WatchDog 2000 Series weather Stations

CONTENTS

General overview

Thank you for purchasing a WatchDog 2000 Series Weather Station. The stations are completely weather-proof and feature 12-bit resolution for higher accuracy. The stations can be accessed at different times by multiple users because the data is not cleared from memory following a download. The 2000-Series weather stations can communicate via direct-wire, radio or telephone connections.

Current weather conditions, historical data, and computed parameters are easily viewed on the station's LCD screen. The station LCD can also be programmed to display a variety of plant disease infection potentials. The arrow keys can be used to program the station's logging interval and assign sensors to the external sensor ports. You can also scroll through the sensor readings, Degree Day/Chill Hour calculations and set your temperature ranges.

Model 2800 Stations

The model 2800 station is equipped with 9 external sensor ports. It can be connected to any WatchDog external sensor. This station is unique in that it has no internal sensors. It is not possible to collect data for air temperature, relative humidity, and wind speed/direction. Therefore, the station cannot calculate Growing Degree Days, Chill Hours, Wind Chill, Dewpoint, Evapotranspiration or any Disease Models.

Although a rain collector is not included as a standard sensor, it can be added as an optional external sensor.

Specifications

Data capacity
8800 data intervals. For example, for a 30-min interval, meter will run for 183 days before wrapping data.
Height
12 inches (30 cm) with rain collector
10 inches (26 cm) without rain collector
Width
8.5 inches (21.5 cm)
Depth
12 inches (30 cm) with rain collector
3.5 inches (8.5 cm) without rain collector
Weight (with rain collector and anemometer)
6.4 lbs (2.9 kg)
Power Source
4 AA batteries
Battery Life
12 months
External Sensor ports
6 (5 on model 2900ET, 9 on model 2800)
Internal Sensors
The following table lists the specifications for sensors that are included with the different models of weather station.

Sensor	Available on Models	Measurement Range	Accuracy
Wind Speed	All but 2800	0-175 mph	±5%
Wind Direction	All but 2800	2^o increments	$\pm 7^o$
Temperature	All but 2800	-20° to 70°C -4° to 158° F	±0.6°C ±1°F
Relative Humidity	2550, 2700, 2900ET	20% to 100% @5° to 50° C	±3%
Rainfall	2600, 2700, 2900ET	0.01” (0.25cm) resolution	±2%
Solar Radiation	2900ET	1-1250 W/m^2	±5%

External Sensors

The following table lists the available optional sensors. All sensors include a 6-foot cable with pin-type connector. To connect an external sensor to the logger, plug the sensor cable into the logger port that has been programmed for that particular sensor. If the sensor is not connected, the message "sensor error" will appear on the LCD display for the respective logger port until the sensor is connected.

Item #	Sensor Description	Measurement Range	Accuracy
3666	Leaf Wetness	0(Dry) - 15(Wet)	N/A
3667 (6ft) 3667-20 (20ft)	External (Soil) Temperature	-30° to 100°C -22° to 212° F	±0.6°C ±1°F
3670	Silicon Pyranometer	1-1250 W/m^2	±5%
3668	Quantum Light	0-2500 $\mu mol/m^2/s$	±5%
3669,	Soil Moisture Transducer	0-100 kPa (R-type)	±2%
6450WD (6ft) 6450WD20 (20ft)	Watermark Soil Moisture Sensor	0-200 kPa (WM-type)	N/A
3664	20 ft. Sensor Extension Cable	N/A	N/A
6451	Irrigation On/Off	Switches at 5 psi	±1 psi
6471	Barometric Pressure	26 - 32 in Hg 660 - 810 mm Hg	±0.05" ±1.3 mm
3673 3674	Input Cable for User Supplied Sensor	0 - 2.5V 4 - 20mA	N/A
6452-20 6452-ADPT	20cm ECHO Soil Moisture Sensor	0% volumetric water content to saturation	±3% vwc

Station Installation

The weather station should be located in an open, unobstructed, grassy area to ensure accurate measurement of wind, rainfall, sunlight, and evapotranspiration.

Mounting hardware is provided to attach the weather station to a 4" x 4" treated wooden post or to a mast/pole up to 1.25 inches in diameter. The mounting pole should be securely anchored perpendicular to the ground.

If you are using the mounting tripod (item # 3396TP), open it and place it where the weather station is to be located. The tripod feet can also serve as mounting brackets if the unit is located on a solid surface. Slide the 3' post through both center screw clamps, adjust the height as desired and tighten the

Weather Station mounted on tripod

Important: Secure the external sensor wires to the mounting pole with a plastic tie. This will ensure that the sensor wires do not become disconnected while recording

Anemometer setup

Apart from the anemometer, the WatchDog Weather Station comes fully assembled and ready to mount. The anemometer arm is attached to the enclosure back plate with two clamps. After positioning the arm, the screws should be tightened to secure it in place.

Push the wind cups onto the bottom of the shaft flush with the bottom of the assembly and tighten the set screw. When released, the cups should drop slightly. If the cups do not spin freely, loosen the set screw and lower the cups slightly. The gap between cup hub and assembly should be about 1/16 inch.

