AUSTRALIA TELESCOPE

AT TECHNICAL REPORT No. E1

CULGOORA WEATHER STATION

M.J. KESTEVEN

AUSTRALIA TELESCOPE

CSIRO DIVISION OF RADIOPHYSICS

CNR VIMIERA & PEMBROKE RDS, EPPING NSW
# Table of Contents

1 Introduction 3

2 Operation of the Station 4
   2.1 Startup 4
   2.2 Restart 5
   2.3 Backups 5
   2.4 Data Archiving 6
   2.5 Examining the Archived Data 6

3 Hardware Overview 7

4 The Sensors 7
   4.1 Anemometer 7
   4.2 Wind Direction monitor 7
   4.3 Temperature Probes 8
   4.4 Solar Radiation (solarimeter) 8
   4.5 Barometer 8
   4.6 Rain Gauge 8
   4.7 Hygrometer 8
   4.8 Connecting the Sensors to the Logger 9

5 Programming the Logger 10
   5.1 Definition of the scanning task 10
   5.2 Definition of the channels to be interrogated 10
5.3 Definition of the calibration algorithms and factors to be applied 10

5.4 Conversing with the Orion 11

6 The PC programs 12

7 History and Acknowledgements 12

8 Appendices

A : The Data Logging program A1

B : The Data Examination program B1
Culgoora Weather Station

M. Kesteven

1 INTRODUCTION

An automated weather station has now been installed at Culgoora. A set of eleven weather statistics are recorded every hour:

a). wind speed - the mean, maximum, minimum and variance from the previous hour;

b). wind direction - hourly mean;

c). temperatures at ground level and at 10m level - five minute mean;

d). solar radiation - hourly mean;

e). barometric pressure - hourly mean;

f). rainfall - total accumulated during the previous hour;

g). humidity - hourly mean.

Additional software is provided to allow the archived data to be examined and listed.

This manual describes the operation of the unit, the hardware involved and the maintenance.
2 OPERATION OF THE STATION

The station is automatic - operator intervention is required only to start (or restart) the program, and to supervise the data archiving once a month. The data is written to a 5" floppy diskette every hour (on the hour). Although the diskette's capacity is adequate for several months operation, it would be wise to replace the diskette every month. The PC display maintains a tally of the amount of data stored on the diskette.

2.1 Startup

a). The sensors

The solar radiation monitor requires 240 v. There is a switch in the junction box at the base of the weather station tower; power to the tower derives from a switch board in the control building.

Two other sensors require power: the anemometer and the barometer. In both cases 24 v DC is needed, derived from the logger rack.

The remaining sensors are passive, and need no action to start operation.

b). The logger

The logger executes a scanning program: every 15 seconds it reads the sensors, scales the data to useful units and then sends the results to the PC. Switching on the logger will cause the program to be transferred from a cartridge tape; the program will then be started automatically. Recovery from a drastic power failure is equally automatic.

The logger has a key switch on the front panel. This needs to be set to the ON position. Two LEDs adjacent to the switch should be lit: one to indicate that the 24 v battery supply is on; the second LED indicates the operational state of the logger (ON or OFF).

Thus the operator's function on start-up is simple: ensure that the tape is in the reader, then switch the unit to ON.
c). The PC

The PC executes a simple task to accept the data from the logger, compile the statistics, and every hour, on the hour, archive the data.

The startup sequence:

1. Place the system in the upper drive, and the data disk in the lower drive.

2. Switch on the machine; after some diagnostics the computer will display its estimate of time and date. The operator should check that these are correct, and enter either a confirming RETURN or else the correct time/date. NOTE: the computer runs on AEST, and not Summer time.

3. Type:

GWBASIC
LOAD "ORION.BAS"
RUN

4. The screen should then be cleared, and the current weather values displayed, accumulating over a period of time.

2.2 Restart

It is possible that a failure may occur after extended power failures, or after violent storms. In this case the logger and/or the PC may need restarting.

a). Logger: switch off, then ON.

b). PC: type RUN

This may produce the error message: "Communications buffer overflow". The response to this is to hit a number of RETURNS, then type: RUN

If all this fails, then switch off the computer and start again.

2.3 Backups

A backup logger program tape and a backup system disk for the PC are kept beside the units. Both are labelled as "Backup".
2.4 **Data Archiving**

The data is written to disk automatically, and needs no intervention. The PC display shows the time and date of the last record written; this should be checked periodically as a guide to the health of the PC operations.

Once a month the disk should be replaced with a fresh disk. Remove the disk from the lower drive and insert a fresh one (pre-initialised). This can be done at any time provided that the PC is not attempting to write to the disk - ie. check the time.

Spare (pre-initialised) disks are kept beside the machine.

Initialising the disks: use DISKCOPY on any other PC, with a pre-initialised disk as model.

The Archive disks should be sent to M. Kesteven.

2.5 **Examining Archived Data**

a). Find a spare PC.

b). Place the WEATHER system disk in the upper drive, and the archive data disk in the lower.

c). Type WEATHER to start the task.

d). Data filename: the standard filename is

   B:WEATHER.DAT

e). Data can be listed and/or printed.

This task can be run on the current data disk: this can be removed from the logging PC provided that no data is to be written to the disk - ie. at times other than on the hour. Check the PC display.
3 HARDWARE OVERVIEW

The station consists of:

a). The sensors.

b). An "ORION" data logger which interrogates the sensors.

c). A P.C. computer which records the data and compiles some statistics.

