  N",NNE,"
 NE",ENE,"  E",ESE,"
 SE",SSE,"  S"
 210 FORD=0TO16:READ
WD$(D):NEXT
 215 C1=PEEK(A):W=IN
T((C1+8)/16)
 220 C1$=WD$(W):RETU
RN
 300 T=PEEK(A+6):T%=
(10*(K2*T-4))+.5
 305 IFT%<0THENT%=AB
S(T%-900)
 310 T%=T%+1000:T$=S
TR$(T%)
 315 C7$=RIGHT$(T$,3
):RETURN
 400 C8%=(PEEK(A+7)*
K3+30)+.5
 405 IFC8%<MNTHENMN=
C8%
 410 IFC8%=>MXTHENMX
=C8%
 415 C8%=MX-MN:C8%=C
8%+100
 420 C8$=STR$(C8%):C
8$=RIGHT$(C8$,2)
 425 MS=MS-1:IFMS<30
THENRETURN
 430 MS=0:MN=70:MX=3
0:RETURN
 500 B$="":N=0
 505 GETK$:IFK$=""TH
EN505
 510 IFASC(K$)=13THE
NB$=A$:PRINT:RETURN
 515 IFASC(K$)=127TH
ENPRINT:PRINT"RETYPE
: ";:GOTO500
 520 IFASC(K$)<>94TH
ENPRINTK$;:N=N+1:B$=
B$+K$:IFN<MTHEN505
 522 IFASC(K$)=94THE
NK$="":GOTO530
 525 K$="":PRINT:RET
URN
 530 S$="
 ":B$=B$+RIGHT$(S$,M
-N):PRINT:RETURN
 600 M=4019:L=LEN(WX
$(1))
 605 FORN=1TOL:OB$=M
ID$(WX$(1),N,1)
 610 POKEM+N,ASC(OB$
):NEXT
 615 M=M+L:L=LEN(WX$
(2))
 620 FORN=1TOL:OB$=M
ID$(WX$(2),N,1)
 625 POKEM+N,ASC(OB$
):NEXT
 630 M=M+L:L=LEN(WX$
(3))
 635 FORN=1TOL:OB$=M
ID$(WX$(3),N,1)
 640 POKEM+N,ASC(OB$
):NEXT
 645 M=M+L:L=LEN(WX$
(4))
 650 FORN=1TOL:OB$=M
ID$(WX$(4),N,1)
 655 POKEM+N,ASC(OB$
):NEXT
 660 POKE4095,M+L-40
19:RETURN
 670 REM
 680 END
```

A$	Utility string which contains "old" manual-entry data during manual input mode. See Lines 30, 510.
B$	Utility string which contains current manual-entry data during manual input mode. See Lines 30, 520.
K$	Keyboard character. See Lines 140, 505.
P$	String character for wave period. See Line 73.
R$	String for "Remarks" entry. See Line 40.
S$	String of 12 spaces, used to equalize length of manual-entry data. See Line 530.
T$	Temporary string value for Tide data. See Line 315.
V$	String for weather/visibility code. See Line 30.
C1$-C8$	See variables C1 through C8.
ID$	Station ID number. See Line 15.
OB$	Utility string for moving characters from array to MODEM output buffer. See Line 605.
SL$	Slash mark. See Lines 15, 90.
WD$(D)	Subscripted array which holds wind direction compass points. See Lines 200, 210, 220.
WX$(1) WX$(2) WX$(3)	Subscripted array which holds weather "groups" one, two, and three. See Line 90.
WX$(4)	Station ID name. See Line 105.

MACHINE LANGUAGE PROGRAM

This is a sequential description of the AIM 65 machine language operation.

I. Initialization

A. Interrupt pointer

1) Store starting address of interrupt service routine in location $A400 and $A401. Starting address is $0CAF.

B. Clear registars

1) Counter locations $0FFD and $0FFE are set to zero.

2) Data storage locations $0FA0 to $0FBE and counter location $0FB0 are set to zero.

C. Detect interrupts set-up

1) User Interrupt Enable Register, UIFR location $A00E, is set to let CB1 (the TIMER) and CA2 (the MODEM) generate interrupts.

2) User Peripheral Control Register, UPCR location $A00C, is set so CB1 detects low to high edges, CA2 detects high to low edges and CB2 (Tri-State enable) is held low.

II. What caused interrupt?

A. Save registers.

1) Take accumulator, x register and Y register are saved, because the uP will not do it for you, in case they are needed to return from an interrupt to the basic program.

B. TIMER or MODEM

1) The User Interrupt Flag Register, UIFR location $A00D, is tested for a TIMER interrupt. If true, branch to TIMER servic routine (see IV).

2) The UIFR is tested for a MODEM interrupt. If true, branch to MODEM Flag routine.

