行政院及所屬各機關出國報告
(出國類別：參觀、訓練)

現代化水文氣象觀測儀器與觀測技術研習

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報告日期：中華民國 九十一 年 十 月 十五 日

分類號／目：

關鍵詞：氣象觀側儀器，通量儀

內容摘要：

配合本校氣象與水文科學結合之跨領域教學研究之發展趨勢，本系所近幾年來正逐步加強水文循環與地—氣、海（水）—氣交互作用之監測系統與研究領域，建製移動式地氣通量觀測系統，以及移動式整合探空系統(ISS)。

此次前去 NCAR，主要研習 Flux Pam 附屬地表能量、熱量、水氣通量之量測系統與觀測技術，學習 profiler 探空的觀測原理。在 Flux PAM 之地表能量、熱量、水氣通量測試儀器的整合測試過程中，對各種 Sensor 整合方面有實地之通盤認知，其中包括有：各種地氣通量 Sensor 的組裝與擴充、datalogger 程式操作與撰寫，學習各種水文氣象觀測儀器之原理，整合觀測系統自我擴充能力及建製檢測維護平台的能力。

目　　次

一、 目的：

配合本校氣象與水文科學結合之跨領域教學研究之發展趨勢，本系所近幾年來正逐步加強水文循環與地—氣、海（水）—氣交互作用之監測系統與研究領域，建製移動式地氣通量觀測系統，以及移動式整合探空系統(ISS)。

此次前去 NCAR，主要研習 Flux Pam 附屬地表能量、熱量、水氣通量之量測系統與觀測技術。在 Flux PAM 之地表能量、熱量、水氣通量測試儀器的整合測試過程中，對各種 Sensor 整合方面有實地之通盤認知，其中包括有：

- 各種地氣通量 Sensor 的組裝與擴充。
- datalogger(EVE 及 CR10X)程式結構、操作與撰寫。
- 各種狀況模擬故障發生時之排除。
- 如何進行測試(利用 TEST CABLE 進行各項 SENSOR 的對談 TALK)。
- 整合觀測系統自我擴充能力及建製檢測維護平台的能力。

二、過程

本次前往 NCAR 研習地表能量、熱量、水氣通量之量測系統之整合測試行程如下：

91.08.20(二)

AM08:00 抵達 NCAR

- 將 Campbell CR10X 交付 NCAR 工程師 Steven，進行

  1.REBS Heat Flux Transducer 擴充。

  於 Campbell CR10X Box 再外加兩組 SENSOR，共三組。與 Steven 討論確定 Box 開孔位置及 CR10X 埠位置的更換後，開始接線及製作新的 Cable。

  2.Trime Soil Moisture Probe 擴充。

  同前項作業。

  3. Campbell CR10X 檢測。

  a. 檢測 CR10X 所有功能一切正常。

- 交付 ISS 之 windprofiler Control Card 予 Mike 進行檢測。向 Mike 說明此 CARD 在遭雷擊後，即無法正常工作，請其檢修，並與其約定下午學習如何檢修及 windprofiler 基本原理。
- 交付 ISS 之 GLASS Receiver 予 Ned 進行檢測。

  向 Ned 說明此 Receiver 無法由 computer 控制，請其協助檢修。

91.08.21(三)

- Campbell CR10X 程式結構講解及更換 sensor 時 Calibration coefficient 之修改方式。
- 檢測 Campbell CR10X 各 sensor 埠方式，隨同 Steven 實習如何測定 CR10X 的功能正常與否，配合工具如下所示：

  a. 穩定直流電源功應器(DC12 V)→CR10X 使用。

  b. 精密 millivoltage 電源供應器→模擬 sensor 值。

  c. PC486 以上(含 Procomm 程式)

- Flux Pam_EVE 硬体結構介紹(John)。

91.08.22

- Flux Pam_EVE 系統程式結構介紹(John)。
- Campbell CR10X 擴充 sensor 後 Flux Pam_EVE 程式修改(John)。
- 模擬 Flux Pam_EVE 長時間 loss power 故障狀況檢測及排除方式(John)。
- Flux Pam_EVE 做 sensor talking 之指令操作(John)。

91.08.23

- Flux Pam_EVE 程式 debug 演練。
- Flux Pam_EVE_Computer Card 上 EEPROM 昇級方式。
- FLUX PAM 故障排除步驟解說。

91.08.24

- 多功用 TEST CABLE 製作及運用方式。
- FLUX PAM 架塔後正北之校正方式。
- RAW DATA 的輸出格式及 Fastout 時軟体及硬体的修改方式。

91.08.25

- Flux Pam 附屬地表能量、熱量、水氣通量之量測系統架設演練及各 SENSOR 測試後帶回台。
- Campbell CR10X Box 及地表能量、熱量及水氣通量 sensor 打包裝箱。
- 搭乘 RTD 公車至 DIA(丹佛國際機場)搭機至 LA(洛杉磯)。

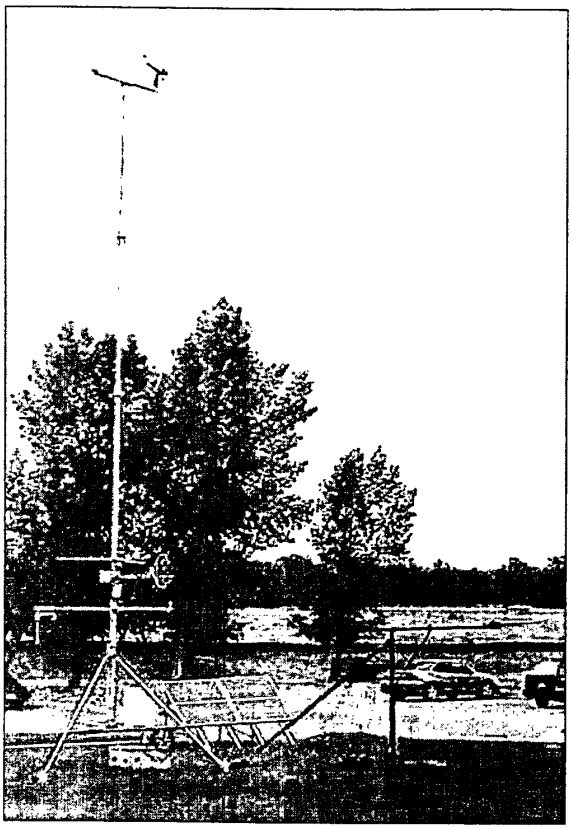
91.08.26,27

- 於 LA 搭乘 BR111 班機返台。

三、心得：

1.FLUX PAM 結構原理：

FLUX PAM 是中央大學大氣系在台灣最早引進的通量觀測儀器，主要部份分硬体部份(如圖一所示)及軟体部份。



(圖一：FLUX PAM 外觀)

a. 硬体部份：

主塔部份(上圖 10 米白塔)：

- **EVE(datalogger):**系統圖如圖二所示。

  DCOM332 CPU:這片介面板上有一個 Motorola 68322 cpu，採用 16.67MHz 運作頻率。內有 512kbytes 的 battery-backed RAM 供 configuration 及 data 的儲存。

  另外在此介面前板上有三個串列埠(p4~P6)分別提供:

  1. console(p4) 2.sensor input(p5-SBUS,p6-CAST Sonic) 使用。

  並且有一個 switch 可供系統 reset 用。

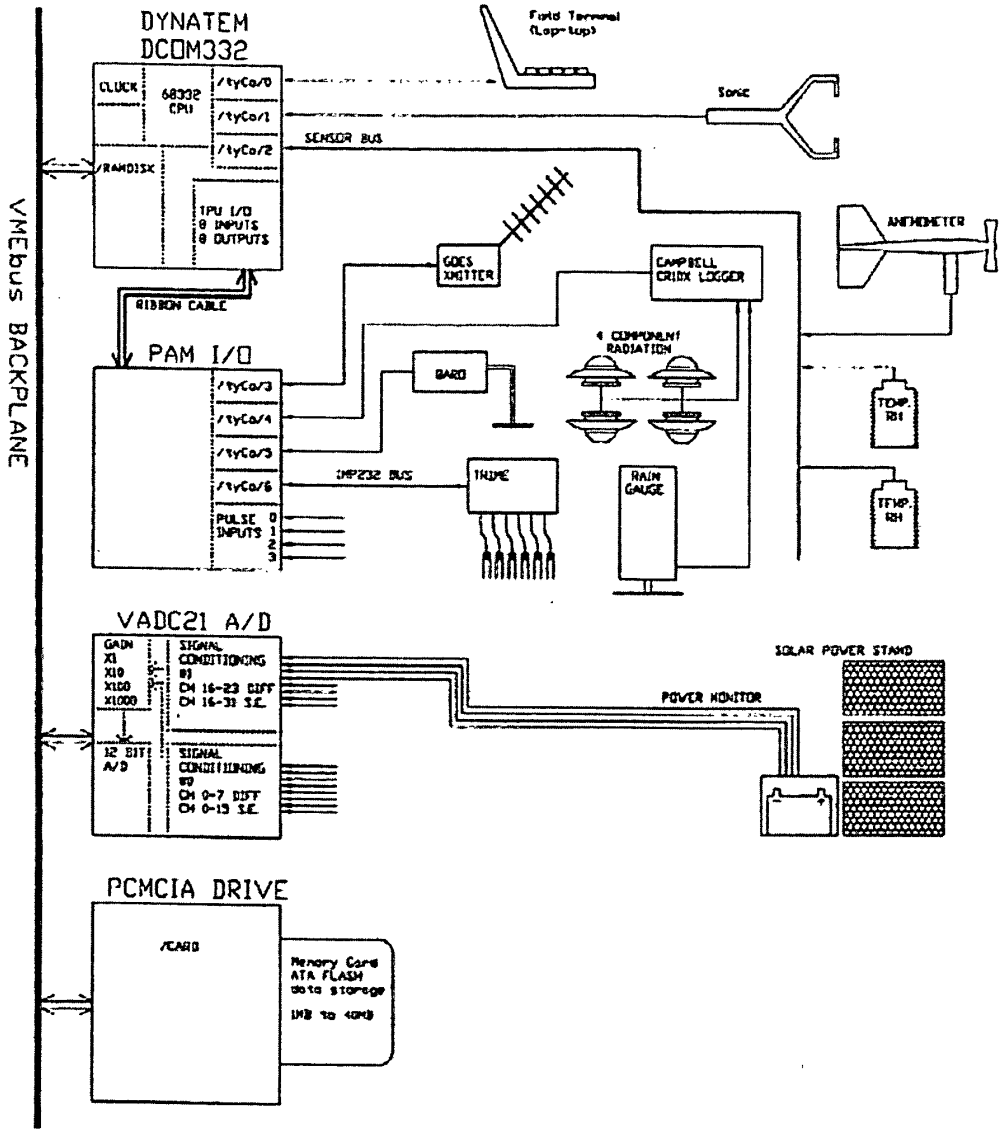


Figure 6: EVE System Diagram

(圖二：EVE 系統圖)