The logger and the computer are battery powered so the weather station will continue to operate during power failures; however, the solar radiation monitor requires 240 volts power, so the solar radiation data may not be continuous.

4 THE SENSORS

4.1 The Anemometer

This is a WEATHERTRONICS device, model # 2030

It has three cups, 5 cm in diameter, on 8 cm arms. The rotating shaft carries a 30 slot optical chopper. An OPTRON optoelectronic chopper (model OPB 804) detects the rotation of the shaft.

The scaling adopted: \[ V \ (\text{km/hr}) = F \ (\text{hz}) \times 0.158 + 0.837 \]

is derived from the WEATHERTRONICS manual.

The wiring diagram for the unit is shown in fig. 1

24 v DC is required; this is derived from the logger rack power supply.

4.2 The Wind Direction Monitor

This is a WEATHERTRONICS device, model #2020

The weather vane drives a 5k\(\Omega\) variable resistor.
4.3 **The Temperature Probes**

These are all four-wire platinum resistor thermometers. Although NML calibration curves are available for all units, we have chosen to use the calibration factors built into the logger.

4.4 **Solar Radiation (solarimeter)**

This is a CASELLA device, model #W6500.

The unit requires +10v and -8v power, derived from a 240v unit. It returns a DC analogue voltage, 1 mV/(W/m²).

4.5 **The Barometer**

This is a WEATHERTRONICS device, model #7100.

It requires 24v DC supply, provided directly from the logger rack. The unit is mounted on the logger rack, with a hose connected to the outside to provide the ambient pressure. It returns a DC analogue voltage proportional to the pressure.

The scaling: \( P \text{ (mb)} = V \times 100 + 600 \). This comes from the manual.

4.6 **The Rainfall Gauge**

This is a WEATHERTRONICS device, model #P501 - I/PN 648001.

The unit contains a small tipping bucket, each tip corresponding to 0.25 mm of rain. Each "tip" produces a pulse which is counted by the logger.

4.7 **The Hygrometer**

Not yet installed.
4.8 CONNECTING THE SENSORS TO THE LOGGER

All the sensors except for the barometer are located on the weather tower to the E of the control building. Four sensors are mounted at the tower top: the anemometer and wind direction; a temperature probe and the hygrometer. A second temperature probe and the solar radiation monitor are at ground level. The rain gauge is some 10m to the south of the tower.

The wiring diagram for the junction box at the tower top is shown in fig. 2; the wiring diagram for the ground level junction box is in fig. 3, and the connections at the logger rack are shown in fig. 4.

The anemometer is connected to channel 5 in the Counter/Timer module of the logger, as shown in figs 5 and 6.

The rain gauge is connected to channel 21 in the Event/Status module, as shown in fig. 7.

All the other sensors are connected to the Reed relay unit, as shown in figs 8, 9, 10, 11 and 12.
5  PROGRAMMING THE LOGGER

The scanning task in the logger is called "weather", and occupies slot #1 on the tape. The program contains:

5.1 Definition of the scanning task

In ORION terms:

<table>
<thead>
<tr>
<th>TA1 OP ME</th>
<th>This is a measurement task</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA1 TR TI DE 5.0</td>
<td>Start after a 5 second delay</td>
</tr>
<tr>
<td>TA1 CO * RE IN IN 0:0:15.</td>
<td>Continuous scanning, looping every 15 s</td>
</tr>
<tr>
<td>TA1 CH1-5,21,61-65,67,68-70</td>
<td>These are the channels to scan</td>
</tr>
<tr>
<td>TA1 AT F</td>
<td>Take 10 readings per sensor</td>
</tr>
<tr>
<td>TA1 LO EV</td>
<td>Log every channel sampled</td>
</tr>
<tr>
<td>TA1 MA EV</td>
<td>And send a time stamp</td>
</tr>
<tr>
<td>TA1 FO CO</td>
<td>Using a compact format</td>
</tr>
<tr>
<td>TA1 TO S0</td>
<td>Send the data to the RS232 port S0</td>
</tr>
</tbody>
</table>

5.2 Definition of the channels to be interrogated

In ORION terms:

<table>
<thead>
<tr>
<th>CH1-5 SE 902 CO1</th>
<th>Wind speed; frequency measurement, 1.0 sec gate; Conversion routine #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH21 SE 741 CO2</td>
<td>Rain gauge; count events</td>
</tr>
<tr>
<td>CH61 SE 410</td>
<td>Ground level T; 4-wire platinum resistor</td>
</tr>
<tr>
<td>CH63 SE 410</td>
<td>10m level T</td>
</tr>
<tr>
<td>CH65 SE 410</td>
<td>Room T</td>
</tr>
<tr>
<td>CH67 SE 254 CO3</td>
<td>Wind direction; resistance measurement</td>
</tr>
<tr>
<td>CH68 SE 114 CO4</td>
<td>Solar radiation; voltage measurement</td>
</tr>
<tr>
<td>CH69 SE 114 CO5</td>
<td>Barometric pressure</td>
</tr>
<tr>
<td>CH70 SE 114 CO6</td>
<td>Relative Humidity</td>
</tr>
</tbody>
</table>

5.3 Definition of the calibration algorithms and factors to be applied

In ORION terms:

<table>
<thead>
<tr>
<th>CO1 MO SC MC 0.158, 0.837 UN KMH</th>
<th>Conversion routine #1, linear scaling (0.158*x + 0.837), units</th>
</tr>
</thead>
<tbody>
<tr>
<td>km/h</td>
<td></td>
</tr>
</tbody>
</table>
CO2 MO SC MC 0.25, 0. UN MM
CO3 MO SC MC 0.072, 0. UN DEG
CO4 MO SC MC 1000., 0. UN WM2
CO5 MO SC MC 100., 600. UN MB
CO6 MO SC MC 1., 0. UN %

5.4 CONVERSING WITH THE ORION

The ORION's RS232 output is currently set to: 300 baud, 7 bits, EVEN parity, 1 stop bit.