Push the wind vane onto the top of the shaft and calibrate (see Calibrating the Anemometer p. 23 for calibration procedure).

Anemometer clamped to back plate (for visibility, black, rubber clamps not shown)

Connection Options

The WatchDog weather station communicates with a PC through either the **Computer** or **AUX** port which are located under the LCD and keypad. The communication options are separated into 3 main categories.

Direct Communication

There are 3 options for connecting directly to the station.

1. PC interface cable - The gray cable that accompanies the SpecWare software. Connects to **Computer** port.
2. A 75-ft Direct Connect Cable (item 3660-75SP) - This cable has a modular (telephone-type) connector on one end and a 9-pin RS-232 connector on the other. Comes with surge protection and connected to the station through the **AUX** port.
3. Short-Range Modem Pair - The weather station can be hardwired up to 4000 feet from a PC with a twisted-pair cable and a short-range modem pair. Powered with an A/C adapter and connected to the station through the **AUX** port.

Caution: Extended lengths of cable can attract lightning. It is recommended that these cables always be connected to surge protectors. This provides upgraded protection against voltage surges caused by nearby lightning strikes.

Wireless Radio Communication

There are 2 options for contacting the station by a wireless radio connection. The short-range transceiver can communicate up to 1000 ft. The mid-range radio has a range of 2 miles. Both wireless options require line of sight between the base and remote radios. See the **WatchDog Wireless Modem** user's guide for additional details.

Long-range (telephone) Communication

If the weather station will be located further than 2 miles from the base PC and/or it is not possible to achieve line-of-sight with the station, the only other remote connection option is via a land-line or cellular telephone connection. These modems are not waterproof and require a power source other than the station's AA batteries. If electricity from a local utility is not available, this power will need to come from a battery. It is common for this battery to be charged by solar panels so that station does not need to be visited on a frequent basis. Contact Spectrum Technologies for additional details on these options.

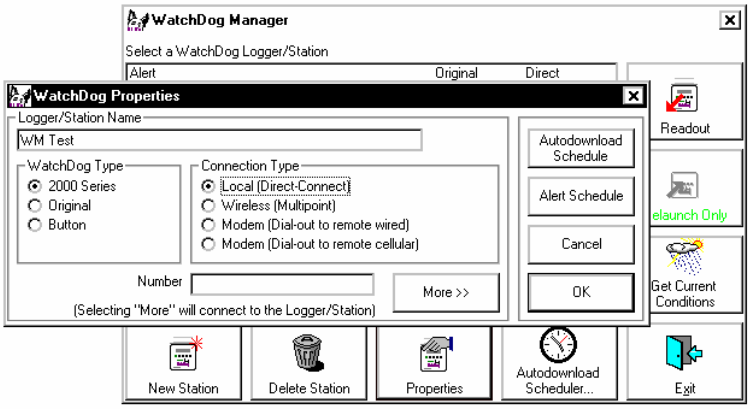
Configuring the Weather Station

The 2000-Series weather station does not have a button or switch for powering up and down. Instead, the device is operational whenever the batteries are installed. The stations are shipped with default logging settings that can be modified with SpecWare software or with the station's keypad. Once the station is configured, it will retain those settings even after the battery is removed or replaced. Note that the time and date must be set manually whenever batteries are installed.

One notable feature of the WatchDog 2000-Series weather stations is that they do not need to be re-launched after being downloaded. This allows greater flexibility for stations that are accessed by multiple users. Although, the station stores data on a pre-set interval, the sensor readings displayed on the LCD are refreshed every 20 seconds.

Configuring the Weather Station with SpecWare

The 2000-Series weather stations can be configured in the **WatchDog Manager** screen of SpecWare software (see SpecWare8 User's Guide for details). Configuration through the software is necessary to change the station name, enable/disable Disease Models or set parameters for the Alarm Output Module. Remember to identify the WatchDog type as 2000-series.



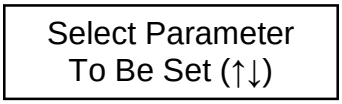
Configuring the Weather Station with the Keypad

For the 2000 Series weather stations, SpecWare software is not necessary to configure the station. The keypad can be used to select all essential configuration options. Configurable parameters are; sensor type, logging interval, Degree Day calculation method and latitude and altitude (model 2900ET only). Configuration through the software is necessary to change the station name, enable/ disable Disease Models or set parameters for the Alarm Output Module.

The keypad sequences to set each parameter are as follows.

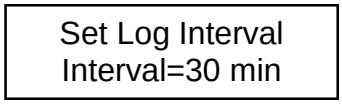
Setting the Logging Interval
If set for a 30-minute logging interval, the station can hold 183 days of data. Changing the logging interval will also change the frequency that the station's memory wraps around and writes over older data.