PAM I/O port:

這個 I/O board 是由 NCAR 製作的，利用光纖直接與 DCOM332 做介面通訊。另外在此介面前板上有五個埠(tyco/3~6 及 pulse)分別提供:

- tyco/3 提供 Data Out 到其他儲存設備使用。
- tyco/4 提供 Logger 通訊用。
- tyco/5 提供 Vaisala PTB220 Barometer 壓力 sensor 使用。
- tyco/6 提供 GPS 使用。
- pulse 保留。

VADC21 A/D Converter：

這 VADC21 板是由 OR 公司製作的，其主要功能在於將類比信號轉換成相對代表值的 12-bit 數位信號。在標準的 PAM 系統中則將其規劃爲 8 個電位差的 Channels 及+/-10 伏的輸入範圍。

PCMCIA/DMEM20 Driver：

使用於儲存大量的 data 資料，這個 Driver 支援 type I 及 type II 的 PCMCIA CARD ，並且使用標準的 MS-DOS 檔案系統，爲的是能夠輕易的將 EVE 上的資料快速的轉移到 PC 上。在 EVE 的目錄名稱爲 /CARD 。

- **Battery & Solar Charger**：

  利用太陽能板產生的電能對 **deep cycle type** 的免保養蓄電池充電，以提供 PAM 系統的運作，此爲 PAM 的主要電力來源。

- **Sensor** ：

  在台灣系統中目前掛有的 sensor 如下所示：

  1. ANEMOMETER(風速風向)
  2. CSAT3 Sonic(超音波風速風向)
  3. I.R. Surface Temperature(紅外線地面溫度)
  4. krypton hygrometer(水汽通量)
  5. TEMP/RH(溫/濕度)
  6. BAROMETER(大氣壓力)
  7. GPS(全球定位系統)

b. 軟体部份：

主塔程式：fmt6002.dat 是 Flux PAM 非常重要的 configuration 程式，包含以下主要結構：

1.sensor I/O port 的定義：

在 EVE 中的 tyco/0~6 各 sensor list 及通訊協定：

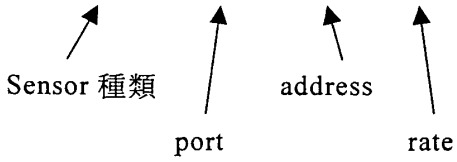
tyco/0：Console port ,9600 none 8 rs232

tyco/1：連接至下列兩個 sensor

SIO: SBUS port,9600 nono 8 rs485

定義串列通訊埠的通訊參數

- SBUS:WIND /tyco/1 0x12 1sec

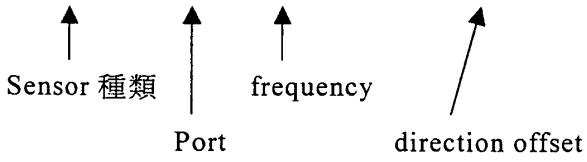


- SBUS:RHT /tyco/1 0x01 5sec

tyco/2：

SIO: /tyco/2 9600 nono 8

CSAT:SONIC /tyco/2 10 BOOMDIR=180



tyco/3：給 Auxconsole 使用，並送出每五分鐘一筆資料。

SIO: /tyco/3 9600 nono 8 RS232

Auxconsole: /tyco/3

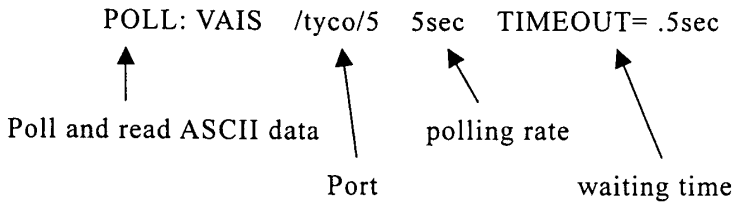
Tyco/4：

SIO: /tyco/4 9600 nono 8 RS232

SENSOR: LOGR asyncIn /tyco/4

Tyco/5：VAISALA barmeter on

SIO: /tyco/5 1200 nono 8



Tyco/6：

SIO: /tyco/6 1200 nono 8 rs232

SERIAL: GPS /tyco/6 GPS_CLOCK_UPDATE=3 MULTI_LINE

2.Data Output 格式如下所示：

year jd hh mm ss stn fmt id vstus lat lon press. temp. rh rain arain v u maxspd sonws sonwd netr licor soilt1 soilt2 soilt3 soilhf1 soilhf2 soilhf3 soilrh soilrm tsfc cstf Krytonv kryton sonicu soniv sonicw sonict u'u' u'v' u'w' u'tc' u'h2o' v'v' v'w' v'tc' v'h2o' w'w' w'tc' w'h2o' tc'tc' h2o'' cnt uhz h20s h2oz uf vf wf tcf battery(v) battery(I) load(I) bat(temp) box(temp) ver watchdog A B C D E F G H

3.EVE Field Terminal Mode

a.在 Field Terminal Mode 中每一行指令前會有" EVE> "訊息，系統啓始後就進入這個模式。若在" EVE> "後直前輸入<CR>它會立即回應可使用的 Message 指令(如下表所示)，而這些指令是被定義於 configuration file 裡的"MESG:"指令。當你輸入各別 message 指令時會出現相對 meassage 指令的 sensor 資料，若該 sensor 沒有產生 data，則會出現"NaN"或"很多的 0"表示之。

WIND TRH GPS BARO LOGGER RAIN TSFC POWER KRYTPON CSAT FLUX SYSTEM STATUS OPER EVE>

4.EVE System Mode

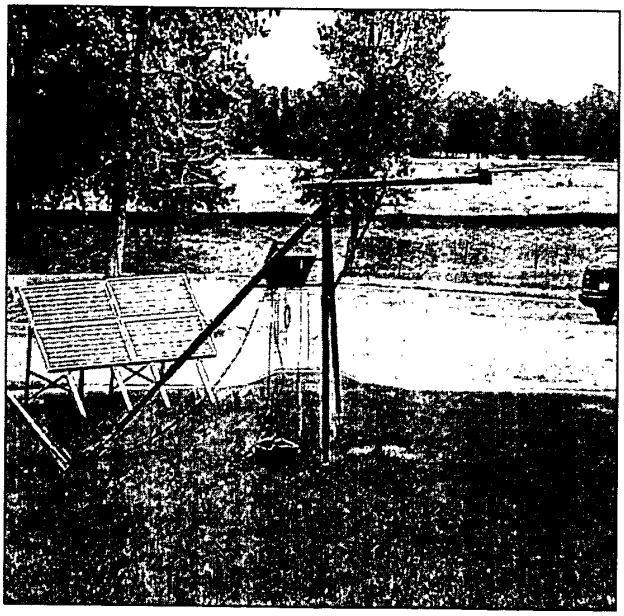
在" EVE> "輸入"entersys"就可以進入系統模式

```
EVE>entersys
.
.
System EVE>
```

在指令列輸入"?"可以得到可使用指令的列表，而各指令的使用方式請參考使用手冊。

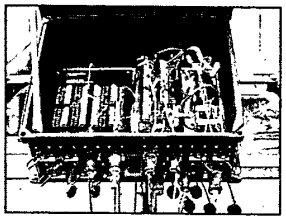
在這個模式中可以存取 EVE 的 configuration file，輸入時間和日期，對 Serial Sensor 做交談，拷貝和刪除檔案及開始或停止收集資料。

<u>幅射塔部份(黑塔)：</u>



利用 Campell CR10 Logger 來收集幅射塔上所有 sensor 的資料，由主塔提供其必需之電力，利用 rs-232 將資料送回主塔 EVE 處理，一併儲存於 RAM CARD 上及由 AUX Console 做 5-min 或 fastout 的 Ascii 資料輸出。

- **Datalogger**：



內置 Campell CR10 Logger 及 multiplexer 收集來自於各個 sensor 的類比信號，將其轉換爲電腦可處理的數位信號，並可儲存於內部的儲存元件。

- **Sensor**：

  目前系統經本次升級擴充後有下列各種 Sensor。

  1. Solar Radiation(Licor LI 200SA)全天空幅射
  2. Net Radiation(Q7)淨幅射
  3. Heat Flux Transducer(REBS)熱通量*3
  4. Tsoil 土壤溫度*3
  5. Rain Gauge(Belfort)雨量計
  6. CS615 Soil Moisture 土壤濕度

