Logging the Instromet sunshine sensor

Sensor description

Instromet are a supplier of weather instruments based in Norfolk, England. Over the past decade or so this simple, reliable, consistent and reasonably-priced sensor (**Figure 1**) has become the sunshine sensor of choice for most of the amateur and hobbyist weather observing community within the UK and Ireland.

The sensor unit is small and light, easy to fix to a mast or rooftop, and relatively undemanding in alignment requirements, needing only to be aligned level and pointing approximately south (in the northern hemisphere). To reduce loss through shadowing, it should be exposed with as clear a view of the sky as possible, typically from a suitable mast or open rooftop position. Once in place, it needs little or no maintenance, although if the unit is safely accessible it is advisable occasionally to check the glass dome for bird droppings and the like, and give it a wipe from time-to-time.

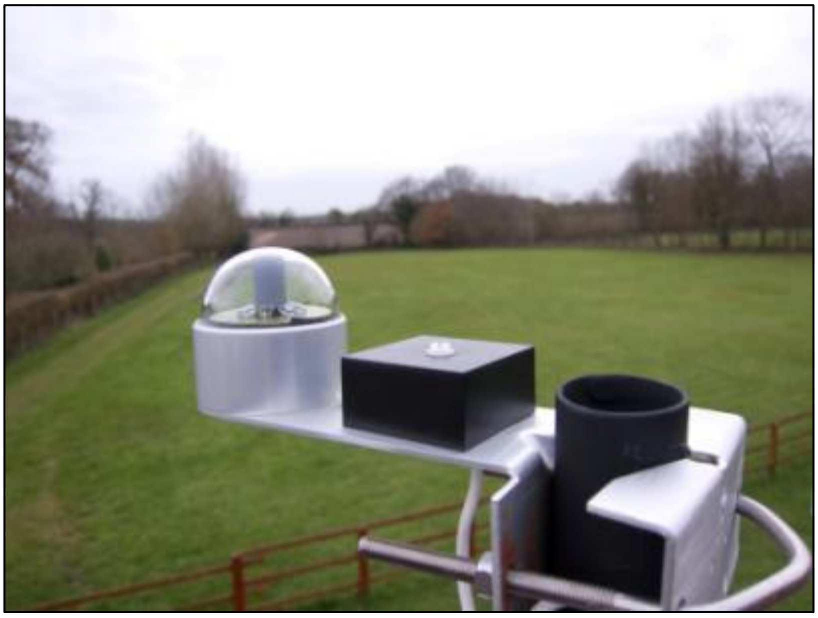

Figure 1 *The Instromet sunshine sensor*

It is suitable for either standalone recording (it comes as standard with a digital display recording to 0.01 h), or for interfacing to a suitable datalogger (both voltage and square-wave pulsed outputs are available, as described below).

As shipped, the Instromet sunshine duration sensor (Figure 1) includes a small digital display unit, giving a read-out of sunshine duration (daily and cumulative) to 0.01 h, with manual reset buttons for each. The electronics module (**Figure 2**) includes two digital outputs which are more logger-friendly.

This note describes how to log sunshine records by interfacing this sensor to a suitable logger. Note however that most pre-built consumer AWSs do not include a 'spare' pulse counter input, and therefore a programmable logger will normally be required for this purpose. The instructions below assume a Campbell Scientific datalogger, but the principles apply to other types too.

Wiring

The sensor and electronics module should be installed per the manufacturer's instructions; the sensor should be installed in an open location, with maximum possible exposure to the path of the solar disk at all times of the year.

The unit as supplied includes 25 m of four-core unscreened data cable (12 v supply and signal) which should be connected to the colour-coded connectors in the electronics module (see **Figure 2**). The electronics module is not weatherproof, and should be located indoors.