1. Press **Display**.
2. Press **Set**.



3. Use the arrow keys to scroll to the 'Log Interval' option.

4. Press **Set**.

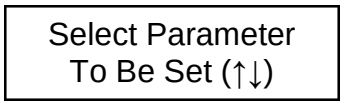


5. Use the arrow keys to scroll to the desired port.
6. Press **Set**. LCD will return to the 'Current Values' screen.

Setting the Sensor Type

Although the keypad can be used to assign a sensor to an external port, this should only be done when initially starting the station, re-starting a station whose memory has been cleared, or for adding a sensor to a previously unused port. If a port's sensor assignation is changed without first downloading the station, all data read from that port, including historical data read before the change, will be translated to engineering units as if the new sensor had always been connected.

1. Press **Display**.
2. Press **Set**.

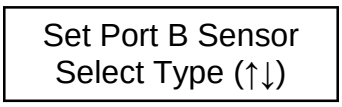


3. Use the arrow keys to scroll to the 'Sensor Type' option.

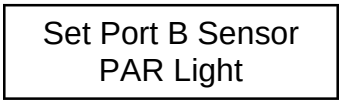
4. Press **Set**.

5. Use the arrow keys to scroll to the desired port.

6. Press **Set** to select the port.



7. Use the arrow keys to scroll to the desired sensor type.

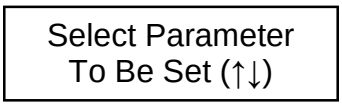


8. Press **Set** to select the sensor type. LCD will then return to the 'Current Values' screen.

Setting Geographic Data for the ET Report

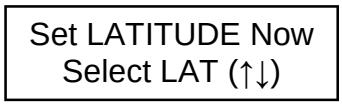
In addition to temperature, relative humidity, wind speed and solar radiation data, the Penman-Monteith algorithm used by the 2900ET statopm uses the station latitude and altitude to compute reference ET. These are input as follows:

1. Press **Display**.
2. Press **Set**.

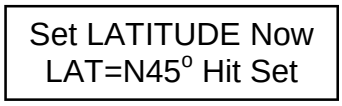


3. Use the arrow keys to scroll to the 'ET Values' option.

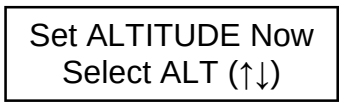
4. Press **Set**.



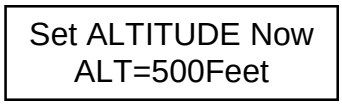
5. Use the arrow keys to scroll to the desired latitude. Take care that N precedes the latitude angle if the station is in the northern hemisphere.



6. Press **Set** to set the latitude angle.



7. Use the arrow keys to scroll to the desired altitude.

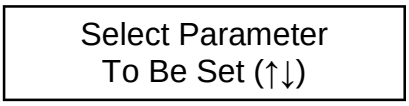


8. Press **Set** to set the altitude. LCD will return to the 'Current Values' screen.

Selecting the Degree Day Calculation Method

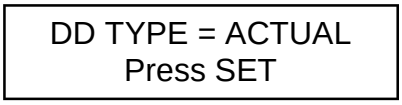
The weather station has 2 options for calculating Degree Days (see Degree Days/Chill Hours, p. 31). The weather station must measure air temperature for this option to be available. The desired method is selected as follows:

1. Press **Display**.
2. Press **Set**.

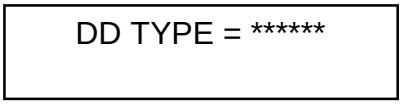


3. Use the arrow keys to scroll to the 'DD Calc Method' option.

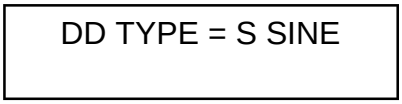
4. The current calculation will be displayed.



5. Press **Set** to make this option modifiable.



6. Use the arrow keys to select the desired method.



7. Press **Set** to select the method. LCD will return to the 'Current Values' screen.

Other Keypad Operations

The most common use of the keypad is to view the weather station's current sensor readings, calculated parameters, and archived data. Pressing the **Display** key once brings the LCD display to life. The screen will initially display descriptive information about the station. The screen then displays current conditions. Current conditions are refreshed every 20 seconds. Pressing the **Display** key a second time will deactivate the display. The station continues to record data when the display is not active. To conserve battery power, the display goes off after 2 minutes of inactivity. The weather station only records the measurements from the sensors. Parameters calculated and displayed on the LCD by the firmware (such as Growing Degree Days) are only retained in the Daily Archive (see Daily Archive, p. 25).

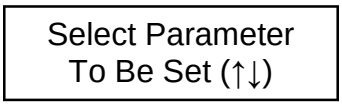
In addition to being able to configure parameters needed by SpecWare, the keypad is also used to set the date/time, calibrate the wind vane, reset the running rain counter, configure the radio and select options for parameters calculated and displayed by the station's firmware.

The keypad sequences to set each parameter are described on the following pages.

Setting the Date and Time

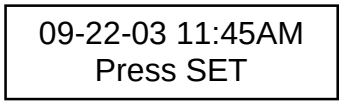
It is necessary to use the keypad to set the date and time for the data being stored in the long-term memory. This is the only keypad function that is reflected in the logged data that can't be handled via a software connection.