A terminal should be connected (in place of the PC).

Communication with the ORION is a bit complicated because of the need to distinguish the two competing output channels which share the same RS232 output port: the microprocessor port and the data port. A simple protocol allows the user to switch from one to the other:

! to gain attention of the ORION's microprocessor
# to release the ORION, and open the data path.

The procedure to modify a program, for example would be:

! This should return C:
HALT To stop any current task C:
TA1 OP ME ... etc

# If data is to flow to S0.

Note: all communication to the ORION must be in upper case.

Further details on the commands available are described in the ORION manual.
"ORION", the PC logging task is listed in appendix A. The task runs under GWBASIC. (An as yet unresolved problem prevents a compiled version running)

"WEATHER", the task to examine the archival data is listed in appendix B. This task is compilable.

7 HISTORY AND ACKNOWLEDGEMENTS

The weather tower was designed by C.J. van der Meulen. The sensors were installed by E.Broderick, with W.Payten supervising. A.Spencer designed and built the pulse shaper/driver for the anemometer. B.Whitelaw drew the diagrams.
Appendix A

The Data Logging Program

10 '
20 ' ORION weather station logging task
30 ' 
40 ' mjk 11 - NOV - 87
50 ' 
60 '...........................................
70 ' 
80 DIM POINTS(8), V.DATA(8)
90 DIM A.NDX(100), B.NDX(100)
95 DIM ARR.DAT(6,10), INDX(100)
100 ' 
110 FALSE = 0: TRUE = NOT FALSE
115 PI = 3.1415926#
117 TM.LOG$ = " (none yet) "
118 KEY OFF
119 T.FACT = .9
120 BLANK$ = STRING$(8,32)
125 ' 
130 OPEN "COM1:" AS #1
140 ' 
150 SKIP = 5
160 ' 
165 GOSUB 2000 : ' task initioaliser
170 GOSUB 1250 : ' screen initialiser
180 ' 
190 ' 
200 FIRST.REC = TRUE
210 ' simple minded loop
220 ' 
230 MSG$ = " "
240 ' 
250 WHILE LOC(1)<=0
260 A$ = INPUT$(1, #1)
270 IF (A$ = CHR$(13)) GOTO 370
280 IF (A$ = CHR$(10)) GOTO 370
290 MSG$ = MSG$ + A$
300 ' 
310 GOSUB 560
320 GOTO 500
330 ' 
340 ' 
350 ' 

ORION.BAS A1 6/29/88 15:46
360 ' decide if there is anything worth printing
370 ' 380 ' IF (NOT FIRST.REC) GOTO 460
390 MSG$ = " "
400 FIRST.REC = FALSE
410 GOTO 510
420 ' 430 GOSUB 660
440 GOSUB 1100
450 MSG$ = " "
460 ' 470 480 ' WEND
490 ' 500 THIS.HR = VAL(MID$(TIMES$,1,2))
510 IF (THIS.HR <> LAST.HR) THEN GOSUB 4000
520 ' 530 A$ = INKEY$
540 IF ((A$="Q") OR (A$="q")) THEN GOTO 545
550 ' 560 GOTO 210
570 ' 580 ' write a last record
590 ' 600 GOSUB 4000 : ' write last record
610 ' 620 ' 630 ' : write record
640 ' 650 ' 660 ' 670 ' SUBROUTINE TO WASTE TIME
680 ' 690 ' 700 ' 710 ' CLS
720 PRINT: PRINT " Weather logger stopped"
730 PRINT:
740 PRINT "data file now has "; N.RECORDS; " records"
750 ' 760 END
770 ' " Subroutine to parse an input line
780 ' subroutine to parse an input line
790 ' 800 PNT = LEN(MSG$)
810 N1 = 1
820 NTERMS = 0
830 '
FOR I = N1 TO PNT
   IF ASC(MID$(MSG$,I,1)) > 32 GOTO 770
   NEXT I
GOTO 1080

N1 = I
   is this time ?

IF (MID$(MSG$,N1,1) <> "S") GOTO 880

NTERMS = 1
POINTS(1) = -1
TM.STR$ = MID$(MSG$,N1+6,10)
TIME$ = TM.STR$
TM.STR$ = TIME$
GOTO 1080

"." ?

IF (MID$(MSG$,N1,1) <> ".") GOTO 940

N1 = N1 + 19
IF (N1 < PNT) GOTO 940
GOTO 1080

IF (MID$(MSG$,N1,1) <> "C") GOTO 1030.