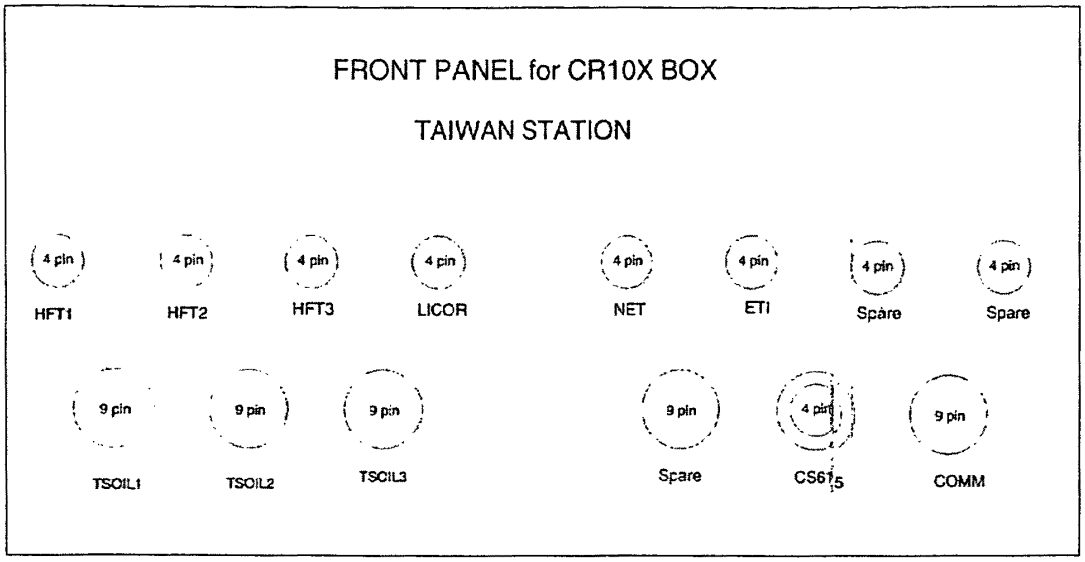
c.軟体部份：

使用 Campbell CR10 Program，可利用 pc208 來編修及編譯程式，於撰寫程式過程中配合 CR10X datalogger 線路配置來定義 Sensor 所接的 I/O Port 及取樣方式，程式完成後進行 compile，無誤後將程式輸入 CR10 進行各 Sensor 的資料收集，而收集的資料則暫存於內部本身記憶体中。

2.此次地表能量、熱量、水氣通量 sensor 擴充及程式的修改:

- sensor 的擴充:

  datalogger Box 接頭重配置，如下圖所示



CR10X datalogger 線路重配置，如附表 1~4 所示

- 程式修改:

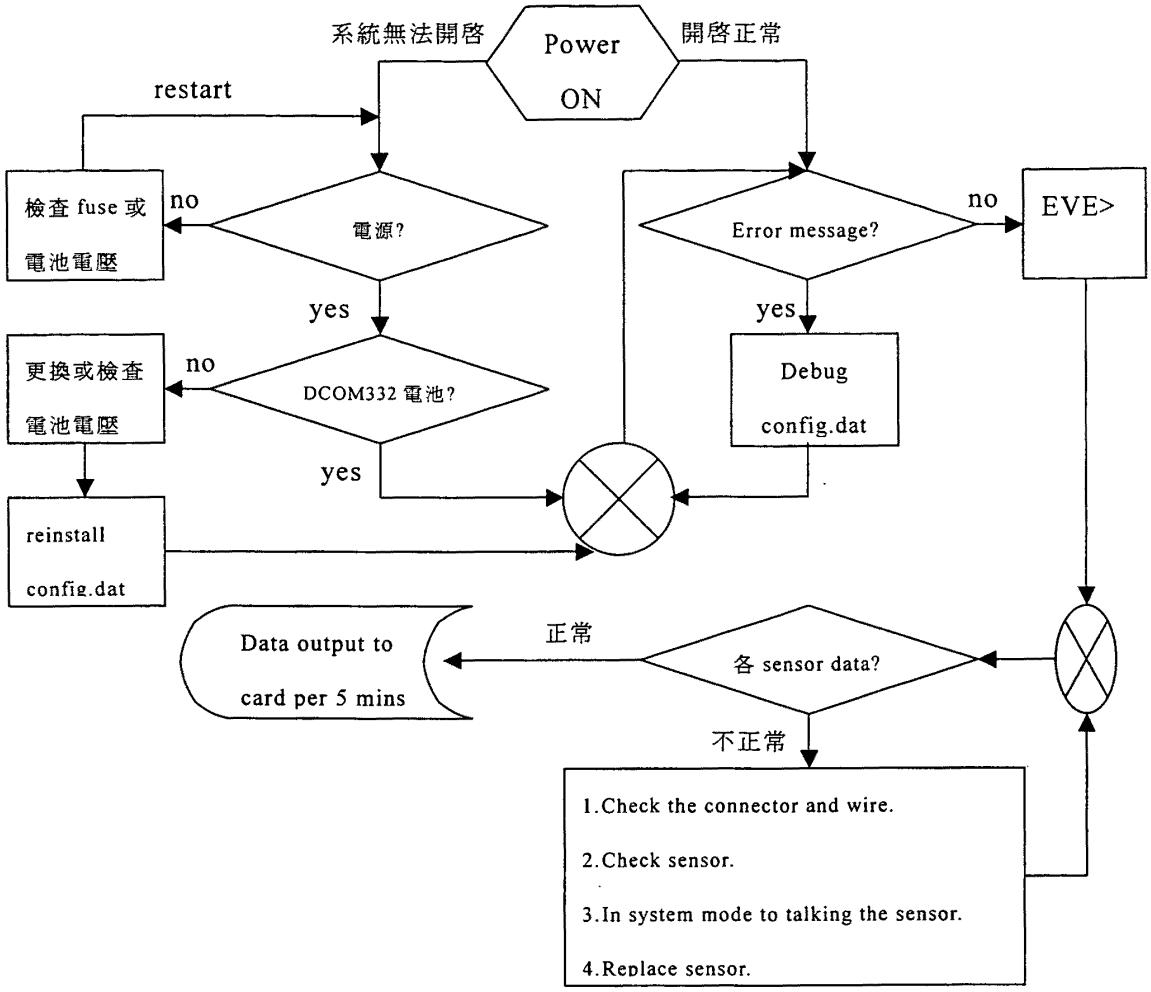
  EVE 部份:此次前往 NCAR 學習如何將程式 upgrade 到 fmt6002.dat (configuration file)裡，配合 CR10 增加 sensor 的 dataoutput 格式增列其輸出格式項目及 Message 訊息。往後欲再增加 sensor 即可有自我規劃 upgrade 的能力 。參考附錄一：fmt6002.dat 程式內容。

  CR10X 部份：

  配合附表 1~4 所示各 sensor 接腳修改程式至相對應 port，並重新輸入各 sensor 的 calibration 係數到 CR10 內的 EEPROM:MODE4(每次 CR10 斷電後均需做此一步驟)。請參考附錄二：CR10 程式。

d. 故障排除模擬:

Flux pam 整個系統故障排除流程圖:



在此特別感謝本校及系上老師給予此次機會前往 NCAR 見習，增加對氣象儀器在觀測上的認識與經驗。此次前去 NCAR 主要習得—

- FLUX PAM 系統架構
- FLUX PAM 系統故障排除技巧
- EVE 的 config.dat 昇級
- CR10 的 sensor 擴充及程式修改
- 地表能量、熱量、水氣通量 sensor 原理。

在以上的各個重點中，主要在建立本校氣象觀測儀器的自我維修及 upgrade 的能力，藉此次前往 NCAR 的機會裡加強對 flux pam 系統及各

sensor 的相關原理及電子技術，以提高對各項氣象學術性研究的配合性及擴充性。

氣象儀器實屬於相當精密之科學測量儀器，唯有完善的自我檢測能力及維修能力之下，才可保持觀測儀器在實驗中的相對可靠度及相對精密度，以提供精確的測量輸出資料，提高本校在氣象教學時更完善及更精確的教學設備。

四、討論與建議：

在此次前往 NCAR 的地表能量 sensor、地表熱量 sensor 及水氣通量 sensor 擴充見習中，明瞭 flux pam 的基本架構，進而對其輸出 OUTPUT DATA 格式希望能有興趣者撰寫其應用程式，將得來資料經過處理過後能得到更多的有用資訊供研究上用。例如可擴充其功能上能在 PC 上每日儲存一個ＦＩＬＥ記錄每五分鐘或每三十秒一筆資料、建立即時顯示資料 table 顯示即時資料、ＳＥＮＳＯＲ故障告警、網路監控能力、歷史資料查詢及資料繪圖等。真正做到無人站台的監控能力，不只是 portable 而已。

各種氣象觀測儀器基本上都是由精密的電子零件組成，建議前往受訓或見學的人員除具備有氣象學科背景外，最好也能先修有基本電學及基本電子學的理論，如此方能收更好的學習效果，以收事半功倍之效，更能於回國後應用該領域，達到物盡其用。

附表一：

TAIWAN LOGGER
Cabling for the PAMIII Radiation/Soil System

REBS Q7 NET RADIOMETER

Q7	AMP 4 socket cable	AMP 4 pin bulkhead	Campbell 416 Multiplexer
net + (red)	1	1	3H
net - (blk)	2	2	3L
	3	3	
shield	4	4	shield