1. Press **Display**.
2. Press **Set**.

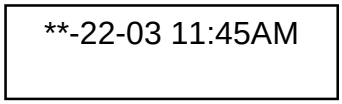


3. Press the down arrow key once to reach the 'Time & Date' screen.

4. Press **Set**.



5. Press **Set**.

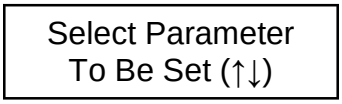


6. Enter the month using the arrow keys. Press **Set**.
7. Enter the day. Press **Set**.
8. Enter the year. Press **Set**.
9. Enter the hour. Press **Set**.
10. Enter the minutes. Press **Set**.
11. Enter AM or PM. Press **Set**.
12. LCD will return to the 'Current Values' screen.

Setting the Display Units

This option determines whether the LCD will show data in English or metric units.

1. Press **Display**.
2. Press **Set**.



3. Use arrows to scroll to 'Display Units'.

4. Press **Set**.

5. Press **Set**.

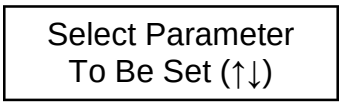
6. Use the arrow keys to choose whether data is displayed in English or metric units.
7. Press **Set**. LCD will return to the 'Current Values' screen.

Note: The unit system used by the 2000-Series Weather Station can be modified by both the keypad and by SpecWare. Although it is advisable to have both the software and firmware using the same unit system, it is not required. SpecWare is equipped to handle situations where it receives data in a different unit system. However, if you use SpecWare to change any of the weather station's configuration parameters (i.e. logging interval), the data logger will also be reconfigured to use the unit system used by SpecWare.

Setting the Degree Day Counter

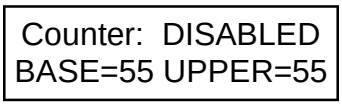
The weather station can be programmed to compute Degree Days for a selected base and upper temperature. This feature is distinct from the Degree Day report in SpecWare.

1. Press **Display**.
2. Press **Set**.

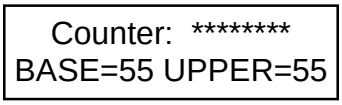


3. Scroll to 'Deg Day Count' screen.

4. Press **Set**.



5. Press **Set**.



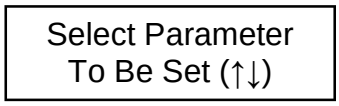
6. Use arrow keys to scroll to "StartNow" option. This will start the degree day counter. The other option is DISABLED.
7. Press **Set**.
8. Choose the base temperature using the arrow keys.
9. Press **Set**.
10. Choose the upper temperature limit using the arrow keys.
11. Press **Set**. LCD will return to the 'Current Values' screen.

Caution: Be careful when entering a parameter update screen for the degree day counter when the counter is enabled. If the **Set** key is pressed, the counter status will become modifiable and the archives WILL BE ERASED. If this is not desirable, press one of the arrow keys instead of the **Set** key to exit the screen.

Setting the Chill Hour Counter

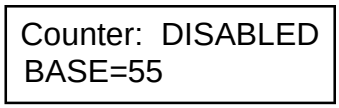
The weather station can be programmed to compute Chill Hours for a selected base temperature. This feature is distinct from the Chill Hours report in SpecWare.

1. Press **Display**.
2. Press **Set**.

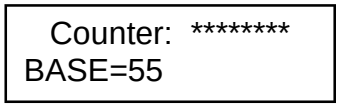


3. Scroll to the 'Chill Hours' screen.

4. Press **Set**.



5. Press **Set**.



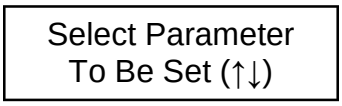
6. Use arrow keys to scroll to "StartNow" option. This will start the chill hour counter. The other option is DISABLED.
7. Press **Set**.
8. Choose base temperature using the arrow keys.
9. Press **Set**. LCD will return to the 'Current Values' screen.

Caution: Be careful when entering a parameter update screen for a chill hour counter when that counter is enabled. If the **Set** key is pressed, the counter status will become modifiable and the archives WILL BE ERASED. If this is not desirable, press one of the arrow keys instead of the **Set** key to exit the screen.

Configuring the Wireless Radio Address

The numerical address of the remote transceiver must be entered into SpecWare software to facilitate wireless communication. The weather station can set the address to be the same as the station's serial number.

1. Press **Display**.
2. Press **Set**.



3. Scroll to the 'Configure Radio' screen.

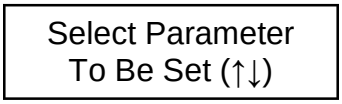
4. Press **Set** to bring up the configuration screen.

5. Press **Set** again to configure radio.
6. When finished, the screen will go back to Current Values.

Calibrating the Wind Vane

When the weather station is initially placed in the field or moved, the wind direction must be calibrated. The following procedure will allow you to establish accurate wind direction readings.