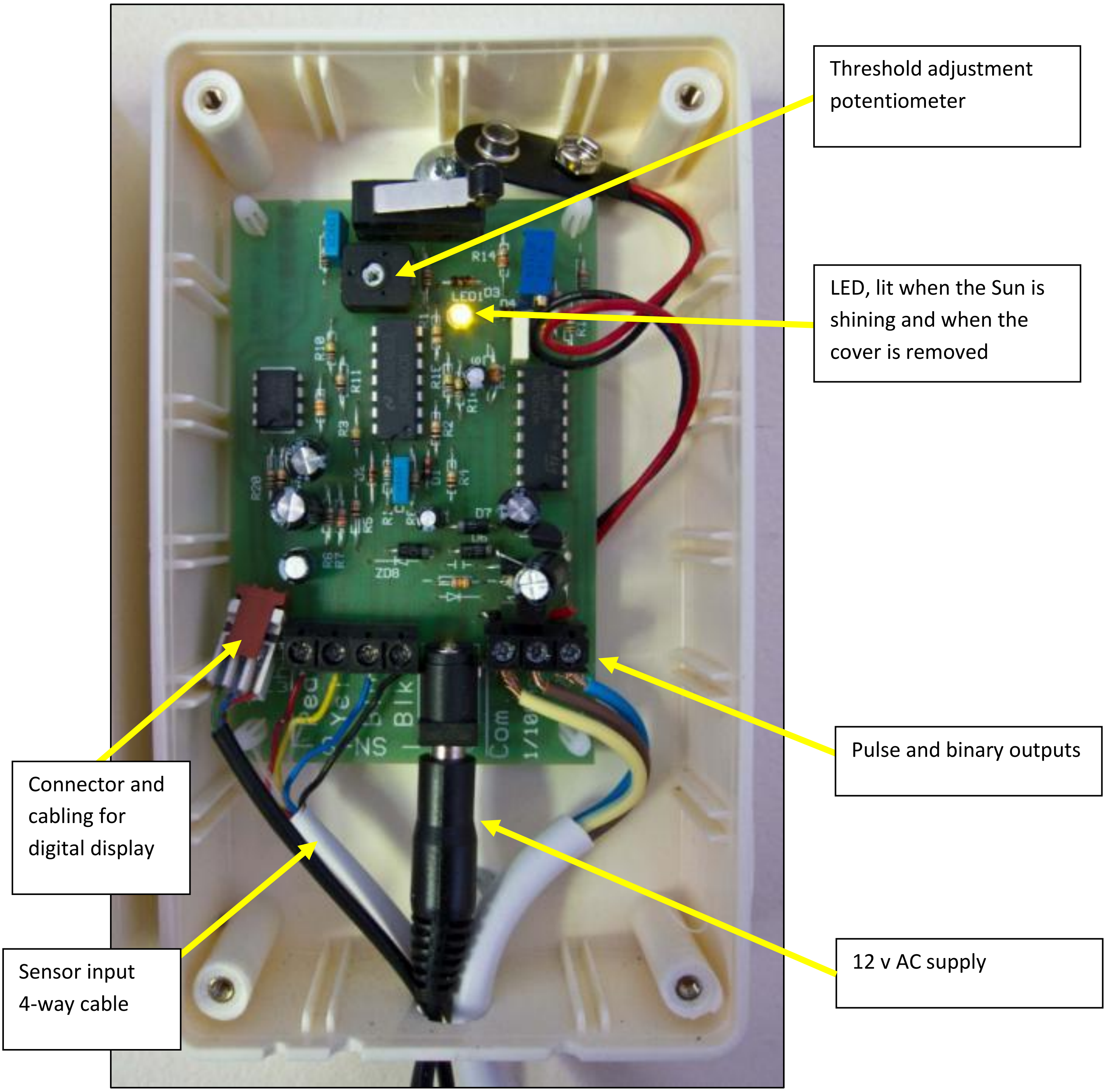

Figure 2 *The Instromet sunshine sensor electronics module. Note that the cable used here for the pulse and binary outputs is standard mains cable, but it is NOT carrying mains voltages*

The display unit is connected to the electronics module using a small four-way connector (**Figure 2**). Assuming that the main data feed will be from logged output, it is not essential that the display unit be connected, although the regular incrementing of the display in sunshine (every 36 s / 0.01 h) does provide a convenient visual check that the unit is working satisfactorily.