NTERMS = NTERMS + 1
PT = VAL(MID$(MSG$,N1+2,3))
POINTS(NTERMS) = PT
IF ((PT>0) AND (PT<6)) THEN POINTS(NTERMS) = 1
V.DATA(NTERMS) = VAL(MID$(MSG$,N1+6,7))
N1 = N1 + 20
IF (N1 < PNT) GOTO 720
GOTO 1080

GOTO 1080

IF (MID$(MSG$,N1,1) = "D") GOTO 1080
PRINT "possible trouble : "
PRINT MSG$
RETURN

Subroutine to describe the values found

IF (NTERMS = 0) GOTO 1220
FOR I = 1 TO NTERMS
   IF (POINTS(I) = -1) GOTO 1200
   A1 = A.NDX(POINTS(I)) : B1 = B.NDX(POINTS(I))
   LOCATE A1,B1 : PRINT BLANK$
LOCATE A1,B1: PRINT USING "#####.#": V.DATA(I)
J = INDX(POINTS(I))
GOSUB 7000 : ' update the data
GOTO 1210

LOCATE 6,33: PRINT TM.STR$
NEXT I
RETURN

CLS
LOCATE 2,10
PRINT "Culgoora weather station and logger - jan6/88 version"
LOCATE 3,60
PRINT DATE$
LOCATE 6,5
PRINT "time of last data sample : "
LOCATE 8,1: PRINT "wind speed : "
LOCATE 8,25: PRINT "k/hr"
A.NDX(1) = 8: B.NDX(1) = 15
A.NDX(2) = 8: B.NDX(2) = 15
LOCATE 8,40: PRINT "wind direction : "
LOCATE 8,70: PRINT "degs"
A.NDX(67) = 8: B.NDX(67) = 60

LOCATE 11,1
PRINT "ground temp : "
LOCATE 11,25: PRINT "C"
A.NDX(61) = 11: B.NDX(61) = 15
LOCATE 11,40
PRINT "10m temp : "
LOCATE 11,70: PRINT "C"
A.NDX(63) = 11: B.NDX(63) = 60

LOCATE 14,1
PRINT "precipitation : "
LOCATE 14,25: PRINT "mm"
A.NDX(21) = 14: B.NDX(21) = 15
LOCATE 14,40
PRINT "humidity : "
LOCATE 14,70: PRINT "%"
A.NDX(70) = 14: B.NDX(70) = 60
LOCATE 17,1
PRINT "pressure :
LOCATE 17,25: PRINT "mb"
A.NDX(69) = 17: B.NDX(69) = 15
LOCATE 17, 40
PRINT "solar rad :
LOCATE 17, 70: PRINT "W/sqm"
A.NDX(68) = 17: B.NDX(68) = 60
LOCATE 20,1: PRINT "room temp :
LOCATE 20, 25: PRINT "C"
A.NDX(65) = 20: B.NDX(65) = 15
LOCATE 22,1
PRINT "Last record at ", TM.LOG$;
PRINT " there are now "; N.RECORDS; " records on disk"
PRINT " This task started on "; STRT.DATES$;
PRINT " at "; STRT.TIMES$
LOCATE 25,1
PRINT "Type Q to halt task";
RETURN
 '**************************************************************************
 ' Subroutine to initialise the various arrays
 '  
 '  "indx(1) = 1 : ' wind speed
 '  "indx(2) = 1 : ' wind speed
 '  "indx(21) = 6 : ' precipitation
 '  "indx(61) = 3 : ' ground level temperature
 '  "indx(63) = 4 : ' 10 m temp
 '  "indx(65) = 5 : ' room temperature
 '  "indx(67) = 2 : ' wind direction
 '  "indx(68) = 9 : ' solar radiation
 '  "indx(69) = 7 : ' pressure
 '  "indx(70) = 8 : ' humidity
 '  
 '  "last.hr = val (mid$(times$1,2))
 '  
 '  "open "b:records.dat" for input as #3
 '  "input #3, n.records
 '  "close #3
 '  
 '  "return

GOSUB 3000 : ' zeroes the data array

INDX(1) = 1 : ' wind speed
INDX(2) = 1 : ' wind speed
INDX(21) = 6 : ' precipitation
INDX(61) = 3 : ' ground level temperature
INDX(63) = 4 : ' 10 m temp
INDX(65) = 5 : ' room temperature
INDX(67) = 2 : ' wind direction
INDX(68) = 9 : ' solar radiation
INDX(69) = 7 : ' pressure
INDX(70) = 8 : ' humidity
LAST.HR = VAL(MID$(TIMES$,1,2))
OPEN "b:records.dat" FOR INPUT AS #3
INPUT #3, N.RECORDS
CLOSE #3
RETURN
2285 ' Subroutine
2300 ' zeroes the data array
2310 ' FOR I = 1 TO 2
2320 FOR J = 1 TO 6
2340 ' IF (J=3) THEN ARR.DAT(J,I) = 1000000!
2345 ARR.DAT(J,I) = 0!
2350 NEXT J
2360 NEXT I
2370 ' FOR I = 1 TO 9
2380 FOR J = 4 TO 6
2390 ' ARR.DAT(J,I) = 0!
2400 NEXT J
2410 NEXT I
2420 ' ARR.DAT(5,3) = 1!
2430 ARR.DAT(5,4) = 1!
2440 ' RETURN
2450 ' Subroutine to log data to disk
2460 ' OPEN "b:weather.dat" FOR APPEND AS #2
2470 ' TM.LOG$ = TIMES$
2480 ' PRINT #2, TM.LOG$, DATE$
2490 ' gather the statistics
2500 ' wind
2510 ' wind direction
2515 J = 1
2520 GOSUB 5000
2525 J = 2
2530 GOSUB 6000
2535 J = 3
2540 GOSUB 5000
2545 J = 4
2550 GOSUB 5000
2555 J = 7
2560 GOSUB 5000
2565 GOSUB 5000
4230  J = 8  : ' humidity
4240  GOSUB 5000
4250  
4251  J = 9  : ' INSOLATION
4252  GOSUB 5000
4253  
4260  PRINT #2, ARR.DAT(4,1), ARR.DAT(5,1), ARR.DAT(2,1),
       ARR.DAT(3,1)
4270  PRINT #2, ARR.DAT(2,2), ARR.DAT(4,3), ARR.DAT(4,4),
       ARR.DAT(4,7)
4280  PRINT #2, ARR.DAT(1,6), ARR.DAT(4,8), ARR.DAT(4,9)
4290  
4300  CLOSE (2)
4310  
4315  GOSUB 9000  : ' update record number counter
4317  
4320  GOSUB 3000 : ' zero the data arrays
4330  
4340  GOSUB 1250 : ' refresh the screen
4350  
4360  LAST.HR = THIS.HR
4370  
4390  
4400  RETURN
4405  '...........................................................
4999  ' subroutine
5000  ' generate the statistics
5010  '      
5020  
5030  WEIGHT = ARR.DAT(6,J)
5040  IF (WEIGHT = 0) GOTO 5150
5050  
5060  MEAN = ARR.DAT(4,J) / WEIGHT
5070  ' 
5080  RMS = ARR.DAT(5,J) / WEIGHT - MEAN*MEAN
5090  IF (RMS < 0) GOTO 5160
5100  RMS = SQR (RMS)
5110  GOTO 5200
5120  ' problems
5160  RMS = 0!
5170  ' 
5200  ARR.DAT(4,J) = MEAN
5210  ARR.DAT(5,J) = RMS
5220  
5230  RETURN
5235  '...........................................................
5999  ' subroutine to deal with the wind direction
IF (ARR.DAT(1,J) = 0 ) GOTO 6500
CC = ARR.DAT(4,J)
SS = ARR.DAT(5,J)
GOSUB 8000  : ' get ATAN2D
ARR.DAT(2,J) = TT
RETURN