1. Press **Display**.
2. Press **Set**.



3. Scroll to the 'Set North' screen.

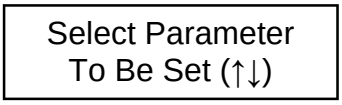
4. Press **Set** to bring up the calibration screen.

5. Press **Set** again to complete calibration.
6. When finished, the screen will briefly display "DONE" then go back to Current Values.

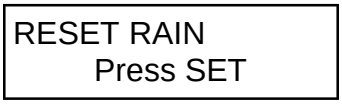
Resetting the Rain Counter

The weather station maintains two rain counters (see LCD Screens, p. 28); rain since midnight and total accumulated rainfall. The second counter can be reset to zero at any time. For example, to track weekly rainfall accumulations, the counter could be zeroed every Monday morning.

1. Press **Display**.
2. Press **Set**.



3. Scroll to the 'Reset Rain' screen.



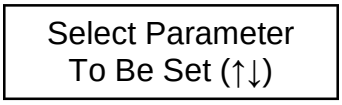
4. Press **Set** to bring up the configuration screen.

5. Press **Set** again to reset rain counter to zero.
6. When finished, the screen will go back to Current Values.

Resetting the Disease Models

This option restarts the disease model calculations and should be done at the beginning of the season.

1. Press **Display**.
2. Press **Set**.

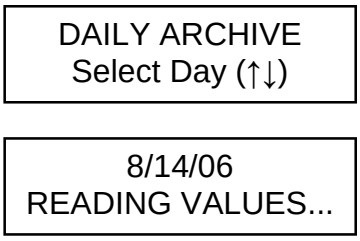


3. Scroll to the 'Reset Disease' screen.

4. Press **Set** to reset the disease model.
5. The screen will go back to Current Values and the disease model will be reset.

DAILY ARCHIVE

The weather station features an archive that allows you to look at historical data for that location without downloading the data. The archive is regularly updated whenever the data logger is actively collecting data. The daily archive retains the last 30 days of data. If the battery power runs low, the station's firmware will stop measuring and archiving data until the battery is replaced.



The archive is accessed by pressing the **Current/ Archive** key. The arrow keys are then used to scroll to the archived day of interest. Once a day is selected, the LCD will cycle through all the information stored for that day. This includes high/ low temperature, high/low relative humidity, total rainfall, the degree day and chill hour counters (if enabled), and a summary of any active disease models. If the Degree Day/Chill Hour Counter was not active on a particular day, the screen will display "No Data" for that day.

Note: If the Degree Day counter is disabled or reset, the entire archive for that counter will be erased. Disabling the Degree Day counter does not affect the storing of data in memory and, thus will not affect any of the SpecWare report functions.

Battery Replacement

The 2000 Series weather stations are powered by 4 AA batteries. This will provide enough power for 1 year of continuous use. The battery compartment is accessed by removing the thumbscrews on the upper cover of the WatchDog (above the LCD). Upon installation of the batteries, the LCD should illuminate and the logger resume functioning. The LCD will prompt you to set the date and time (see Setting the Date and Time, p. 19).

Whenever the battery is replaced, the time and date must be reset immediately so the data is time-stamped correctly. However, all settings related to Degree Days, Chill Hours and IPM parameters (disease models, DIF, etc.) remain stored in the meter's memory even when the batteries are removed.

Clearing the Logger's memory

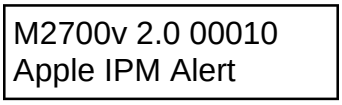
The memory of the 2000-Series weather station is not automatically cleared when the station is downloaded or the batteries are replaced. The station can be cleared manually through SpecWare software. This may be desired if, for example, the station is being shut down for the season or is being moved to a new location.

Once the command is sent from SpecWare to clear the memory, the data erasure is carried out automatically by the logger itself. The PC interface cable can then be disconnected without affecting the process. A data erasure will take several minutes to complete and the station cannot be contacted in the interim. Once the memory is cleared, it is impossible to recover. SpecWare provides warning messages to prevent an accidental clearing of the memory. See the SpecWare user's guide for more details.

LCD Screens

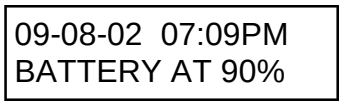
The following figures give examples of some of the various weather station LCD screens. Not all screens will be available on all models.

-Initial information screen



This is the first screen that appears when the **Display** button is pressed. The first line gives the model number, version number and serial number. The second line indicates whether a disease model has been activated. This screen is from a Model 2700 version 2.0, serial number 10. The apple disease model enabled. This screen is visible for 2 seconds before proceeding to the date/time/batter screen (below).

-Time, Date, Battery Level

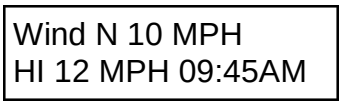


This screen shows the current date, time and battery strength. The current date is 09-08-02 and the time is 07:09 PM. The battery is at 90%.