LICOR 200-SA Pyranometer

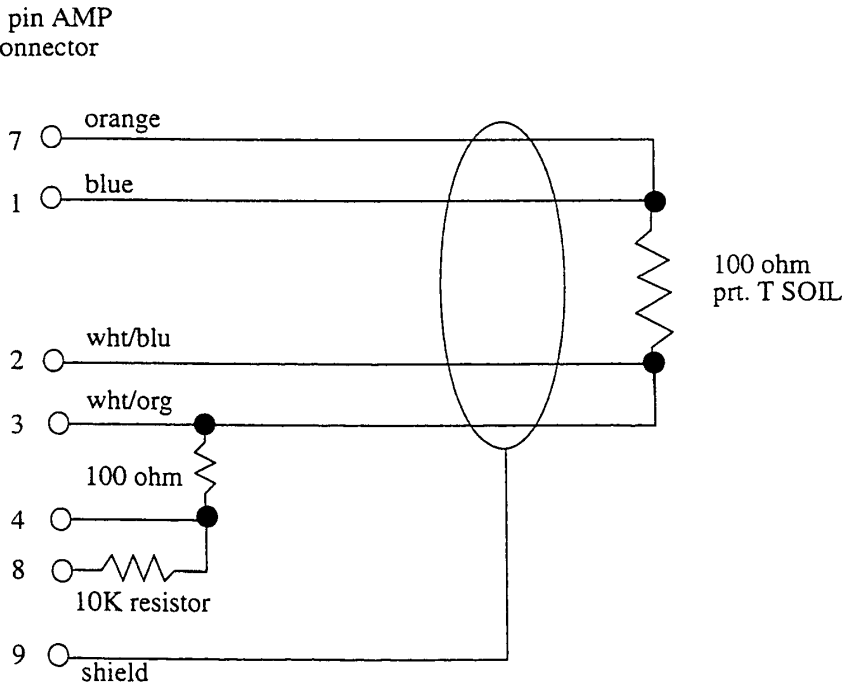
LICOR	AMP 4 pin cable	AMP 4 pin bulkhead	147 ohm BNC	Campbell 416 Multiplexer
sol_dn +	1	1	blue	4H
sol_dn -	2	2	green	4L
	3	3		
shield	4	4		shield

附表二：

REBS T SOIL PRT

T Soil	AMP 9 pin cable	AMP 9 pin bulkhead	Campbell 10X - AM416		
			Tsoil1	Tsoil2	Tsoil3
PRT #1 (blu)	1	1	1-2H	2-2H	3-2H
PRT #2 (wht/blu)	2	2	1-2L	2-2L	3-2L
PRT #3 (wht/org)	3	3	1-1H	2-1H	3-1H
100 Ω	4	4	1-1L	2-1L	3-1L
PRT #4 (orange)	7	7	AG	AG	Ag
10KΩ	8	8	E1	E1	E1
shield	9	9	gnd	gnd	gnd

The diagram below shows the wiring of the Tsoil probe. The 100 ohm and 10K resistors are mounted inside the backshell of the 9 pin AMP connector.



附表三：

REBS HFT-3 HEAT FLOW TRANSDUCER

HFT-3	AMP 4 socket cable	AMP 4 pin bulkhead	CR10X - AM416		
heat flux + (red)	1	1	4-1H	4-2H	5-1H
heat flux - (blk)	2	2	4-1L	4-2L	5-1L
	3	3			
shield	4	4	shield	shield	shield

BELFORT RAIN

ETI	AMP 4 socket cable	AMP 4 pin bulkhead	CR10X
pulse	1	1	P1
sig gnd	2	2	GND
+12 Vdc	3	3	+12 Vdc
GND	4	4	GND

CS615 Soil Moisture

CS615	AMP 4 socket cable	AMP 4 pin bulkhead	CR10X
pulse	1	1	11 (S)
sig gnd	2	2	C3
+12 Vdc	3	3	+12 Vdc
GND	4	4	GND
shield	4		

附表四：

416 MUX to CR10X

10X logger	416 Multiplexer
1-H	comm 1-H
1-L	comm 1-L
G (shield)	comm shield
2-H	comm 2-H
2-L	comm 2-L
G (shield)	comm shield
C1	reset
C2	clock
G (shield)	
E1	10K of T soil system

LOGGER to EVE

CR10	AMP 9 pin bulkhead	AMP 9 socket cable	AMP 9 pin bulkhead	EVE
XMIT	1	1	1	RX (eve)
REC	2	2	2	TX (eve)
	3	3	3	DTR
sig gnd	4	4	4	sig gnd
shield	6	6	6	shield
+12 Vdc	8	8	8	+12 Vdc
GND	7	7	7	GND