Logger output

The electronics module provides three terminals for two digital output options, labelled **Comm** (Common), **1/100** (pulse output) and **1/0** (binary output). The response time of the combined sensor/electronics unit is about 1 s.

Pulse output option – the 1/100 connection

A connection across Comm and 1/100 will provide 5 v pulses at 0.01 h intervals in sunshine. These pulses can be fed to any logger with suitable pulse input capability.

- On a Davis AWS, this can replace the tipping-bucket raingauge input if required (set calibration to 0.01 units). Note that there is no easy way of altering the Davis datalogging software to identify the input as ‘sunshine’ rather than ‘rainfall’, however, although this may be possible on third-party options.
- On a Campbell Scientific CR10X logger, the code shown in **Appendix 1** will log, total and output the pulses from the sensor.

Note that where the logging interval is not an exact multiple of 0.01 h, some pulses will be ‘split’ across two logging intervals. For example, at a logging interval of 5 min, continuous sunshine will be logged as two 0.08 h and one 0.09 h ‘counts’ in every 15 minutes (total 0.25 h).

Minimum duration of sunshine

As pulses are generated only every 36 s, a spell of sunshine shorter than this will not be recorded. Although over a period of weeks or months the total effect will be small, on days with short spells of fleeting sunshine it is possible for the instrument to record little or no sunshine despite visual or other instrumental evidence of this. The binary output method, described below, will record sunshine of as little as 1 s duration, and for this reason is the preferred method of logging the Instromet sensor.

Binary output option – the 1/0 connection

This is the preferred method of logging the output from this device.

A connection across Comm and 1/0 will provide continuous 5 v output when the sun is shining, and 0 v otherwise. Using a datalogger with a short-duration voltage measurement enables the binary output to be checked at every polling interval, and so a suitable short polling interval combined with the fast response time of the sensor enables the logging of very short spells of sunshine. A polling interval of 1 s will be sufficient for almost all purposes; shorter than this is not justified with the sensor response time of ~ 1 s, while longer polling intervals increase the risk of missing short spells of sunshine.

- On Campbell Scientific CR10X or CR1000 loggers, the code shown in **Appendix 1** will log, total and output the binary signal from the sensor to provide 1 s resolution sunshine data.
- If required, hourly totals in thousandths of an hour can be derived by dividing this by 3600 (3600 seconds in 1 h). This is also shown in the output coding.
- Note that the Campbell logger integer handling will sum only to 6999 counts, which is sufficient for hourly totals but insufficient for daily records. The author's practice is to use the datalogger only for hourly and sub-hourly totals (1 min resolution, seconds of sunshine) and to use a spreadsheet to sum daily totals in post-processing; alternatively a full-length integer variable can be specified as the variable name in the logger software.

Dropping the output voltage

The sensor's binary output is 5 v, which is convenient for powering an external indicator device, such as lighting a suitable LED to indicate 'sunshine' (if one is required, connect across 'Comm' and 1/0). Note however that a Campbell logger can accept only a maximum input signal of 2.5 v, and therefore the output signal must be reduced to avoid damaging the logger. This is easily achieved using a simple potential divider circuit, as shown in **Figure 3**. The resistors shown will reduce the binary output signal to approx 1.6 v, but the actual value of this voltage (and thus the resistors) is not critical as the code shown for the Campbell logger triggers the count only above a specified voltage threshold – here, 500 mv is used, but any suitable value within the logger's input specification can be chosen, provided the trigger level is set high enough to eliminate any spurious counts from minor electrical noise.