Subroutine to update the data arrays
DATUM = V.DATA(I)
ARR.DAT(1,J) = DATUM
IF (J = 2) GOTO 7500  : ' wind direction
IF (J = 3) GOTO 7700  : ' temperature
IF (J = 4) GOTO 7700
TMP = ARR.DAT(1,J)
ARR.DAT(4,J) = ARR.DAT(4,J) + TMP
ARR.DAT(5,J) = ARR.DAT(5,J) + TMP*TMP
ARR.DAT(6,J) = ARR.DAT(6,J) + 1
IF (ARR.DAT(2,J) < TMP) THEN ARR.DAT(2,J) = TMP
IF (ARR.DAT(3,J) > TMP) THEN ARR.DAT(3,J) = TMP
check daily wind max/min
IF (J <> 1) GOTO 7800
IF (ARR.DAT(2,10) < TMP) THEN ARR.DAT(2,10) = TMP
IF (ARR.DAT(3,10) > TMP) THEN ARR.DAT(3,10) = TMP
GOTO 7800
T = ARR.DAT(1,2)
T = T * PI / 180!
SPEED = ARR.DAT(1,1)
C = COS(T) * SPEED
S = SIN(T) * SPEED
ARR.DAT(4,2) = ARR.DAT(4,2) + C
ARR.DAT(5,2) = ARR.DAT(5,2) + S
ARR.DAT(6,2) = ARR.DAT(6,2) + 1
CC = ARR.DAT(4,2)
SS = ARR.DAT(5,2)
GOSUB 8000 : ' get atan2D
ARR.DAT(2,2) = TT
GOTO 7800

' temperature : want 5 min. averaging

ARR.DAT(4,J) = ARR.DAT(4,J)*T.FACT + DATUM
ARR.DAT(6,J) = ARR.DAT(6,J) + ARR.DAT(5,J)
ARR.DAT(5,J) = ARR.DAT(5,J)*T.FACT

RETURN

subroutine to evaluate ATAN2D

IF (CC <> 0) GOTO 8110
TT = PI / 2!
IF (SS < 0) THEN TT = -PI/2!
GOTO 8500

TT = SS / CC
TT = ATN(TT)
IF (CC < 0) THEN TT = TT + PI
TT = TT * 180! / PI

RETURN

subroutine
updates the record counter file
OPEN "b:records.dat" FOR INPUT AS #3
INPUT #3, N.RECORDS
CLOSE #3
N.RECORDS = N.RECORDS + 1
OPEN "b:records.dat" FOR OUTPUT AS #3
PRINT #3, N.RECORDS
CLOSE #3
RETURN
Appendix B