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A

(fmt6002.dat 程式)

```
# ========================================
# CONFIGURATION FOR Taiwan
# ========================================
#
# MODIFICATIONS
# -------------
# $Log: fmt6002.dat,v $
# Revision 1.1  2002/06/11 15:40:39  militzer
# Initial Checkin.
# Similar to fmt6001.dat except added SoilT2, SoilT3 in logger message
# and output statement.
# Removed csat 'SpdDir' references for ws/wd since the scalars were not
# useful.
#
#
# Taiwan Station, Initial Configuration
# 21Aug02, jwm  Modified logger message by adding SoilHF2, SoilHF3
#           and changed SoilHF to SoilHF1
#              These were requested by Pay-Liam and Mr Hu during their
#                    visit.  Steve Semmer and Mr. Hu added these to the logger.
# 11Jun02, jwm  Modified logger message by adding SoilT2, SoilT3,
#           and changed SoilT to SoilT1
#              These were requested by Pay-Liam.  Steve Semmer
#              will modify the logger code for these.
#              The 2 new values were added after the existing tsoil
#              value in the previous logger message,
#              and also added to the OUTPUT message in the same
#              respective position.
# 20Mar02, jwm  Removed CSAT 'WS/WD' and SpdDir references
#              These never really worked and the scalars
#              were of little value.
#              Vector values generated, SONIC.ws SONIC.wd
#              should be used only.
# 20Mar00, jwm  Changed Krypton, adding MESG
#              and reworked calculation of H2o
#              adding constants for cal. coefficients as
#              provided by Campbell.  should be easier
#              to understand how to edit them.  Also
#              they are reported in the message now.
#           Installed 'BOOMDIR=180' for CSAT and '180'
#              offset for calculation of scalar speed/dir.
#              Angle used during roof Tests at NCAR only.
#           Commented out periodic software REBOOT
#              not generally needed except for doing bandpass
#              covariance and we want to make sure it stays
#              synchronized.
# 15Feb00, jwm  Created
#
#     SYNC10, covars, 5-minute ascii file output.
#
# Sensor list:
#     tyCo/0 = Console
#     tyCo/1 = SBUS
#                 RMY prop vane ID = 0x12 1-second
#                 TRH ID = 0x01         5-second
#     tyCo/2 = CSAT3 Sonic, 10hz ascii (9600 n 8)
#                 with SpdDir Scalar Wind Speed/Dir
#                 NOTE: EDIT/Adjust BOOMDIR for proper
#                 alignment direction of sonic mount.
#     tyCo/3 = AUXConsole
#           5-min Ascii data output also
#     tyCo/4 = CR10 Logger (9600 n 8)
#                 Belfort rain
#                 REBS Q7*, Rnet
#                 Licor, SOLDN
#                 REBS, SoilHF
#                 REBS, SoilT1-3
#                 REBS, CS615 SoilMois
#                 REBS, CS615 SoilMoisTime (raw data)
#     tyCo/5 = Baro, Polled, (1200 n 8)
#     tyCo/6 = GPS, clock update (1200 n 8)
#     A/D 0-3= Station Power, .5hz
#     A/D 4  = Tsfc .5hz (combined w/power ingest to save extra task)
#     A/D 5  = Krypton (H2O), 10Hz.
#
# NOTE: Rain Rate is calculated and provided by the logger for mm/hour.
#     The logger will send a once every 5-second msg and converting
#     from the .01" for each tip to mm/hr using the conversion factor:
#           .01 * 25.4 / 5 * 3600 = 182.9 mm/hr / tip
#
#------------------
# STATION / FORMAT / System LogFile Size
#
#
STATION_ID: 1

FORMAT:    6002

LOGFILE_SIZE: 25000

# Use reboot if we need to resynchronize for some
# reason.  Normally not needed.
#REBOOT: every 24:00:00 DELAY=00:00:30


#================================================
# Sensor bus Port / Items
#================================================
#
SIO: /tyCo/1 9600 none 8 rs485

#SBUS: name port  address rate [MAX_ERRORS=xx] [COMMAND=xxx] [TIMEOUT=seconds]


############################################### WIND -- RMY unit
SBUS: WIND /tyCo/1  0x12 1sec MAX_ERRORS=0
```

```
W: %f %d
SPD F
DIR I 1 0
:

DO: GETUAVG WIND.SPD WIND.DIR =Uavg
DO: GETVAVG WIND.SPD WIND.DIR =Vavg
DO: MAX WIND.SPD =max

MESG: WIND
Errors = %d\n\
Speed = %7.2f m/s   Dir = %7.1f deg  Uavg=%7.2f m/s  Vavg=%7.2f m/s\n\
MAX speed = %7.2f m/s\n
WIND/ERR
WIND.SPD
WIND.DIR
WIND.Uavg
WIND.Vavg
WIND.max
:

############################################## T_RH
SBUS: TRH /tyCo/1  0x01 5sec MAX_ERRORS=0
TRH%d %f %f
/ID
Tdry F
rh   F
:

DO: AVG TRH.Tdry
DO: AVG TRH.rh

MESG: TRH
ID = %d \n\
Errors = %d\n\
Tdry = %7.2f   rh = %7.2f\n
TRH/ID
TRH/ERR
TRH.Tdry
TRH.rh
:


#=============================================
# End of Sensor Bus Items
#=============================================



#-----------------------------------------------
# VAISALA barometer on /tyCo/5
#-----------------------------------------------
SIO: /tyCo/5 1200 none 8
POLL: VAIS /tyCo/5 5sec TIMEOUT=.5sec
\r\nSEND 1\r\n
B%u %f %f
/ID
PRES F
BOX_TEMP F
:

DO: AVG VAIS.PRES
DO: AVG VAIS.BOX_TEMP

MESG: Baro
Vaisala Pressure = %7.2f Box_temp = %7.2f\n\
        Status:\n\
          ID = %4d\n\
 ERROR COUNT = %4d\n
VAIS.PRES
VAIS.BOX_TEMP
VAIS/ID
VAIS/ERR
:



#-----------------------------------------------
# Logger  9600,n,8,1
#-----------------------------------------------

SIO: /tyCo/4 9600 none 8
SENSOR: LOGR asyncln /tyCo/4
%*d,%d,%f,%f,%f,%f,%f,%f,%f,%f,%f,%f,%f
/ID
TIP F
Rnet F
Soldn F
SoilHF1 F
SoilHF2 F
SoilHF3 F
SoilT1 F
SoilT2 F
SoilT3 F
SoilMois F
SoilMoisTime F



DO: AVG LOGR.Soldn
DO: AVG LOGR.Rnet
DO: AVG LOGR.SoilT1
DO: AVG LOGR.SoilT2
DO: AVG LOGR.SoilT3
DO: AVG LOGR.SoilHF1
DO: AVG LOGR.SoilHF2
```

```
DO: AVG LOGR.SoilHF3
DO: AVG LOGR.SoilMois
DO: AVG LOGR.SoilMoisTime

# Do rain rate in mm/hr
# Calculate mm total rate (mm/hr * 5sec*(1/3600 sec/hr))
DO: TOTAL LOGR.TIP
CREATE: ACCUM=multiplyC LOGR.TIP .00138888
DO: NZTOTAL LOGR.TIP.ACCUM


#
MESG: RAIN
Belfort Rain from Campbell Logger: \n\
%6.2f (mm/hr rate)  %5.2f (mm amount)   %6.2f (mm total accum.) \n
LOGR.TIP.TOTAL
LOGR.ACCUM
LOGR.ACCUM.NZTOTAL
:

MESG: Logger
Logger ID=%4d, Errors=%4d\n\
Rain  = %5.2f\n\
Rnet  = %7.1f W/SqM\n\
Soldn = %7.1f W/SqM\n\
Soil Temp. 1-3 = %6.2f  %6.2f  %6.2f degC \n\
Soil Heat Flux = %6.2f  %6.2f  %6.2f \n\
CS615 Moisture / Time = %.4g %%vol / %.4g\n
LOGR/ID
LOGR/ERR
LOGR.TIP
LOGR.Rnet
LOGR.Soldn
LOGR.SoilT1
LOGR.SoilT2
LOGR.SoilT3
LOGR.SoilHF1
LOGR.SoilHF2
LOGR.SoilHF3
LOGR.SoilMois
LOGR.SoilMoisTime
:



#-----------------------------------------------
# GPS on ttyCo/6
# Note: LAT/LONG are broken into integer and decimal portions to
#       keep all significant digits in data reporting.
# Note: Clock update every 3 hours
#-----------------------------------------------
SIO: /ttyCo/6 1200 none 8
```

```
SERIAL: GPS /ttyCo/6  GPS_CLOCK_UPDATE=3 MULTI_LINE
LINE=$GPRMC
$GPRMC,%*d,%*c,%2d%2d.%4d,%c,%3d%2d.%4d,%c,%*f,%*f,%*f,%f,%c
LATd I 1 0
LATm I 1 0
LATs I .006 0
LATns B 1 0
LONGd I 1 0
LONGm I 1 0
LONGs I .006 0
LONGew B 1 0
MAGN F
MAGNew B 1 0
:

# Combine into a real Lat/Lon
CREATE: LATdx=scale GPS.LATm .016666667 0
CREATE: LATdy=scale GPS.LATs .00027777778 0
CREATE: LATreal=add GPS.LATd GPS.LATdx
CREATE: LATreal=add GPS.LATreal GPS.LATdy

CREATE: LONGdx=scale GPS.LONGm .016666667 0
CREATE: LONGdy=scale GPS.LONGs .00027777778 0
CREATE: LONGreal=add GPS.LONGd GPS.LONGdx
CREATE: LONGreal=add GPS.LONGreal GPS.LONGdy


# Correct value for Hemisphere if needed
#       If north/south = S (83 decimal) negate
#       If east/west = W (87 decimal) negate
#       If magnetic declination east/west = W (87 decimal) negate
#
CREATE: MAGN=ifEQscale GPS.MAGNew GPS.MAGN 87 -1.0 0
CREATE: LATd=ifEQscale GPS.LATns GPS.LATd 83 -1.0 0
CREATE: LONGd=ifEQscale GPS.LONGew GPS.LONGd 87 -1.0 0
CREATE: LATreal=ifEQscale GPS.LATns GPS.LATreal 83 -1.0 0
CREATE: LONGreal=ifEQscale GPS.LONGew GPS.LONGreal 87 -1.0 0

DO: AVG GPS.LATreal =latavg
DO: AVG GPS.LONGreal =lonavg

MESG: GPS
LAT  = %.3g deg %.2g min %.4g sec  = %7.4g\n\
LONG = %.3g deg %.2g min %.4g sec  = %7.4g\n\
lat/lon avg = %7.4g %7.4g\n\
DECLINATION =%.4g (west is neg)\n\