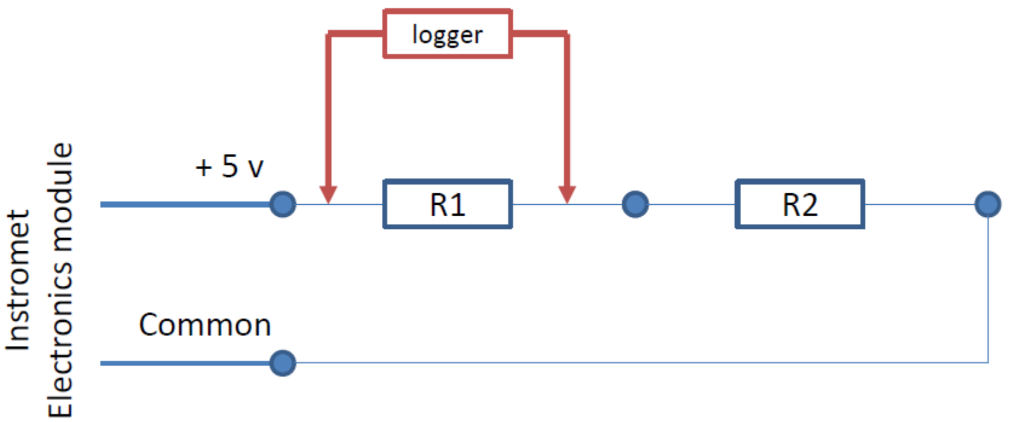

Figure 3 *A suitable voltage divider circuit to reduce the binary output to ~ 1.6 v across the logger. R1 = 2.2 kΩ, R2 = 4.7 kΩ*

Combining pulse and binary outputs

Provided the datalogger has sufficient available ports, both pulse and binary outputs can be logged simultaneously. There may be slight rounding errors when comparing 1 s output to the pulse total, and very short periods of sunshine will be missed with the pulse output, thus 1 s binary logging is the preferred method.

Known instrumental issues

Vague sensitivity threshold

Perhaps the biggest drawback to this instrument is its vague threshold calibration. The control unit includes a small potentiometer which can be adjusted to vary the detection threshold of sunshine (shown in **Figure 2**). It is suggested that this be left at the manufacturer's factory setting unless there is good reason to change it (i.e. it is obviously under- or over-reading when compared with an instrument of known calibration). It should not be continuously 'fiddled with', as the results obtained will then not be consistent over time.

Misting up

The Instromet sensors are reliable, with a low failure rate. Some users have reported that the sensor's glass dome (**Figure 1**) mists up internally over time, which will obviously affect the detection threshold and thus the records obtained. There is no desiccant cartridge, and the dome is sealed; if it does mist up, make a note of this in the station metadata and seek the advice of the manufacturers.

Excess pulses

A quirk of some Instromet units is that between 101 and 102 pulses per hour are generated in unbroken sunshine (i.e. it will indicate a sunshine duration of 1.01 or 1.02 h). Whilst the absolute error is small in climatological and sensor terms, it can lead to sunshine durations in excess of the maximum possible (the astronomical day length) on days of unbroken sunshine. If the instrument output is logged hourly, all hourly totals greater than 1.00 h should be corrected to 1.00 h exactly using a quality control routine or a 'search and replace' function in a spreadsheet. The daily sunshine total should then be taken as the sum of the hourly durations, rather than a 24 hour logged value or the reading from the digital display, both of which will include the excess pulses. This problem does not occur when using the 'binary' output voltage threshold method, which is another reason why it is preferred.

Lack of record in mains power failure

A drawback to this instrument is its dependence on a 12 v AC supply (through a mains transformer). Power outages result in loss of record, although this is not obvious, because even when logged the gap is shown only as 'nil sunshine' rather than 'missing data' (and of course there is no way to determine whether a gap in record has occurred solely from the digital display unit). Supplementary records (eye observations or logged solar radiation data) are therefore required to assess whether the Sun was shining while the power was off, and thus complete any short gap in the record. It is next to impossible to complete gaps in the record of more than an hour or so without supplementary instruments, such as a logged pyranometer.