The Data Examination Program

20 ' Weather data analysis
30 ' mjk, 7/jan/88
50 ' ...........................................................
80 ' DIM ARR.DAT(11), WANT(11), L.TITLES$(11), L.UNIT$(11)
100 ' FALSE = 0 : TRUE = NOT FALSE
120 ' KEY OFF
140 ' GOSUB 2290 : initialise titles
160 ' CLS : LOCATE 5,5
180 ' INPUT " Enter data filename : ", IN.FIL$
200 ' OPEN IN.FIL$ FOR INPUT AS #1
220 ' LOCATE 7,5 : PRINT " Patience while we read the file ",
230 ' find the first record
260 ' N.LINE = 0
280 ' LINE INPUT #1, F.MSG$
290 ' N.LINE = N.LINE + 1
300 ' IF (N.LINE>10) GOTO 860 : probable error
310 ' IF (MID$(F.MSG$,3,1)<>":") GOTO 280
320 ' GOSUB 960 : read the 3 lines of the first record
340 ' N.REC = 1
360 ' WHILE (NOT EOF(1))
370 ' LINE INPUT #1, MSG$
380 ' IF (MID$(MSG$,3,1)<>":") GOTO 370 : resynch if necessary
390 ' GOSUB 960 : read 3 lines of data
400 ' N.REC = N.REC + 1
410 ' WEND
420 ' CLOSE #1
440 '  
450 '  
460   P.DATE$ = "01-01-1900"  
470   OPEN IN.FIL$ FOR INPUT AS #1  
480 '  
485   SKIP = FALSE  
490   MORE = TRUE  
500   WHILE (MORE)  
510 '  
520   GOSUB 1360 : ' options setup  
530 '  
540   IF (NOT MORE) GOTO 800  
550 '  
560   FOUND = FALSE  
570 '  
580   WHILE (NOT EOF(1))  
590 '  
600   IF (NOT SKIP) THEN LINE INPUT #1, T.MSG$  
605   SKIP = FALSE  
610   IF (MID$(T.MSG$,3,1) <> ";") GOTO 600  
620   IF (MID$(T.MSG$,15,10)<=L.DATES) GOTO 680  
630 '  
640   GOSUB 1050 : ' read and print the data  
650   FOUND = TRUE  
660   GOTO 710  
670 '  
680   IF (FOUND) GOTO 730 : ' can quit  
690 '  
700   GOSUB 960 : ' skip 3 lines  
710   WEND  
720 '  
730 '  
740   PRINT  
750 '  
760   IN.MSG$ = "Continue"  
770   GOSUB 2160 : ' asks for yes/no to continue  
780   MORE = ANS  
790 '  
800   WEND  
810 '  
820   CLOSE #1  
830 '  
840   END  
850 '  
860 '  
870 '  
880   CLOSE #1  
890   cls  
900   PRINT
PRINT "No time stamp found"
PRINT " Is "; IN.FIL$; " the correct filename?"
PRINT
STOP

' subroutine
reads 3 lines, no data resulting
LINE INPUT #1, C1$
LINE INPUT #1, C2$
LINE INPUT #1, C3$
RETURN

' subroutine
reads 3 lines; extracts 10 items
FOR I = 1 TO 11
IF ((I=11) AND (L.DATE$<"01-08-1988")) GOTO 1120
INPUT #1, ARR.DAT(I)
NEXT I
GOSUB 1180 : print
RETURN

' subroutine
prints the required data
PRINT MID$(T.MSG$,1,8); IF (L.PRINT) THEN LPRINT MID$(T.MSG$,1,8);
FOR I = 1 TO 11
IF(NOT WANT(I)) GOTO 1300
PRINT USING "##.####"; ARR.DAT(I);
IF (L.PRINT) THEN LPRINT USING "##.####"; ARR.DAT(I);
NEXT I
PRINT " 
IF (L.PRINT) THEN LPRINT " 
RETURN

' subroutine
options setup
CLS
1400 PRINT " There are "; N.REC; " records
1410 PRINT
1420 PRINT " from "; F.MSG$ 
1430 PRINT " to "; MSG$ 
1440 '  
1450 F.DATE$ = MID$(F.MSG$,15,10) 
1460 E.DATE$ = MID$(MSG$,15,10)
1470 IF (NOT FOUND) THEN P.DATE$ = "01-01-1900"
1480  
1490 LOCATE 6,2
1500 INPUT "Enter date to list (mm-dd-yyyy) : ", L.DATE$
1510 IF ((L.DATE$>=F.DATE$)AND(L.DATE$<=E.DATE$)) GOTO 1560
1520 ERR.MSG$ = "Date not on file"
1530 GOSUB 2680
1540 GOTO 1490
1550 '  
1560 LOCATE 8,2
1570 IN.MSG$ = "Do you want to change the options? "
1580 GOSUB 2160
1590 IF (NOT ANS) GOTO 1830
1600 '  
1610 IN.MSG$ = "Do you want to list on the printer? "
1620 GOSUB 2160
1630 L.PRINT = ANS
1640 '  
1650 PRINT "Options: Wind speed, rms, max, min"
1660 PRINT " wind dir, temps (ground level and 10m)"
1670 PRINT " pressure, precipitation, humidity"
1680 PRINT " numbered 1 to 11"
1690 '  
1700 INPUT "Enter number of items to list (<9) : ", L.NUM
1710 IF (L.NUM>9) THEN L.NUM = 8
1720 '  
1730 FOR I = 1 TO 11
1740 WANT(I) = FALSE
1750 NEXT I
1760 '  
1770 FOR I = 1 TO L.NUM
1780 PRINT "Enter ", I; " th. item number ";
1790 INPUT ": ", J
1800 WANT(J) = TRUE
1810 NEXT I
1820 '  
1830 SKIP = TRUE
1835 IF (L.DATE$>P.DATE$) GOTO 1870
1840 CLOSE #1
1850 OPEN IN.FIL$ FOR INPUT AS #1
1855 SKIP = FALSE
1860 '  
WEATHER.BAS  B4  6/29/88  15:32
P.DATES$ = L.DATES$

PRINT
PRINT L.DATES$ : PRINT
IF (NOT L.PRINT) GOTO 1940
L.PRINT: LPRINT L.DATES$: LPRINT

PRINT " time "; IF (L.PRINT) THEN LPRINT " time ";
FOR I = 1 TO 11
IF (NOT WANT(I)) GOTO 1990
PRINT L.TITLE$(I);
IF (L.PRINT) THEN LPRINT L.TITLE$(I);
NEXT I
PRINT " 
IF (NOT L.PRINT) GOTO 2030
LPRINT " 