-Rain

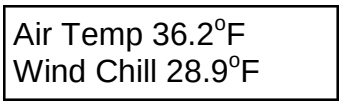
This screen shows the current status of both rainfall counters. The top counter is the amount of rain since midnight. The lower counter is the amount of rain since the counter was last reset (See Resetting Rain Counter, p. 24).

-Wind



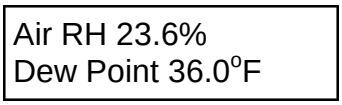
This top line shows the current wind speed and direction. The second line shows the high wind speed for the day and the time it occurred. (See Calibrating the Wind Vane, p. 23).

-*Temperature/Wind Chill*



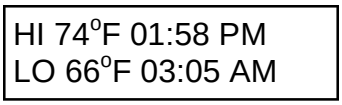
This screen shows the current air temperature and wind chill. Note that wind chill is not defined for air temperatures greater than 50°F. In that case, wind chill will be the same as air temperature.

-*Relative Humidity/Dew Point*



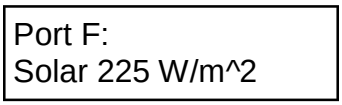
This screen shows the current relative humidity as well as the dew point temperature.

-*Daily High and Low Values*



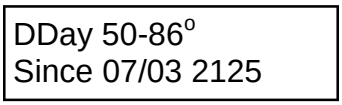
For temperature and RH, a screen is available that displays the current high and low values for the day, along with the times at which they occurred.

-*External Sensor Ports*



Data for sensors connected to an external port are displayed with the sensor port on the first line and the sensor type and measurement on the second line.

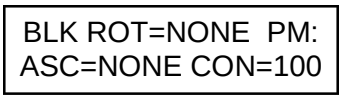
-*Degree Day Counter*



This screen shows the information for the Degree Day Counter . This counter is using a temperature range of 50 to 86°F. So far, it has accumulated 2125 degree days since the counter was started or reset on July 3. Degree Days calculated by the station are not saved in downloadable memory.

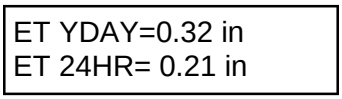
Note: SpecWare uses stored temperature data to produce its own Degree Day reports.

-Disease Name/Index Values



This screen shows the current disease risks. This screen will be different for each of the disease models. (See more detailed descriptions on pgs. 31-41) This screen shows no risk for Black Rot, no risk for ascospore infection, and a conidial index of 100.

-Evapotranspiration



This screen is only available with model 2900ET. It displays two reference evapotranspiration (ET) values. The top line is the total reference ET from the previous calendar day. The bottom line is a value which represents the total amount of ET accumulated in the last 24 hours. For example, if it is currently Tuesday at 8:00am. The lower line will give the amount of ET accumulated from 8:00am Monday to 8:00am Tuesday. ET calculated by the meter are not saved in memory.

Note: SpecWare uses stored weather data to produce its own ET reports.

Degree Days/ Chill Hours

Degree Days

Temperature is a key factor contributing to the development of plants, insects and plant diseases. Degree Days are a way to quantify the amount of heat that is available, which is a function of the time the temperature is within a given temperature range. For example, if the base temperature is determined to be 40 degrees and the actual temperature is 41 degrees for 24 consecutive hours, one Degree Day is said to have accumulated (41 – 40 = 1 degree for 24 hours or 1 day). Degree Days indicate the developmental stage of a pest generation. This allows for more precise pesticide recommendations.

The station's firmware has two options for calculating Degree Days, the Actual Degree Day Method and the Single Sine Method.

Actual Degree Day Method

Rather than simply using high and low temperature data for an entire day, the Actual Degree Day Method integrates the data at smaller time steps. Degree Day subtotals are calculated at 15 minute intervals to produce Degree Quarter-Hours (DQH), which are then summed over a full day. DQH are calculated as follows:

$$DQH = T_{avg} - T_{base}$$

Where T_{avg} is the average temperature over the 15-minute interval and T_{base} is the base temperature. If the average temperature is greater than the upper limit of the temperature range, the upper temperature limit is used instead of the average temperature when calculating DQH. If the average temperature is less than the base temperature, DQH is set equal to zero for that interval.

Single Sine Method

The Single Sine Method uses the day's maximum and minimum temperatures to generate a sine curve. This approximates the pattern of temperature variation during a typical day. The area between this curve and the lower threshold temperature represents the accumulated Degree Days for that day.

Chill Hours

Chill hours are calculated as the amount of time spent below a base temperature. Chill hours accumulations are used to estimate dormancy for tree fruit.

Activating Optional Disease Models

If you have purchased a disease model option for the 2000 Series weather station, this option must be activated with SpecWare. This will require an authorization code that can be obtained by calling Spectrum Technologies. You will be asked for the Serial and Registration numbers that appear on the "SpecWare 8" information screen. This screen is brought up by selecting the "About SpecWare" option from the **Help** menu on the SpecWare main screen.

Once a disease model has been activated on a station, the infection risk will be available on the LCD at all times. Once the data is downloaded, more complete reports can be run within SpecWare itself. Only one disease model can be activated on a station at a time, but there is no limit on the number of disease reports that can be run within SpecWare.