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www.measuringtheweather.com

v1.0 January 2012
v1.1 March 2012 – *added CR1000 logger code*

The information in this guide is given in good faith. No liability can be accepted for any loss, damage or injury occasioned as a result of using this guide or any of the information contained within, howsoever caused.

CONTACT DETAILS

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CAMPBELL SCIENTIFIC	**Campbell Scientific Ltd** Campbell Park, 80 Hathern Road Shepshed, Loughborough LE12 9GX, UK Tel: +44(0)1509 601141 www.campbellsci.co.uk	Campbell Scientific manufacture dataloggers, data acquisition system and measurement/control systems used worldwide in research and industry. Campbell Scientific dataloggers form an integral part of many automatic weather station installations around the world. They can also supply a wide range of third party professional sensors and accessories. Founded in Logan, Utah, USA in 1974, they have offices in Australia, Brazil, Canada, Costa Rica, France, Germany, South Africa, Spain and UK.

APPENDIX 1

Code for Campbell Scientific **CR10X logger** to record pulse and binary outputs from Instromet logger and output 1 min and hourly totals. (Sample code for **CR1000 logger** follows.) *Be sure to change the input channel instructions to reflect the input port used.*

For more information on Campbell loggers, see www.campbellsci.co.uk

<u>CR10X logger</u>

```
;{CR10X}
;
*Table 1 Program
  01: 1          Execution Interval (seconds)
;
; CSSUN collection program
; Stephen Burt - September 2001
;
; INSTROMET SUNSHINE SENSOR
; ************************

; Pulse output - 0.01 h increments
; Connect Comm to G and 1/100 output to a spare control port

1:  Pulse (P3)
 1: 1         Reps
 2: 8         Control Port 8 (switch closure only)
 3: 0         High Frequency, All Counts
 4: 16        Loc [ INSSunPu ]
 5: .01       Mult
 6: 0.0       Offset

; Voltage output - 'sunshine' => 500 mv

; Measure the sunshine state output
; Connect Comm to G and voltage divider output to spare single-ended
; port

2:  Volt (SE) (P1)
 1: 1         Reps
 2: 05        2500 mV Slow Range
 3: 6         SE Channel
 4: 17        Loc [ INSTsig  ]
 5: 1.0       Multiplier
 6: 0.0       Offset

; If Greater than 500 mV sun is shining

3:  If (X<=>F) (P89)
 1: 17        X Loc [ INSTsig  ]
 2: 3         >=
 3: 500       F
 4: 30        Then Do

; Count sunshine duration in seconds

; Load the time between scans, in seconds, into
```

```
; an input location

     4:  Z=F x 10^n (P30)
      1: 1         F
      2: 0         n, Exponent of 10
      3: 18        Z Loc [ INSsunSec ]

; Count sunshine duration in thousandths of hours

; Load the time between scans, in hours, into
; an input location (= 1 sec/3600*1000)

     5:  Z=F x 10^n (P30)
      1: 0.27778   F
      2: 0         n, Exponent of 10
      3: 19        Z Loc [ INSsunHr ]

    6:  Else (P94)

; Otherwise if the sun is not shining, load zero in both locations

     7:  Z=F x 10^n (P30)
      1: 0.0       F
      2: 0         n, Exponent of 10
      3: 18        Z Loc [ INSsunSec ]

     8:  Z=F x 10^n (P30)
      1: 0.0       F
      2: 0         n, Exponent of 10
      3: 19        Z Loc [ INSsunHr ]


9:  End (P95)

; ----------------------- 1 MINUTE OUTPUTS --------------------

39:  If time is (P92)
 1: 0     -- Minutes (Seconds --) into a
 2: 60       Interval (same units as above)
 3: 10       Set Output Flag High (Flag 0)

40:  Set Active Storage Area (P80)^24640
 1: 01       Final Storage Area 1
 2: 01       Array ID

41:  Real Time (P77)^20774
 1: 110      Day,Hour/Minute (midnight = 0000)

46:  Totalize (P72)^15738
 1: 1        Reps
 2: 18       Loc [ INSsunSec ]

; ----------------------- 60 MINUTE OUTPUTS --------------------


59:  If time is (P92)
 1: 0        Minutes (Seconds --) into a
 2: 60       Interval (same units as above)
```

```
 3: 10       Set Output Flag High (Flag 0)

60:  Set Active Storage Area (P80)^17018
 1: 01       Final Storage Area 1
 2: 60       Array ID

61:  Real Time (P77)^3026
 1: 110      Day,Hour/Minute (midnight = 0000)

66:  Totalize (P72)^15013
 1: 1        Reps
 2: 18       Loc [ INSsunSec ]

; Output hourly sunshine totals in thousandths of hours

71:  Totalize (P72)^17586
 1: 1        Reps
 2: 19       Loc [ INSsunHr ]

*Table 2 Program
  02: 0.0000    Execution Interval (seconds)

*Table 3 Subroutines

End Program
```