 ERROR COUNT = %4d\n
GPS.LATd
GPS.LATm
GPS.LATs
GPS.LATreal
GPS.LONGd
GPS.LONGm
```

```
GPS.LONGs
GPS.LONGreal
GPS.latavg
GPS.lonavg
GPS.MAGN
GPS/ERR
:



#================================================
# Analog Sensor Declarations
#================================================

################################## ANALOG POWER
################################## with ANALOG Tsurface
#
# Need calibration for Everest? Range is -400mv to 1000mv = -40 to 100 degC
#
ANALOG: Ad .5Hz
Batt-v        0     1     0.02663       0
Charge-i      1     10    0.0454860     0
Load-i        2     100   0.00454860    0
Batt-temp     3     1     0.48852       -273.15
Tsfc          4     10    0.048852      0
:

DO: AVG Ad.Tsfc

DO: MIN Ad.Batt-v
DO: AVG Ad.Batt-v
DO: AVG Ad.Charge-i
DO: AVG Ad.Load-i
DO: MAX Ad.Load-i
DO: AVG Ad.Batt-temp

MESG: POWER
Power System\n\
Batt Volt = %7.2fv  Temp = %7.2f deg C\n\
Load Avg  = %7.3fA  Max  = %7.3fA\n\
Charging Current = %7.3fA\n\
Errors = %d\n
Ad.Batt-v
Ad.Batt-temp
Ad.Load-i
Ad.Load-i.MAX
Ad.Charge-i
Ad/ERR
:

MESG: TSFC
Everest Tsurface = %7.2f deg C   A/D errors = %d\n
Ad.Tsfc
Ad/ERR
:



#-----------------------------------------------------------------
#   Analog:  Krypton at 10Hz
#
# Note:
#      1) Calibrations/id of Krypton are usually
#      in a separate 'krypton.dat' file and loaded
#      <KRYPTON.DAT
#      Since Taiwan only has 1 sensor, we'll put
#      the actual cals in here instead.
#
# Output in milliVolts
#
#<KRYPTON.DAT
#-----------
ANALOG: Krypton 10Hz ID=1398
h2oV   5      1   4.8828    0
:

DO: AVG Krypton.h2oV =h2oVavg

# Subtract LN(V0)
# And Calculate:
# Y = AX+B  A = 1/(pathLength * Cal_KW)
#         B = - bias
# Use 'Clean' window, full vapor range
# Constant vo ln(mv), 1/coefficient XKw
# To give Result in moisture density (gm/m^3)
#
# Old Method
#CREATE: X=ln Krypton.h2oV
#CREATE: X=subtractC Krypton.X 8.434
#CREATE: h2o1=scale Krypton.X -5.46448087 0.0
#
# New Method maybe easier to understand calib values.

CREATE: lnVo=constant Krypton.h2oV 8.434
CREATE: path=constant Krypton.h2oV 1.262
CREATE: calxKw=constant Krypton.h2oV -.183

CREATE: X=ln Krypton.h2oV
CREATE: X=subtract Krypton.X Krypton.lnVo
CREATE: h2o=divide Krypton.X Krypton.calxKw

MESG: Krypton
Krypton = %6.2f mV  %6.2f gm/m^3\n\
ID=%d  A/D errors=%d\n\
```

```
Calib.; Windows clean, full range:\n\
  xKw=%6.3f  lnVo=%6.3f  path=%6.3f\n
Krypton.h2oV
Krypton.h2o
Krypton/ID
Krypton/ERR
Krypton.calxKw
Krypton.lnVo
Krypton.path
:

#=================================================
# End of Analog Sensor Items
#=================================================


#-------------------------------------------------
# Campbell CSAT3 SONIC
#
# 10-byte message output (5 16-bit words) and 2 Sync characters
# U V W Tc Range/Flags 55 AA
#
# Note the CSAT Code has embedded default declarations for...
# Uraw short small signed 0.001 0
# Vraw short small signed 0.001 0
# Wraw short small signed 0.001 0
# Tsonicraw short small signed 0.001 340
# cstat short small unsigned 1 0
# Note: Tsonicraw is converted to virtual temperature
#       in the ingest routine and reported in deg-C.
# CSAT: name port freq [SpdDir] [FASTOUT=%d]
#
# NOTE: Adjust BOOMDIR for proper alignment of sonic mount
#-------------------------------------------------
SIO: /tyCo/2 9600 none 8
CSAT: SONIC /tyCo/2 10 BOOMDIR=0
:

DO: COUNT SONIC.Wraw =cnt
DO: FREQ SONIC.Wraw =freq
DO: OR SONIC.cstat =csflags


# Flush out bad values.  The NCAR ingest of CSAT3
# generates -99.99 for hardware problems,
#
CREATE: U=minCheck SONIC.Uraw -99
CREATE: V=minCheck SONIC.Vraw -99
CREATE: W=minCheck SONIC.Wraw -99
CREATE: Tsonic=minCheck SONIC.Tsonicraw -99

#These averages will be done on the Synced data...
#DO: AVG SONIC.U =Uavg
#DO: AVG SONIC.V =Vavg
#DO: AVG SONIC.W =Wavg
#DO: AVG SONIC.Tsonic =Tsonicavg

# TO GENERATE / SAVE Vector Average WS/WD
# Uncomment these lines and move the
# output statements to the desired output
# statement
#
CREATE: offset=constant SONIC.Uraw 180.0
DO: GETWS SONIC.U SONIC.V =ws
DO: GETWD SONIC.U SONIC.V SONIC.offset =wd



MESG: CSAT
Raw:      U = %7.2f      V = %7.2f   W = %7.2f   Ts = %6.1fdeg-C\n\
Status:   cstat= %.0f   flags =%.0f\n\
Raw Sample Cnt = %.0f    Freq =%7.3f\n\
Errors: = %d\n
SONIC.Uraw
SONIC.Vraw
SONIC.Wraw
SONIC.Tsonicraw
SONIC.cstat
SONIC.csflags
SONIC.cnt
SONIC.freq
SONIC/ERR
:



#------------------ Despiker ------------------
# Count only, derived data isn't sent through
# ATI version: Doesn't use the synced stuff
# Despiker not used version.
# The VALx items are discarded out of the despike routine
# To make this a despiked version swap all VALx and VAL items
CREATE: Ux Uflag=despike SONIC.U 1e-5 2.5
CREATE: Vx Vflag=despike SONIC.V 1e-5 2.5
CREATE: Wx Wflag=despike SONIC.W 1e-5 2.5
CREATE: Tsonicx Tcflag=despike SONIC.Tsonic 1e-5 2.5

                ;

#-------------------------------------------------
# Sync
#-------------------------------------------------


SYNC: Sync10 10Hz
SONIC.U
SONIC.V
```

```
SONIC.W
SONIC.Tsonic
Krypton.h2o
:

# The covars
#
DO: COVAR Sync10.SONIC.U Sync10.SONIC.U =UU
DO: COVAR Sync10.SONIC.U Sync10.SONIC.V =UV
DO: COVAR Sync10.SONIC.U Sync10.SONIC.W =UW
DO: COVAR Sync10.SONIC.U Sync10.SONIC.Tsonic =UTs
DO: COVAR Sync10.SONIC.U Sync10.Krypton.h2o  =Uh2o

DO: COVAR Sync10.SONIC.V Sync10.SONIC.V =VV
DO: COVAR Sync10.SONIC.V Sync10.SONIC.W =VW
DO: COVAR Sync10.SONIC.V Sync10.SONIC.Tsonic =VTs
DO: COVAR Sync10.SONIC.V Sync10.Krypton.h2o =Vh2o

DO: COVAR Sync10.SONIC.W Sync10.SONIC.W =WW
DO: COVAR Sync10.SONIC.W Sync10.SONIC.Tsonic =WTs
DO: COVAR Sync10.SONIC.W Sync10.Krypton.h2o =Wh2o

DO: COVAR Sync10.SONIC.Tsonic Sync10.SONIC.Tsonic =TsTs
DO: COVAR Sync10.Krypton.h2o Sync10.Krypton.h2o =h2oh2o

DO: AVG Sync10.SONIC.U =Uavg
DO: AVG Sync10.SONIC.V =Vavg
DO: AVG Sync10.SONIC.W =Wavg
DO: AVG Sync10.SONIC.Tsonic =Tsavg
DO: AVG Sync10.Krypton.h2o =h2oavg

DO: COUNT Sync10.Krypton.h2o =h2oCnt
DO: FREQ Sync10.Krypton.h2o =h2oFrq
DO: COUNT Sync10.SONIC.U =UCnt
DO: FREQ Sync10.SONIC.U =UFrq


# The FLUX message is for checking the data synchronization.
MESG: FLUX
Synced Flux Calculation Rate:\n\
Raw  Sonic  Counts = %7.4g   Freq = %7.4g Hz\n\
Sync  Sonic  Counts = %7.4g   Freq = %7.4g Hz\n\
Sync Krypton Counts = %7.4g   Freq = %7.4g Hz\n
SONIC.cnt
SONIC.freq
Sync10.UCnt
Sync10.UFrq
Sync10.h2oCnt
Sync10.h2oFrq
:
```

```
#-----------------------------------------------


MESG: STATUS
Sensor    Errors  Status\n\
Wind      %3d \n\
T-rh      %3d     %#x\n\
Sonic     %3d \n\
Krypton   %3d \n\
slowAD    %3d \n\
Barometer %3d \n\
Logger    %3d \n\
Gps       %3d \n
WIND/ERR
TRH/ERR
TRH/STAT
SONIC/ERR
Krypton/ERR
Ad/ERR
VAIS/ERR
LOGR/ERR
GPS/ERR
:

MESG: SYSTEM
SYSTEM STATUS\n\
\tStation Num = %d  Config Format = %d\n\
\tBatt Volt = %4.1f\n\
\tC Errors  = %4d\n\
\tVersion   = %4d\n\
\tWatchdog  = %4d\n
/STATION_ID
/FORMAT
Ad.Batt-v
/C_ERRORS
/VERSION
/WATCHDOG
:



# Commutating STATUS value/index
# NOTE: predefined values in EVE Man.
# NOTE: At least for testing purposes, store the error counts every
#       OUTPUT in the SLOW_DATA message rather than commutate here
#
#   param # or name = sensor-data/status {1...8} optional_bias optional_offset

STATUS:
# A sensor data value may be used as a status value. Bias and offset values
# should be provided.  The battery voltage shown below would become 13
```

```
# if it were 13.8.  A multiplier of 10 allows the value 138 to be used instead
#BATT_V=Ad.BATT_V  1  10.0 0.
PRES_ERR=VAIS/ERR 1
T_RH_ERR=TRH/ERR 1
WIND_ERR=WIND/ERR 1
30=SONIC/ERR 1
31=GPS/ERR 1
32=Ad/ERR 1
33=LOGR/ERR 1
WATCHDOG 1
C_ERRORS 1
#
PRES_ID=VAIS/ID 2
T_RH_ID=TRH/ID 2
VERSION 2
34=Krypton/ID 2
FORMAT 2
VISIT -2
:



#-------------------------------------------------------------------------
#                    DATA OUTPUT COMMANDS.
#-------------------------------------------------------------------------


# Rad and Met Data Combined here
#
OUTPUT: MET_DATA 300 sec ASCII
 %2d %4d \
%7.2f %7.2f \
%7.2f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f \
%7.2f %7.2f \
%6.1f %6.1f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f %6.2f