PRINT " "; IF (L.PRINT) THEN LPRINT " ";
FOR I = 1 TO 11
IF (NOT WANT(I)) GOTO 2090
PRINT L.UNIT$(I);
IF (L.PRINT) THEN LPRINT L.UNIT$(I);
NEXT I
PRINT " ": PRINT
IF (NOT L.PRINT) GOTO 2130
LPRINT " ": LPRINT " 
RETURN

 subroutine
 as for a yes/no response
 returns ans (logical)

OUT.MSG$ = IN.MSG$ + " [y/n] "
PRINT OUT.MSG$;
INPUT "; ", CH$ 
ANS = TRUE
IF ((CH$="n") OR (CH$="N")) THEN ANS = FALSE 
RETURN

 subroutine
 initialise the titles and options

L.TITLE$(1) = " speed"
L.TITLE$(2) = " rms 
L.TITLE$(3) = " max 
L.TITLE$(4) = " min 

WEATHER.BAS

B5

6/29/88 15:32
L.TITLE$(5) = " dirtn"
L.TITLE$(6) = " T(gr)"
L.TITLE$(7) = " T(10)"
L.TITLE$(8) = " Press"
L.TITLE$(9) = " Rain"
L.TITLE$(10) = " Humid"
L.TITLE$(11) = " Sun"

L.UNITS$(1) = " km/hr"
L.UNITS$(2) = " km/hr"
L.UNITS$(3) = " km/hr"
L.UNITS$(4) = " km/hr"
L.UNITS$(5) = " degs"
L.UNITS$(6) = " C"
L.UNITS$(7) = " C"
L.UNITS$(8) = " mbars"
L.UNITS$(9) = " mm"
L.UNITS$(10) = " %"
L.UNITS$(11) = " w/sqm"

L.PRINT = FALSE
FOR I = 1 TO 11
    WANT(I) = FALSE
NEXT I

WANT(1) = TRUE
WANT(3) = TRUE
WANT(4) = TRUE
WANT(6) = TRUE
RETURN

LOCATE 25,1
PRINT ERR.MSG$
BEEP: BEEP
RETURN

---------------------------------------------
subroutine
error report

---------------------------------------------
subroutine
extract N.VAL items from the string C.STR$

L = LEN(C.STR$)
F1 = 0
FOR I = 1 TO N.VAL
2850     F1 = F1 + 1
2860     IF (F1>L) GOTO 2990
2870     IF (MID$(C.STR$,F1,1) = " ") GOTO 2850
2880     
2890     F2 = F1
2900     F2 = F2 + 1
2910     IF (F2>L) GOTO 2940
2920     IF (MID$(C.STR$,F2,1) <> " ") GOTO 2900
2930     
2940     
2950     F3 = F2 - F1
2960     TMP = VAL(MID$(C.STR$,F1,F3))
2970     GOTO 3010
2980     
2990     TMP = -1
3000     
3010     INDX = N.START + (I-1)
3020     ARR.DAT(INDX) = TMP
3030     
3040     NEXT I
3050     
3060     RETURN
Culgoora Weather Station

Top Junction Box Wiring (Revised)

(as Per Wind Direct Change 6/12/85)
Fig. 7.3 Location of switches S1-S5

PL1 Connections

+5V TTL Channel 1 Windspeed

PL1 signals

<table>
<thead>
<tr>
<th>PIN NO.</th>
<th>SIGNAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F1-</td>
</tr>
<tr>
<td>2</td>
<td>G1-</td>
</tr>
<tr>
<td>3</td>
<td>F2-</td>
</tr>
<tr>
<td>4</td>
<td>G2-</td>
</tr>
<tr>
<td>5</td>
<td>F2-</td>
</tr>
<tr>
<td>6</td>
<td>G3-</td>
</tr>
<tr>
<td>7</td>
<td>F3-</td>
</tr>
<tr>
<td>8</td>
<td>G4-</td>
</tr>
<tr>
<td>9</td>
<td>F4-</td>
</tr>
<tr>
<td>10</td>
<td>G5-</td>
</tr>
<tr>
<td>11</td>
<td>+15V</td>
</tr>
<tr>
<td>12</td>
<td>0V</td>
</tr>
<tr>
<td>13</td>
<td>0V19</td>
</tr>
<tr>
<td>14</td>
<td>F1+</td>
</tr>
<tr>
<td>15</td>
<td>G1+</td>
</tr>
<tr>
<td>16</td>
<td>F2+</td>
</tr>
<tr>
<td>17</td>
<td>G2+</td>
</tr>
<tr>
<td>18</td>
<td>F3+</td>
</tr>
<tr>
<td>19</td>
<td>G3+</td>
</tr>
<tr>
<td>20</td>
<td>F4+</td>
</tr>
<tr>
<td>21</td>
<td>G4+</td>
</tr>
<tr>
<td>22</td>
<td>F5+</td>
</tr>
<tr>
<td>23</td>
<td>G5+</td>
</tr>
<tr>
<td>24</td>
<td>-30V</td>
</tr>
<tr>
<td>25</td>
<td>+12V</td>
</tr>
</tbody>
</table>

For test purposes only

Fig. 5 PL1 Pin Numbering
TTL INPUTS: Active Hi

Input connections for a floating signal source

Channel 1
Windsped

5V ACTIVE — — —
0V

PART OF COUNTER/TIMER
+19V
PART OF SWITCH (S1–S5)
F or G HALF
AS APPROPRIATE

PL1

EARTH RETURN
(VIA EARTH PIN IN
LOGGER MAINS PLUG)