CR1000 logger

Be sure to change the input channel instructions to reflect the input port used

```
' CSAWS100x CR1000 collection program
' Revision History
'
' Feb 2012 – Instromet sunshine sensor sample code for CR1000 logger
' Stephen Burt

'\\\\\\\\\\\\\\\\\\\\\\\\\ DECLARATIONS /////////////////////////

Public INSsig, INSSunPu, INSsunSec, INSsunHr

'\\\\\\\\\\\\\\\\\\\\\\\\ OUTPUT SECTION ////////////////////////

' ----------- 1 minute outputs --------------------

DataTable(Table1,true,-1)

  DataInterval(0,1,Min,10)

  Totalize(1, INSsunSec, FP2, 0)

EndTable

' ----------- 60 minute outputs --------------------

DataTable(Table60,true,-1)
```

```
  DataInterval(0,60,Min,10)

    Totalize(1, INSsunSec, FP2, 0)

  Totalize(1, INSsunHr, FP2, 0)

  Totalize(1, INSSunPu, FP2, 0)

EndTable

' ----------- 24 hour outputs --------------------

DataTable(Table240,true,-1)

  DataInterval(0,24,Hr,10)

  Totalize(1, INSsunSec,IEEE4, 0)

  Totalize(1, INSsunHr,IEEE4, 0)

  Totalize(1, INSSunPu, FP2, 0)

EndTable

'\\\\\\\\\\\\\\\\\\\\\\\\\ SUBROUTINES //////////////////////////


'\\\\\\\\\\\\\\\\\\\\\\\\\\\ PROGRAM ////////////////////////////

BeginProg

  Scan(1,Sec, 10, 0)

' INSTROMET 1 SUNSHINE SENSOR
' ***************************
' Pulse output - 0.01 h increments
    PulseCount(INSSunPu, 1, 18, 0, 0, 0.01, 0)

' Voltage output - 'sunshine' => 500 mv
' Measure the sunshine state output
    VoltSe(INSsig, 1, mV2500, 5, False, 0, 250, 1, 0)
' If Greater than 500 mV sun is shining
    If (INSsig >= 500) Then
' Count sunshine duration in seconds
' Load the time between scans, in seconds, into
' an input location
      INSsunSec = 1
' Count sunshine duration in thousandths of hours
' Load the time between scans, in thousandths of hours, into
' an input location (= 1 sec/3600*1000)
      INSsunHr = 0.2778
    Else
' Otherwise if the sun is not shining, load zero in both locations
      INSsunSec = 0
      INSsunHr = 0
    EndIf
```

```
' ----------------------- 1 MINUTE OUTPUTS --------------------
    CallTable Table1
' ----------------------- 60 MINUTE OUTPUTS --------------------
    CallTable Table60
' ----------------------- 24 HOUR MIDNIGHT OUTPUTS --------------------
    CallTable Table240

  NextScan
EndProg
```