#
# Special data names to get status info
@IstatusIdNext U 6 1 0          lname="id.status"
@IstatusValue N 12 1 0          lname="value.status"
#
GPS.latavg S 16 100 0           lname="latitude"        lunits="deg"    llong_name="Degrees N Latitude"
GPS.lonavg S 16 100 0           lname="longitude"       lunits="deg"    llong_name="Degrees E Longitude"
#
VAIS.PRES.AVG S 16 100 -85000   lname="P"       lunits="mbar"   llong_name="Pressure"
TRH.Tdry.AVG S 16 200 0         lname="T"       lunits="degC"   llong_name="Temperature"
TRH.rh.AVG U 12 20.0 0          lname="RH"      lunits="%"
LOGR.TIP.TOTAL U 6 1 0          lname="rainr.mri"       lunits="mm/hr"  llong_name="TIP rain rate"
LOGR.ACCUM.NZTOTAL U 12 1 0     lname="raina.mri"       lunits="mm"     llong_name="TIP rain
accumulation"
WIND.Vavg S 12 25.0 0           lname="V"       lunits="m/s"    llong_name="PropVane"
WIND.Uavg S 12 25.0 0           lname="U"       lunits="m/s"    llong_name="PropVane"
WIND.max S 12 25.0 0            lname="Spdmax"  lunits="m/s"    llong_name="PropVane"
#
```

```
# Sonic Vector Average Ws/Wd
SONIC.ws S 16 50.0 0    lname="ws"      lunits="m/s"    llong_name="Sonic speed"
SONIC.wd S 16 10.0 0    lname="wd"      lunits="m/s"    llong_name="Sonic dir"
# Rad Stuff
LOGR.Rnet.AVG S 12 3 0          lname="Rnet"    lunits="W/m^2"  llong_name="Net radiation"
LOGR.Soldn.AVG S 12 1 0         lname="Rsw.in"  lunits="W/m^2"  llong_name="Licor Pyranometer"
LOGR.SoilT1.AVG S 12 10 0       lname="Tsoil1"  lunits="degC"   llong_name="Soil Temp 1"
LOGR.SoilT2.AVG S 12 10 0       lname="Tsoil2"  lunits="degC"   llong_name="Soil Temp 2"
LOGR.SoilT3.AVG S 12 10 0       lname="Tsoil3"  lunits="degC"   llong_name="Soil Temp 3"
LOGR.SoilHF1.AVG S 12 10 0      lname="Gsoil1"  lunits="W/m^2"  llong_name="Soil HeatFlux1"
LOGR.SoilHF2.AVG S 12 10 0      lname="Gsoil2"  lunits="W/m^2"  llong_name="Soil HeatFlux2"
LOGR.SoilHF3.AVG S 12 10 0      lname="Gsoil3"  lunits="W/m^2"  llong_name="Soil HeatFlux3"
LOGR.SoilMois.AVG S 12 20 0     lname="Qsoil"   lunits="% vol"  llong_name="CS615 Soil Moisture"
LOGR.SoilMoisTime.AVG S 12 1000 -2047   lname="Qsoil"   lunits="msec"   llong_name="CS615 Soil
Moisture raw time"
Ad.Tsfc.AVG S 12 20 0           lname="Tsfc"    lunits="degC"   llong_name="Everest 4000.4GL surface
temp"
:



OUTPUT: SYS 300 sec ASCII
%5.1f %5.1f %5.1f %5.1f %5.1f \
%d %d %d %d %d %d %d %d %d %d
Ad.Batt-v.AVG  S 12 100 0       lname="vdc.batt"        llong_name="battery Voltage"    lunits="VDC"
Ad.Charge-i.AVG S 12 100 0      lname="i.batt"          llong_name="charging Current"   lunits="Amps"
Ad.Load-i.AVG  S 12 200 0       lname="i.load"          llong_name="load Current"       lunits="Amps"
Ad.Batt-temp.AVG S 12 10 0      lname="Tbatt"           llong_name="battery Temp"       lunits="degC"
VAIS.BOX_TEMP.AVG S 12 50 -500  lname="Tbox.eve"        llong_name="box temp status"
lunits="degC"
#
/VERSION U 12 1 0           lname="version"         lunits="chksum" llong_name="version status"
/WATCHDOG U 12 1 0          lname="watchdog"        lunits="cnt"    llong_name="watchdog"
/C_ERRORS U 12 1 0          lname="err.softw"       lunits="cnt"    llong_name="C_errors"
VAIS/ERR U 12 1 0           lname="err.baro"        lunits="cnt"    llong_name="Barometer errors"
TRH/ERR U 12 1 0            lname="err.trh"         lunits="cnt"    llong_name="Trh errors"
SONIC/ERR U 12 1 0          lname="err.sonic"       lunits="cnt"    llong_name="Sonic errors"
LOGR/ERR  U 12 1 0          lname="err.logr"        lunits="cnt"    llong_name="Logger errors"
WIND/ERR U 12 1 0           lname="err.wind"        lunits="cnt"    llong_name="Wind errors"
GPS/ERR U 12 1 0            lname="err.gps"         lunits="cnt"    llong_name="GPS errors"
Ad/ERR  U 12 1 0            lname="err.slowAD"      lunits="cnt"    llong_name="Slow A/D errors"
:



OUTPUT: FLUX_DATA 300 sec ASCII
%4.0f \
%6.2f %6.2f %7.2f %7.2f %7.2f %6.2f \
%9.4f %9.4f %9.4f %9.4f %9.4f %9.4f %9.4f %9.4f %9.4f %9.4f \
%9.4f %9.4f %9.4f %9.4f \
%4.0f %5.1f %4.0f %5.1f \
%4.0f %4.0f %4.0f %4.0f
#
```

```
# CSAT Sonic flags, range =0-15
SONIC.csflags S 12 1 0        lname="csatflags"      lunits="cnt"   llong_name="CSAT3 flags max"
lcounts="counts.sonic"
#
# Averages performed on the synced data
Krypton.h2oVavg S 12 2048 0    lname="volt.h2o" lunits="mV"   llong_name="Krypton Vavg"
lcounts="counts.krypton"
Sync10.h2oavg S 16 1000 -30000 lname="h2o"     lunits="gm/m^3" llong_name="Krypton"
lcounts="counts.krypton"
Sync10.Uavg S 16 500.0 0       lname="u"       lunits="m/s"   llong_name="Sonic Uwind"
lcounts="counts.sonic"
Sync10.Vavg S 16 500.0 0       lname="v"       lunits="m/s"   llong_name="Sonic Vwind"
lcounts="counts.sonic"
Sync10.Wavg S 16 1000.0 0      lname="w"       lunits="m/s"   llong_name="Sonic Wwind"
lcounts="counts.sonic"
Sync10.Tsavg S 16 200 0        lname="tc"      lunits="degC"  llong_name="Sonic Virtual Temperature"
lcounts="counts.sonic"
#
#.Covars Performed on the Synced data
#
Sync10.UU S 18 4000 0          lname="u'u'"          lunits="m^2/s^2"      lcounts="counts.sonic"
Sync10.UV S 18 4000 0          lname="u'v'"          lunits="m^2/s^2"      lcounts="counts.sonic"
Sync10.UW S 18 4000 0          lname="u'w'"          lunits="m^2/s^2"      lcounts="counts.sonic"
Sync10.UTs S 18 10000 0        lname="u'tc'"         lunits="m/s degC"     lcounts="counts.sonic"
Sync10.Uh2o S 18 4000 0        lname="u'h2o'"        lunits="m/s g/kg"     lcounts="counts.rh2o"
Sync10.VV S 18 4000 0          lname="v'v'"          lunits="m^2/s^2"      lcounts="counts.sonic"
Sync10.VW S 18 4000 0          lname="v'w'"          lunits="m^2/s^2"      lcounts="counts.sonic"
Sync10.VTs S 18 10000 0        lname="v'tc'"         lunits="m/s degC"     lcounts="counts.sonic"
Sync10.Vh2o S 18 4000 0        lname="v'h2o'"        lunits="m/s g/kg"     lcounts="counts.rh2o"
Sync10.WW S 18 4000 0          lname="w'w'"          lunits="m^2/s^2"      lcounts="counts.sonic"
#
Sync10.WTs S 18 10000 0        lname="w'tc'"         lunits="m/s degC"     lcounts="counts.sonic"
Sync10.Wh2o S 18 4000 0        lname="w'h2o'"        lunits="m/s g/kg"     lcounts="counts.rh2o"
Sync10.TsTs S 18 2000 0        lname="tc'tc'"        lunits="degC^2"       lcounts="counts.sonic"
Sync10.h2oh2o S 18 4000 0      lname="h2o'h2o'"      lunits="g^2/kg^2"     lcounts="counts.rh2o"
#
#
Sync10.UCnt U 12 1 0           lname="counts.Uraw"   lunits="cnt"   llong_name="Unsynced Sonic Tc
Counts
Sync10.UFrq U 12 100 0         lname="freq.Uraw"     lunits="Hz"    llong_name="Unsynced Sonic Tc
Freq"
Sync10.h2oCnt U 12 1 0         lname="counts.h2o"    llong_name="Synced h2o Samples" lunits=" "
Sync10.h2oFrq U 12 100 0       lname="freq.h2o"      llong_name="Synced h2o Freq"   lunits="Hz"
#
# The "counts=" attribute must be the same for all stations
SONIC.Uflag U 12 1.0 0         lname="uflag"  lunits=" "     llong_name="U spikes"
lcounts="counts.sync"
SONIC.Vflag U 12 1.0 0         lname="vflag"  lunits=" "     llong_name="V spikes"
lcounts="counts.sync"
SONIC.Wflag U 12 1.0 0         lname="wflag"  lunits=" "     llong_name="W spikes"
lcounts="counts.sync"
SONIC.Tcflag U 12 1.0 0        lname="tcflag" lunits=" "     llong_name="Tc spikes"
lcounts="counts.sync"
```

```
#=============================================================================

#-----------------------------------------------------------------------
#     ACTUAL COMMANDS TO SEND THE DATA SOMEWHERE
#-----------------------------------------------------------------------

# Note: Cannot save 'sys.ascii'
#     because the size of this ascii.dat file would exceed what's
#     available.  May need to adjust "%f's"
FILE: ASCII.DAT day each 00:05:00 qty 1 SOURCE=1 CARDCOPY
MET_DATA.ASCII
FLUX_DATA.ASCII
SYS.ASCII
:


# Port TyCo/3 for Auxconsole and to
# Send Ascii Data every 5 minutes
#
# This permits the RS232/485 communications
# or in the future, a freewave radio
#
SIO: /tyCo/3 9600 none 8
AUXCONSOLE: /tyCo/3

FILE: /tyCo/3 ALL each 00:05:00 qty 1 SOURCE=2
MET_DATA.ASCII
FLUX_DATA.ASCII
SYS.ASCII
:
```