F and G INPUT CIRCUITS
ARE IDENTICAL

S1 to S5 Settings (for floating or earthed signal source)

Required Switch Settings

S1

S1 to S5 RELATE TO
CHANNELS 1 to 5
RESPECTIVELY

G, F
closed
open

BOTH F and G SWITCHES
ARE SHOWN SET FOR TTL
ACTIVE HI INPUT.
F and G SWITCHES MAY BE
SET INDEPENDENTLY FOR
DIFFERENTIAL OR TTL
AS REQUIRED.
(DIFFERENTIAL SETTINGS
ARE SHOWN IN FIG. 7.1)

Fig. 6 TTL Inputs: Active Hi
Event/Status Module  Slot 5  35302A

Rain Gauge Connections

Event Recording

INPUT CONNECTOR ASSEMBLY (COVER PLATE REMOVED)

H  Hi  see H & L TERMINALS below
L  Lo
+  5V floating supply

Rain Gauge Sw.
Switch Closure.
Gives Logic H to Logic L
Log event Hi → Lo

DIGITAL CHANNELS

<table>
<thead>
<tr>
<th>21</th>
<th>5V</th>
<th>22</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
<td>+</td>
</tr>
<tr>
<td>23</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>24</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>28</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>29</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>32</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>33</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>34</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>35</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>36</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>37</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>38</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>39</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NUMBERING
Numbering for channels 1-20 only is shown; subsequent sets of 20 channels are similarly numbered, ie 21-40, 41 to 60, and so on, up to 181-200.
Channel numbering on any input connector is dependent on which slot it occupies in the logger mainframe.

H & L TERMINALS
For each input channel circuit to conduct, the H terminal must have a +ve potential with respect to the L terminal. When the input circuit conducts the logger gives a measurement of Logic 0. When the input circuit does not conduct the logger gives a measurement of Logic 1.

Fig 7. Input connector: Channel Numbering and Pin Assignment.
Reed Relay Unit. Slot 7.

PRT. Connections.
Wind Direction Connections
Solar Radiation Connections
Barometric Pressure Connection
Relative Humidity Connection

PRT. RRecording
Resistance Recording
D.C. Volts Recording
D.C. Volts Recording
D.C. Volts Recording

<table>
<thead>
<tr>
<th>H</th>
<th>L</th>
<th>G</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>Lo</td>
<td>Guard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Source A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Source B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Current Return</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sense</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INPUT CONNECTOR ASSEMBLY (COVER PLATE REMOVED)

3-POLE CHANNELS

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

Barometric Pressure

Wind Direction

<table>
<thead>
<tr>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>G</td>
</tr>
</tbody>
</table>

8-POLE CHANNELS

<table>
<thead>
<tr>
<th>61</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

PRT 1
Tower Top

<table>
<thead>
<tr>
<th>62</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

PRT 2
Tower Bot

<table>
<thead>
<tr>
<th>63</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

PRT 3
Room Temp

<table>
<thead>
<tr>
<th>64</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

Solar Radiation

Relative Humidity

Fig. 8 Channel Numbering and Assignment of Terminals on Input Connectors
2.5 4-TERMINAL RESISTANCE OR PRT MEASUREMENT

2.5.1 Theoretical Diagram

The energising current is generated and switched automatically, no additional linking or connections are required.

2.5.2 Practical Connection Diagram

Slot 7

Connection Diagram for PRTs

PRT 1. Tower top ch. 61
PRT 2. Tower bot ch. 63
PRT 3. Room Temp ch. 65

Fig. 9
2.4 2-TERMINAL RESISTANCE MEASUREMENT

2.4.1 Theoretical Diagram

![Theoretical Diagram Image]

2.4.2 Practical Connection Diagram

Wind Direction Connection
Slot 7
Resistance Measurement

Channel 67

N.B. Use Reed Relay Selector 35301A only. 2-terminal resistance measurement is suitable for applications where less accuracy is required (e.g. measuring 10k to 1% accuracy). For greater accuracy, use 4-terminal resistance measurement, see page 4.24.
2.2 VOLTAGE MEASUREMENT

2.2.1 Theoretical Diagram

SP1 or SP2
SPLIT PAD ON REED SELECTOR.
IF BRIDGED, COMMITS ALL
10 ASSOCIATED CHANNELS
TO SAME L-TO-G CONNECTION.
(SP1 = ODD CHANNELS
SP2 = EVEN CHANNELS)
SEE PAGE 4.21.

2.2.2 Practical Connection Diagram

ANY ODD ANY EVEN
CHANNEL CHANNEL

Slot 7
Channel 68
Solar Radiation

CONNECT G TO GUARD, SCREEN
OR SOURCE OF COMMON MODE POTENTIAL.
OR CONNECT G TO L AT POINT OF MEASUREMENT
OR USING SPLIT PAD IN LOGGER.

Fig. 11
2.2 VOLTAGE MEASUREMENT

2.2.1 Theoretical Diagram

SP1 OR SP2
SPLIT PAD ON REED SELECTOR.
IF BRIDGED, COMMITS ALL
10 ASSOCIATED CHANNELS
TO SAME L-TO-G CONNECTION.
(SP1 - ODD CHANNELS
SP2 - EVEN CHANNELS)
SEE PAGE 4.21.

2.2.2 Practical Connection Diagram

Slot 7
Any Odd Any Even Channel Channel
H L G G L H

Channel 69
Barometric Pressure

Connect G to guard, screen
or source of common mode potential,
or connect G to L, at point of measurement
or using split pad in logger.

Fig. 12