C. Restore registers

1) The accumulator, x register and Y registers are restored to the same values as when "what caused interrupt?" routine was entered.

D. Return from the interrupt, RTI.

III. MODEM flag set

A. Clear the interrupt flag.

1) Read Part A to clear the interrupt and reset it.

B. Set flag

1) Set a bit, as a flag, in the MSB's of location $OFFE.

C. Jump back to Restore registers (II. C).

IV. TIMER Service

A. Initial set up: set a bit, as a flag, in the LSB's of $OFFE. Set the sensor count, channel address, to zero by storing 0 in $OFB2.

B. Set up to read a Sensor.

2) Make Port A an output to send channel address

3) Send Channel address and latch to A/D by bringing ALE high.

C. Do a conversion

1) Send a start pulse to A/D

2) Set up CA1 to detect the EOC signal in UIER

3) Wait some time to let the conversion finish

4) Check to see if EOC has occured by checking CA1 flag.

5) If CA1 is not set check it again

6) Conversion is finished, disable the CA1 flag in UIER

7) Make Port A an input to read data. (Note: this will let the port float, since their seems to be pull resistors, and in essence could give the A/D a new address and start pulse so the following step should be next).

8) Bring CB2 high to enable the Tri-State

9) Read and store the data in location $ØFAØ-ØFAF

D. Disable the Tri-State, bring CB2 low.

E. Increment the sensor count, $OFB2 , and test if all A/D channels have been read. If all have not been read, go read the next channel (IV. B)

F. All of the A/D channels have been read, now read the BCD data.

1) Make Port B an input

2) Bring CB2 high to enable the Tri-State

3) Read and store the data in location $ØFBØ

4) Bring CB2 low to diable the Tri-States

G. Increment the TIMER service counter, $ØFFD

H. Jump back to restore registers (II. C)

V. MODEM Service

A. Clear MODEM service flag

B. Program BAUD rate to 300 by loading C20C into locations $A417 &18

C. Send ASCII codes for 'carriage return', 'line feed' and 'null' out to TTY., #ØD, #ØA & #ØØ to $EEA8

D. Send data out to TTY, location $ØFB4-end too $EEA8

E. Send ending 'carriage return' and 'line feed' to TTY

VI. MODEM Record

A. Turn on printer, $E6El

B. Clear the display/printer pointers, $EB44

C. Send ASCII code for MODEM to printer Buffer, $E97A

D. Print out MODEM by sending 'carriage return' - 'line feed', $EAl3

E. Send and print out data, locaiton $OFB4 end to $E97A

F. Print out final characters in print buffer, $EA24

VII. Tape Control/Printer OFF

A. Turn tape #l power off by Toggling $A800, if it is on..

B. Turn printer off by loading #ØØ into $A4ll.

Routines II, III and IV take about 2 ms to run through so it is operated on an unconditional interrupt basis. That is, whenever an interrupt comes, part of the above will be executed.

A modem service and data update, send data out to modem and convert A/D data to "Engineering" units, takes more time. These are also destructive to operator inputs if one is typing in data. These routines are run on a conditional interrupt basis, if the operator is not trying to make an input, they will execute; otherwise, they will wait.

