MODEL 237-LC
LEAF WETNESS SENSOR
FOR
METDATA1

4/97

WARRANTY AND ASSISTANCE

The **237-LC LEAF WETNESS SENSOR FOR METDATA1** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

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Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.

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MODEL 237-LC LEAF WETNESS SENSOR FOR METDATA1

1. GENERAL

Leaf wetness sensors are classified into three types: surface contact types that measure the electrical resistance of a water film on the leaf surface, artificial leaf electrical resistance types, and mechanical types that detect a change in sensor length or weight. The 237 is an artificial leaf type for use with the CR7, CR10, and 21X dataloggers.

The sensor consists of a circuit board with interlacing gold-plated copper fingers. Condensation on the sensor lowers the resistance between the fingers which is measured by the datalogger. Droplets small enough to not touch two fingers simultaneously do not change the sensor resistance. For this reason, this type of sensor is often coated with flat latex paint to spread the water droplets. The color and type of paint affect sensor performance. Campbell Scientific supplies only the raw sensor since individual modifications vary depending on the application. The following paper details the effect of paint color and sensor angle on the response of the leaf wetness sensor:

Gillespie, T.J. and Kidd, G.E. 1978. Sensing duration of leaf moisture retention using electrical impedance grids. Can. J. Plant Sci. 58:179-187.

2. INSTALLATION

The 237 cable is attached to the enclosure connector labeled #4.

3. PROGRAMMING

> **NOTE:** Information in this section is not necessary when programming the MetData1 with the Short Cut Program Builder software.

There are three steps involved in programming the datalogger to output results of leaf wetness with the 237 Sensor. There is the excitation and measurement of the sensor, the calculation of sensor resistance, and programming for the desired output.

3.1 MEASUREMENT

The AC Half Bridge Instruction 5 is used to read the 237 sensor. Instruction 5 returns the ratio of the measured voltage to the excitation voltage (V_s/V_x), which is equal to a ratio of sensor resistances as shown below (refer also to Figure 1).

$$V_s/V_x = R_2/(R_2+R_1+R_s)$$

3.2 CALCULATING SENSOR RESISTANCE

An alternate expression of leaf wetness is sensor resistance (R_s) in thousands of ohms (kohms). R_s is calculated as follows:

$$R_s = R_2/(V_s/V_x) - R_2 - R_1$$

where R_2 is 1 kohm and R_1 is 100 kohms, substituting these values yields:

$$R_s = 1/(V_s/V_x) - 101.$$

After Instruction 5, use Instruction 42 to invert V_s/V_x. Instruction 34 is then used to add -101 kohms. The result is the resistance of the sensor in kohms. See Section 5 "Program Example For The CR10."

The sensor resistance varies from above 3,000,000 ohms when dry to around 1,000 ohms when wet. If outputting resistance measurements, the reading will be 99999 if the sensor is completely dry. A completely dry sensor is an open circuit, and therefore has infinite resistance.

3.3 OUTPUT - RECORDING FRACTION OF TIME WET AND DRY

Outputting the fraction of time wet or dry cannot be done until the resistance at the wet/dry transition point is determined. See Section 4 "Calibration."

The fraction of time the sensor is wet or dry can be obtained using the Histogram Instruction 75 with a single bin and closed form. The bin select value for the histogram is the Input Location containing sensor resistance. The lower limit of the histogram is zero and the upper limit is the calibrated wet/dry transition point. This will give the fraction of the output interval the sensor is wet. Subtract this fraction from 1 to get the fraction of the output interval the sensor is dry. Multiply both fractions by 100 to obtain the percent of time wet and the percent of time dry.

3.4 METDATA1 PROGRAM EXAMPLE

The following CR10 datalogger program is an example only, parts of this program will vary for each application. This program measures one 237 Leaf Wetness Sensor every 15 minutes, calculates resistance, and outputs the fraction of time wet on a daily basis.

```
                        Table 1 Programs                    15 minute
    01:      900        Sec. Execution Interval             table ex.

01:           P5        AC Half Bridge                      Excite and
    01:        1        Rep                                 Measure the
    02:       13        25 mV fast Range                    237 Sensor
    03:        8        IN Chan
    04:        3        Excite all reps w/EXchan 1
    05:     2500        mV Excitation
    *06:       1        Loc : VS/VX Loc                     resulting in
    07:      1.0        Mult                                VS/VX
    08:   0.0000        Offset

02:          P42        Z=1/X                               Invert VS/VX
    *01:       1        X Loc
    *02:       2        Z Loc : Res Loc

03:          P34        Z=X+F                               and
    *01:       2        X Loc                               Add -101.0
    02:   -101.0        F                                   to get
    *03:       2        Z Loc : Res Loc                     Res.(kohm)

04:          P92        If time is                          Every 24
    *01:       0        minutes into a                      hours
    *02:    1440        minute interval
    *03:      10        Set high Flag 0 (output)            Output

05:          P77        Real Time                           Julian Day
    *01:     220        Day,Hour-Minute                     and Time

06:          P75        Histogram                           and
    *01:       1        Rep                                 the fraction
    *02:       1        No. of Bins                         of time
    *03:       1        Closed form                         wet for
    04:        2        Bin Select Value Loc                that day
    05:     0000        WV Loc Option
    06:   0.0000        Low Limit
    *07:     150        High Limit

07:           P        End Table 1
```

* Parameter entries will vary depending on the datalogger program.

4. CALIBRATION

The resistance of the sensor at the wet/dry transition point should be determined. A sharp change in resistance occurs in the wet-dry transition on the uncoated sensor. Coated sensors have a poorly defined transition. The resistance of the uncoated sensor at the wet/dry transition is normally between 50 and 200 kohms. The coated sensor transition normally occurs from 20 kohms to above 1,000 kohms.

For best results, the leaf wetness sensor should be field calibrated. The transition point will vary for different areas and vegetation. Place the sensor among the vegetation whose wetness is to be monitored. Observe the vegetation until it reaches the desired wetness by natural means. When the vegetation is at the desired "wetness", note the measured resistance on the datalogger. This resistance is the transition point.

The sensor's resistance is artificially reduced by contaminants such as fingerprints and smudges. Before painting and calibrating the sensor, wash it with alcohol to remove possible contaminants.