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(CR10 程式)

```
;{CR10X}
; PROGRAM:  TAIWAN PLATFORM
; This software is based off the standard PAMIII flux station.
; The logger hardware is configured the same as the PAMIII; however,
; the Taiwan system does not use all the channels.
;
; CR10 CHANNEL ASSIGNMENTS
; ANALOG CHANNELS
;       1H - comm 1H of AM416
;       1L - comm 1L of AM416
;       2H - comm 2H of AM416
;       2L - comm 2L of AM416
;
;       3H -    + Q7 net radiation
;       3L -    -
;
;       4H -    LICOR 200-SA
;       4L -          -
;
;       11S - soil moisture, CS615  (channel 6H)
;
;
; EXCITATION CHANNELS
;       E3 - excitation for T soil probe
;
; PULSE CHANNELS
;       P1 - ETI rain gauge
;
; NOTE:  The rain count is multiplyed by 182.88. This gives
;       an output rainrate of mm/hr.
;       25.4 (ml/inch) * .01 (inch/count) * 3600 (secs/hr) / 5 (sec)
;
;
; CONTROL PORTS
;       C1 - reset signal to AM416
;       C2 - clock to AM416
;       C3 - control to soil moisture CS-615
;
; AM416 MULTIPLEXER CHANNELS
;       1-1H    Tsoil1
;       1-1L
;       1-2H
;       1-2L
;
;       2-1H    Tsoil2
;       2-1L
;       2-2H
;       2-2L
;
;       3-1H    Tsoil3
;       3-1L
;       3-2H
;       3-2L
;
;       4-1H    + HFT1
;       4-1L    -
;
;       4-2H    + HFT2
;       4-2L    -
;
;       5-1H    + HFT3
;       5-1L    -
;
; OUTPUT MESSAGE FORMAT
;       LOGGER #
;       rainfall
;       Q7
;       licor
;       Heat Flux 1
;       Heat Flux 2
;       Heat Flux 3
;       Tsoil 1
;       Tsoil 2
;       Tsoil 3
;       CS615 volumeteric water content
;       CS615 period
;       <CRLF>
;
; NOTE: The volumetric water content values are computed
;       using calibration coefficients with electrical conductivity
;       <= 1.0. The user should refer to the CS615 manual for
;       additional information. These coefficients are stored in
;       locations 45 thru 47. Compensation for temperature is not
;       applied.

; EEROM  SPACE USED FOR CALIBRATION COEFFICIENTS

;location     value       Serial Number   description
;  0          xxxx                        logger ID
;  1          9.4         Q99257          Q7 positive output  W/m^2/mV
;  2          11.59                       negative output
;  3          -76.6       PY34650         Licor LI-200SA, (-11.26/147) * 1000
;  5          38.8        H993559         REBS Heat Flux Transducer, W/m^2/mV
;  6          38.6        H013119         REBS Heat Flux Transducer, W/m^2/mV
;  7          36.2        H013120         REBS Heat Flux Transducer, W/m^2/mV
;  10         -241.620216 STP99239        Tsoil1, A0
;  11         231.720496                  A1
;  12         10.088405   ;               A2
;  13         -242.7375   STP01007        Tsoil2, A0
;  14         232.3767                    A1
;  15         9.254419                    A2
;  16         -243.9552   STP01008        Tsoil3, A0
;  17         235.9004                    A1
;  18         8.213751                    A2
;  20         -0.187      .               CS615 Soil Moisture, A0
;  21         0.037                       A1
```

```
;  22       0.335                  A2
;
*Table 1 Program
 01: 1.0      Execution Interval (seconds)

1: Z=F (P30)
 1: 0       F @@0
 2: 00      Exponent of 10
 3: 10      Z Loc [ LoggerID  ]

;  get rain tips from Belfon

2:  Pulse (P3)
 1: 1       Reps
 2: 1       Pulse Input Channel
 3: 2       Switch Closure
 4: 11      Loc [ BELrain   ]
 5: 182.88  Mult
 6: 0.0     Offset

; get Q7 data
3:  Volt (Diff) (P2)
 1: 1       Reps
 2: 4       ?250 mV Slow Range
 3: 3       DIFF Channel
 4: 12      Loc [ Q7        ]
 5: 1.0     Mult
 6: 0.0     Offset

; get Licor data
4:  Volt (Diff) (P2)
 1: 1       Reps
 2: 4       ?250 mV Slow Range
 3: 4       DIFF Channel
 4: 13      Loc [ licor     ]
 5: 1.0     Mult
 6: 0.0     Offset

;  now, get data from the multiplexer
5:  Do (P86)
 1: 41      Set Port 1 High

; get Tsoil data
6:  Beginning of Loop (P87)
 1: 0000    Delay
 2: 3       Loop Count

7:  Do (P86)
 1: 72      Pulse Port 2

8:  Excitation with Delay (P22)
 1: 1       Ex Channel
 2: 0       Delay W/Ex (units = 0.01 sec)
 3: 1       Delay After Ex (units = 0.01 sec)
 4: 0       mV Excitation

; get Tsoil1 thru Tsoil3

9:  Full Bridge w/mv Excit (P9)
 1: 1       Reps
 2: 3       ?25 mV Slow Ex Range
 3: 3       ?25 mV Slow Br Range
 4: 1       DIFF Channel
 5: 1       Excite all reps w/Exchan 1
 6: 2100    mV Excitation
 7: 30   -- Loc [ Ts1_raw   ]
 8: 1.0     Mult
 9: 0.0     Offset

10:  End (P95)

;  get Heat Flux data
11:  Beginning of Loop (P87)
 1: 0000    Delay
 2: 2       Loop Count

12:  Do (P86)
 1: 72      Pulse Port 2

13:  Excitation with Delay (P22)
 1: 1       Ex Channel
 2: 0       Delay W/Ex (units = 0.01 sec)
 3: 1       Delay After Ex (units = 0.01 sec)
 4: 0       mV Excitation

14:  Volt (Diff) (P2)
 1: 1       Reps
 2: 3       ?25 mV Slow Range
 3: 1       DIFF Channel
 4: 33   -- Loc [ HFT1_raw  ]
 5: 1.0     Mult
 6: 0.0     Offset

15:  Volt (Diff) (P2)
 1: 1       Reps
 2: 3       ?25 mV Slow Range
 3: 2       DIFF Channel
 4: 35   -- Loc [ HFT2_raw  ];
 5: 1.0     Mult
 6: 0.0     Offset

16:  End (P95)

17:  Do (P86)
 1: 51      Set Port 1 Low
```

```
; get soil moisture

18: Do (P86)
 1: 43      Set Port 3 High

19: Excitation with Delay (P22)
 1: 1       Ex Channel
 2: 0       Delay W/Ex (units = 0.01 sec)
 3: 1       Delay After Ex (units = 0.01 sec)
 4: 0       mV Excitation

20: Period Average (SE) (P27)
 1: 1       Reps
 2: 4       2 V Peak to Peak/200 kHz Max. Freq.
 3: 11      SE Channel
 4: 10      No. of Cycles
 5: 5       Timeout (units = 0.01 seconds)
 6: 21      Loc [ SM1_P     ]
 7: .001    Mult
 8: 0.0     Offset

21: Do (P86)
 1: 53      Set Port 3 Low

; convert raw data to calibrated information

; Q7 convert

22: Do (P86)
 1: 1       Call Subroutine 1

; licor

23: Z=X*F (P37)
 1: 13      X Loc [ licor     ]
 2: 0.0     F @@3
 3: 13      Z Loc [ licor     ]

; REBS HFTs

24: Z=X*F (P37)
 1: 33      X Loc [ HFT1_raw  ]
 2: 0.0     F @@5
 3: 14      Z Loc [ HFT1      ]

25: Z=X*F (P37)
 1: 35      X Loc [ HFT2_raw  ]
 2: 0.0     F @@6
 3: 15      Z Loc [ HFT2      ]

26: Z=X*F (P37)
 1: 34      X Loc [ HFT3_raw  ]
 2: 0.0     F @@7
 3: 16      Z Loc [ HFT3      ]

; compute Tsoils

27: Polynomial (P55)
 1: 1       Reps
 2: 30      X Loc [ Ts1_raw   ]
 3: 17      F(X) Loc [ Tsoil1 ]
 4: 0.0     C0 @@10
 5: 0.0     C1 @@11
 6: 0.0     C2 @@12
 7: 0.0     C3
 8: 0.0     C4
 9: 0.0     C5

28: Polynomial (P55)
 1: 1       Reps
 2: 31      X Loc [ Ts2_raw   ]
 3: 18      F(X) Loc [ Tsoil2 ]
 4: 0.0     C0 @@13
 5: 0.0     C1 @@14
 6: 0.0     C2 @@15
 7: 0.0     C3
 8: 0.0     C4
 9: 0.0     C5

29: Polynomial (P55)
 1: 1       Reps
 2: 32      X Loc [ Ts3_raw   ]
 3: 19      F(X) Loc [ Tsoil3 ]
 4: 0.0     C0 @@16
 5: 0.0     C1 @@17
 6: 0.0     C2 @@18
 7: 0.0     C3
 8: 0.0     C4
 9: 0.0     C5

; compute water moisture content

30: Polynomial (P55)
 1: 1       Reps
 2: 21      X Loc [ SM1_P     ]
 3: 20      F(X) Loc [ SM1_V  ]
 4: 0.0     C0 @@20
 5: 0.0     C1 @@21
 6: 0.0     C2 @@22
 7: 0.0     C3
 8: 0.0     C4
 9: 0.0     C5

; Is it time to send data out?

31: Time (P18)
```

```
 1: 00      Option
 2: 5       Mod/By
 3: 2       Loc [ TimeHack  ]

32:  IF (X<=>F) (P89)
 1: 2       X Loc [ TimeHack  ]
 2: 4       <
 3: 1       F
 4: 10      Set Output Flag High

33:  Sample (P70)
 1: 1       Reps
 2: 10      Loc [ LoggerID  ]

34:  Resolution (P78)
 1: 1       High Resolution

35:  Totalize (P72)
 1: 1       Reps
 2: 11      Loc [ BELrain   ]

36:  Average (P71)
 1: 10      Reps
 2: 12      Loc [ Q7        ]

37:  Serial Out (P96)
 1: 52      Printer Comma/9600 Baud


*Table 2 Program
  02: 0.0      Execution Interval (seconds)

*Table 3 Subroutines

1:  Beginning of Subroutine (P85)
 1: 1       Subroutine 1

;  calibrate value of net rad based on sign

2:  IF (X<=>F) (P89)
 1: 12      X Loc [ Q7      ]
 2: 4       <
 3: 0       F
 4: 30      Then Do

3:  Z=X*F (P37)
 1: 12      X Loc [ Q7      ]
 2: 0       F @@2
 3: 12      Z Loc [ Q7      ]

4:  Else (P94)

5:  Z=X*F (P37)
 1: 12      X Loc [ Q7      ]
 2: 0       F @@1
 3: 12      Z Loc [ Q7      ]

6:  End (P95)

7:  End (P95)

End Program

-Input Locations-
1 V_Vx      1 0 0
2 TimeHack  1 1 1
3 _________ 1 0 0
4 _________ 0 0 0
5 _________ 0 0 0
6 _________ 0 0 0
7 _________ 0 0 0
8 _________ 0 0 0
9 _________ 0 0 0
10 LoggerID  1 1 1
11 BELrain   1 1 1
12 Q7        5 4 3
13 licor     9 2 2
14 HFT1      9 0 1
15 HFT2      1 0 1
16 HFT3      1 0 1
17 Tsoil1    9 0 1
18 Tsoil2    1 0 1
19 Tsoil3    1 0 1
20 SM1_V     17 1 1
21 SM1_P     1 0 1
22 _________ 0 0 0
23 _________ 0 0 0
24 _________ 0 0 0
25 _________ 0 0 0
26 _________ 0 0 0
27 _________ 0 0 0
28 _________ 0 0 0
29 _________ 0 0 0
30 Ts1_raw   1 1 1
31 Ts2_raw   1 1 0
32 Ts3_raw   1 1 0
33 HFT1_raw  1 1 1
34 HFT3_raw  1 1 0
35 HFT2_raw  1 1 1
36 dummy     0 0 0
-Program Security-
0000
0000
0000
-Mode 4-
0
```

1
2
3
5
6
7
10
11
12
13
14
15
16
17
18
20
21
22
-Final Storage Area 2-
0
-CR10X ID-
0
-CR10X Power Up-
3