All disease models require, at least, air temperature and leaf wetness data. Therefore, an additional leaf wetness sensor must be purchased and connected to port A on the station.

The Disease/Report option is set using the "Report" pull-down menu on the Properties screen within the WatchDog Manager in SpecWare (see SpecWare user's guide).

Note: Because the model 2800 weather station does not measure air temperature, Disease Models cannot be activated on this station.

The available disease models are described on the following pages.

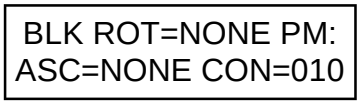
Grape Powdery Mildew

This option predicts two infectious stages, an ascospore stage and a conidial stage (Thomas, Gubler, and Leavitt 1994; Weber, Gubler, and Derr 1996). Ascospores are released in the spring from the structure in which the disease overwintered. Conidial spores are the result of an ascospore infection. Ascospores cause primary infections and conidial spores cause secondary infections. Your State Agricultural Extension Service can advise you about which stage is important in your area.

Ascospore Infection risk is determined using the daily average temperature and the hours of leaf wetness. A modified Mills Table (2/3 the original Mills leaf wetness value) is used to determine the development of a **'Heavy' Ascospore Infection**, the point at which treatment should begin.

Three consecutive days with 6 consecutive hours of temperatures between 70°F and 85°F are required to initiate the **Conidial Index**. Thereafter, the index increases by 20 with each day having six consecutive hours between 70°F and 85°F. The index decreases by 10 on days with less than six consecutive hours in the range of 70°F to 85°F and on days with a maximum temperature greater than 95°F. The index will always be between zero and 100.

Infection Severity Screen



This screen shows the risk for Black Rot and Powdery Mildew. The Powdery Mildew ascospore infection is none, and the conidial index is 10.

Grape Mills Table

Daily Average Temperature (F)	Hours of Leaf Wetness required for heavy ascospore infection (2/3 original Mills value)
42	40
43	34
44	30
45	27.3
46	25.3
47	23.3
48-49	20
50	19.3
51	18
52	17.3
53	16.7
54-55	16
56-57	14.7
58-59	14
60-61	13.3
62	12.7
63-75	12
76	12.7
77	14
78	17.3

Conidial Index:

0 - 30 = **Light** infection risk
40 - 50 = **Medium** infection risk
60 - 100 = **Heavy** infection risk

Grape Black Rot

Black Rot is a disease caused by the fungus *Guignardia bidwelli*. It overwinters in in old mummified berries. In spring, the primary inoculum is released which starts the initial round of infection. Those initial spores are dispersed by rain and wind. After the initial infection period, secondary infections are spread by rain splash. This model predicts infection periods of Black Rot based upon the Spotts model.

This model uses **temperature** and **leaf wetness** period to estimate the onset of an infection period. The temperature is compared with the period of leaf wetness needed to produce an observable infection. If the wetness period exceeds the required period for that temperature, the word **RISK** will appear

Infection Severity Screen

```
BLK ROT=RISK PM:
ASC=NONE CON=010
```

This screen shows a risk for Black Rot as well as Powdery Mildew. This screen shows a risk for Black Rot.

Temperature (F)	Hours of Leaf Wetness
50	**24**
55	**12**
60	**9**
65	**8**
70	**7**
75	**7**
80	**6**
85	**9**
90	**12**

Source R.A. Spotts, Ohio State University
Data represent Concord, Catawba, Aurora and Baco Noir.

Apple Scab
Sooty Blotch Flyspeck

This option predicts the approximate "Infection Degree" for **Apple Scab** and **Sooty Blotch Flyspeck**.

There are 2 models for Apple Scab. The Mills model Mills **Apple Scab** model as modified by A.L. Jones 1980 (see page 39, 40). A modified Mills table is shown on the following 2 pages. The Washington State (WSU) model is based on the original Mills chart (see pg 38).

The infection severity (None, Light, Medium, or Heavy) is triggered by the accumulation of sufficient hours of leaf wetness that occur between the base and upper temperature limits.

The screen also contains accumulated leaf wetness hours which is used to time for Sooty Blotch Flyspeck (Babadoost et al. 2004). After the first-cover fungicide spray is applied, begin accumulating wet hours as measured by the Weather Tracker. After 175 hours of wetness have accumulated, apply the second-cover fungicide spray, or if a standard spray program is being used, include an eradicant fungicide at that time. The warning system is only active until the threshold has been reached. After the threshold has been reached, a calendar-based fungicide-spray program should be used until shortly before harvest.

Infection Severity Screen

This screen shows the infection risk for the day. The risk on this screen is light. The apple scab risk is calculated daily.