```
<KO>*=0C82
/
 0C82 EA NOP
 0C83 EA NOP
 0C84 EA NOP
 0C85 78 SEI
 0C86 A9 LDA #AF
 0C88 8D STA A400
 0C8B A9 LDA #0C
 0C8D 8D STA A401
 0C90 A9 LDA #00
 0C92 8D STA 0FFE
 0C95 8D STA 0FFD
 0C98 A2 LDX #13
 0C9A 9D STA 0FBF,X
 0C9D CA DEX
 0C9E F0 BE0 0CA3
 0CA0 4C JMP 0C9A
 0CA3 A9 LDA #91
 0CA5 8D STA A00E
 0CA8 A9 LDA #D0
 0CAA 8D STA A00C
 0CAD 58 CLI
 0CAE 60 RTS
 0CAF 78 SEI
 0CB0 48 PHA
 0CB1 8A TXA
 0CB2 48 PHA
 0CB3 98 TYA
 0CB4 48 PHA
 0CB5 AD LDA A00D
 0CB8 29 AND #10
 0CBA D0 BNE 0CDA
 0CBC AD LDA A00D
 0CBF 29 AND #01
 0CC1 D0 BNE 0CCC
 0CC3 68 PLA
 0CC4 A8 TAY
 0CC5 68 PLA
 0CC6 AA TAX
 0CC7 68 PLA
 0CC8 58 CLI
 0CC9 40 RTI
 0CCA EA NOP
 0CCB EA NOP
 0CCC AD LDA A001
 0CCF A9 LDA #10
 0CD1 0D ORA 0FFE
 0CD4 8D STA 0FFE
 0CD7 4C JMP 0CC3
 0CDA A9 LDA #01
 0CDC 0D ORA 0FFE
 0CDF 8D STA 0FFE
 0CE2 EA NOP
 0CE3 EA NOP
 0CE4 EA NOP
 0CE5 EA NOP
 0CE6 A9 LDA #00
 0CE8 8D STA 0FB2
 0CEB 38 SEC
 0CEC A9 LDA #FF
 0CEE 8D STA A002
 0CF1 AD LDA 0FB2
```

I

II

III

ROCKWELL AIM 65

"WETHR"

MACHINE CODE- 2/81

```
 0CF4 8D STA A00F
 0CF7 09 ORA #80
 0CF9 8D STA A00F
 0CFC 09 ORA #40
 0CFE 8D STA A00F
 0D01 ED SBC A00F
 0D04 8D STA A00F
 0D07 A9 LDA #C1
 0D09 8D STA A00C
 0D0C EA NOP
 0D0D EA NOP
 0D0E 20 JSR 0DE8
 0D11 AD LDA A00D
 0D14 29 AND #02
 0D16 D0 BNE 0D18
 0D18 4C JMP 0D11
 0D1B A9 LDA #02
 0D1D 8D STA A00E
 0D20 A9 LDA #00
 0D22 8D STA A003
 0D25 A9 LDA #E0
 0D27 8D STA A00C
 0D2A AD LDA A00F
 0D2D AE LDX 0FB2
 0D30 9D STA 0FA0,X
 0D33 A9 LDA #C0
 0D35 8D STA A00C
 0D38 EE INC 0FB2
 0D3B AD LDA 0FB2
 0D3E C9 CMP #10
 0D40 D0 BNE 0CEB
 0D42 A9 LDA #00
 0D44 8D STA A002
 0D47 A9 LDA #E0
 0D49 8D STA A00C
 0D4C AD LDA A000
 0D4F AE LDX 0FB2
 0D52 9D STA 0FA0,X
 0D55 A9 LDA #D0
 0D57 8D STA A00C
 0D5A EE INC 0FFD
 0D5D 4C JMP 0CC3
 0D60 78 SEI
 0D61 EA NOP
 0D62 EA NOP
 0D63 EA NOP
 0D64 EA NOP
 0D65 EA NOP
 0D66 EA NOP
 0D67 AD LDA 0FFE
 0D6A 29 AND #0F
 0D6C 8D STA 0FFE
 0D6F A9 LDA #0C
```

IV

V

```
 0D71 8D STA A417
 0D74 A9 LDA #C2
 0D76 8D STA A410
 0D79 A9 LDA #0D
 0D7B 20 JSR EEA8
 0D7E A9 LDA #0A
 0D80 20 JSR EEA8
 0D83 A9 LDA #00
 0D85 20 JSR EEA8
 0D88 A2 LDX #00
 0D8A BD LDA 0FB4,X
 0D8D 20 JSR EEA8
 0D90 E8 INX
 0D91 EC CPX 0FFF
 0D94 90 BCC 0D8A
 0D96 A9 LDA #0D
 0D98 20 JSR EEA8
 0D9B A9 LDA #0A
 0D9D 20 JSR EEA8
 0DA0 20 JSR E6E1
 0DA3 20 JSR EB44
 0DA6 A9 LDA #4D
 0DA8 20 JSR E97A
 0DAB A9 LDA #4F
 0DAD 20 JSR E97A
 0DB0 A9 LDA #44
 0DB2 20 JSR E97A
 0DB5 A9 LDA #45
 0DB7 20 JSR E97A
 0DBA A9 LDA #4D
 0DBC 20 JSR E97A
 0DBF 20 JSR EA13
 0DC2 A2 LDX #00
 0DC4 BD LDA 0FB4,X
 0DC7 20 JSR E97A
 0DCA E8 INX
 0DCB EC CPX 0FFF
 0DCE 90 BCC 0DC4
 0DD0 20 JSR EA24
 0DD3 AD LDA A800
 0DD6 29 AND #10
 0DD8 F0 BE0 0DDD
 0DDA 20 JSR E6BD
 0DDD A2 LDX #11
 0DDF A9 LDA #00
 0DE1 9D STA A400,X
 0DE4 58 CLI
 0DE5 60 RTS
 0DE6 EA NOP
 0DE7 EA NOP
 0DE8 A9 LDA #F0
 0DEA 8D STA 0FFC
 0DED EE INC 0FFC
 0DF0 AD LDA 0FFC
 0DF3 D0 BNE 0DED
 0DF5 60 RTS
 0DF6 EA NOP
 0DF7 EA NOP
 0DF8 EA NOP
 0DF9 EA NOP
```

VI

VII

IV