Apple WSU Table

Average tempera-ture	Light	Moderate	Heavy	Incubation
deg. F	hrs(b)	hrs	hrs	days(a)
78	13	17	26	
77	11	14	21	
76	9.5	12	19	
64 to 75	9	12	18	9
62	9	12	19	10
61	9	13	20	10
60	9.5	13	20	11
59	10	13	21	12
58	10	14	21	12
57	10	14	22	13
56	11	15	22	13
55	11	16	24	14
54	11.5	16	24	14
53	12	17	25	15
52	12	18	26	15
51	13	18	27	16
50	14	19	29	16
49	14.5	20	30	17
48	15	20	30	17
47	17	22	35	
46	19	25	38	
45	20	27	41	
44	22	30	45	
43	25	34	51	
42	30	40	60	
33 to 41(c)				

(a)Approx. no. days required for conidial development after primary scab infection.
(b)The infection period is considered to start at the beginning of the rain.
(c)Data are incomplete at low temperatures.
** From W.D. Mills, Cornell University. Mills, W.D. 1944.*

Apple Mills Table

Approximate numbers of hours of wetting required for primary apple scab infection at different air temperatures			
Average Temp.	Degree of Infection (hrs)		
(°F)	Light	Medium	Heavy
78	13	17	26
77	11	14	21
76	9.5	12	19
63 to 75	9	12	18
62	9	12	19
61	9	13	20
60	9.5	13	20
59	10	13	21
58	10	14	21
57	10	14	22
56	11	15	22
55	11	16	24
54	11..5	16	24
53	12	17	25
52	12	18	26
51	13	18	27

Apple Mills Table

Approximate numbers of hours of wetting required for primary apple scab infection at different air temperatures			
Average	Degree of Infection (hrs)		
(°F)	Light	Medium	Heavy
50	14	19	29
49	14.5	20	30
48	15	20	30
47	15	23	35
46	16	24	37
45	17	26	40
44	19	28	43
43	21	30	47
42	23	33	50
41	26	37	53
40	29	41	56
39	33	45	60
38	37	50	64
37	41	55	68
33 to 36	48	72	96

TOM-CAST

This option uses **Tom-Cast**, a tomato disease forecasting program designed to predict Early Blight, Septoria Leaf Spot, and Anthracnose. (Pitblado ~1985; Bolkan and Reinert 1994) **Tom-Cast** calculates a disease severity value (**DSV**) to predict the development of these diseases.

An increasing number of leaf wetness hours and a higher temperature cause the **DSV** to increase at a faster rate. A **Cumulative DSV** of 15 to 20 is usually viewed as the threshold for initiating a spray program. Contact your State Agricultural Extension Service for further information regarding disease management in your area.

Infection Severity Screen

This screen shows the DSV values for the day as well as the accumulated DSV values. The daily DSV on this screen is 2 and the number of DSV's accumulated since the reset is 10.

Disease Severity Value Chart					
Average Temp During Leaf Wet Hours (ºF)	**Hours of Leaf Wetness per Day**				
55-63	0-6	7-15	16-20	21 +	
64-69	0-3	4-8	9-15	16-22	23+
70-78	0-2	3-5	6-12	13-20	21+
79-84	0-3	4-8	9-15	16-22	23+
Daily DSV =	**0**	**1**	**2**	**3**	**4**

References

Babadoost, M et al. (2004). Evaluation a Wetness-based Warning System and Reduced-risk Fungicides to Manage Sooty Blotch and Flyspeck of Apple. Hortechnology. 14: 51-57

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Holcombe, Veronda B., Kelly Lewis, and James E. Faust. "How Much Light Do Bedding Plants Really Need?" *Greenhouse Product News* July 2001:26-30.

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Mills, W. D. (1944). Efficient Use of Sulfur Dusts and Sprays During Rain to Control Apple Scab. N.Y. Agriculture Experiment Station Ithaca Extension Bulletin 630.

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Spotts, R. A., (1977). Effect of Leaf Wetness Duration and Temperature on the Infectivity of Guignardia Bidwelli on Grape Leaves. Phytopathology 67:1378-1381.

Thomas, C. S., W. D. Gubler, and G. Leavitt. (1994). Field Testing of a Powdery Mildew Disease Forecast Model on Grapes in California. Phytopathology, 84:1070 (abstract)

Weber, E., D. Gubler, and A. Derr. (1996). Powdery Mildew Controlled with Fewer Fungicide Applications. Practical Winery & Vineyard, January/February.

Warranty

The 2000-Series Data Logger is warranted to be free from defects in materials and workmanship for a period of 1 year from the date of original purchase. During the warranty period, Spectrum will, at its option, either repair or replace products that prove to be defective. This warranty does not cover damage due to improper installation or use, lightning, negligence, accident, or unauthorized service, or to incidental or consequential damages beyond the Spectrum products themselves. Implied warranties are limited in duration to the life of this limited warranty.

Some states do not allow limitation on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations may no apply to you. This warranty gives you specific legal rights. You may have other rights, which vary from state to state.

Returning Products to Spectrum

Before returning a failed unit, you must obtain a Returned Goods Authorization (RGA) number from Spectrum. You must ship the product(s), properly packaged against further damage, back to Spectrum (at your expense) with the RGA number marked clearly on the outside of the package. Spectrum is not responsible for any package that is returned without a valid RGA number or for the loss of the package by any shipping company.