110-WS-25DL

User Manual

110-WS-25DL

Data Logger

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Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

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NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

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1 FORWARD

Thank you for purchasing NovaLynx products. NovaLynx has been designing and manufacturing weather instruments since 1988. NovaLynx represents several well-known brands of quality manufacturers, including Gill Instruments, RM Young, Kipp & Zonen, and Vaisala. It is our hope that our products will meet all your monitoring requirements.

2 INTRODUCTION

The **110-WS-25DL Data Logger** is designed to provide an affordable and easy-to-use solution for environmental monitoring purposes. It supports up to three anemometers, recording wind speed, gust, pulse count and direction. Seven analog channels for temperature, humidity, pressure, solar radiation, and many other types of sensors can be set up using the front-panel programming buttons. Spare anemometer channels can be re-purposed to monitor tipping bucket rain gauges or other pulse-type sensors.

Sensor readings are recorded directly on a 512MB Secure Digital (SD™) card along with the time and date. A new file is created each day in a convenient comma-separated values (CSV) format. The logger is compatible with SD cards up to 2GB, but does not support SDHC cards. We recommend purchasing tested spare cards directly from NovaLynx for best results.

Real-time data can be viewed in a terminal program or displayed with the optional 110-WS-STR Graphical Display Software on a Windows PC. An add-on device server board (NovaLynx 110-WS-25DS) is available for a hosted internet connection.

Consult NovaLynx for a list of compatible sensors, mounting equipment and solar panels for remote applications.

The 110-WS-25DL Data Logger may be ordered without sensors. However, when sensors are ordered with the logger most of the input channel programming is done at the factory, making installation that much simpler. NovaLynx offers modular weather stations with selected sensors and a tripod:

- 110-WS-25 Desktop Enclosure Wind Speed & Direction, Temperature, Relative Humidity, Barometric Pressure, Precipitation
- 110-WS-25N NEMA Enclosure Wind Speed & Direction, Temperature, Relative Humidity, Barometric Pressure, Precipitation
- 110-WS-25P-A Carrying Case Wind Speed & Direction, Temperature
- 110-WS-25P-B Carrying Case Wind Speed & Direction, Temperature, Relative Humidity

3 SPECIFICATIONS

OPERATOR INTERFACE

- 16 character by 2 line LCD display
- Backlight with automatic or manual shutoff
- Adjustable contrast
- Three momentary buttons

LOGGING AND STORAGE

- Logs at 10 to 16,000 second intervals
- Secure Digital™ or Multi Media Card™
- Supports 2 gigabyte or smaller cards
- Data files in Comma Separated Vertical (CSV). Can be used with spreadsheet software, databases, or custom software
- One data file per calendar day

RS232 INTERFACE

- EIA/TIA-232 voltage levels
- Four position screw terminals connector. Accepts 0.08 to 1.5 mm2 (28-16 AWG) wire. Strip length, 5.5 mm (0.21 in)
- 1200, 2400, 4800, 9600, 19200, 57600, and disabled baud rates, 8 bits, no stop bit, 1 parity bit (8N1)
- No hardware handshaking
- Accessible through connector marked “RS-232”
- Outputs raw data logger record in same format as written to memory card

ANALOG INPUTS

- 0 to 5 volt range
- 12 bit analog to digital converter, 1.22 mV precision
- Internal 5 volt 1% band gap voltage reference
- RC low pass on all inputs (fc=159 Hz)
- User configurable linear functions for displaying real units as well as voltage

DIGITAL INPUTS

- Supports dry contact switch, hall effect switch, or TTL level signal
- RC low pass filter on each input (fc=159 Hz)
- Inputs pulled to 5 volts with internal 4.7k resistor

POWER

- 8 to 32 volts DC
- 2.1 x 5.5 mm power jack

- 50mA peak power while writing to SD card
- 35mA with backlight on
- 15mA with backlight off
- All sensors inputs have Transient Voltage Suppression (TVS) protection

4 COMPONENTS

The logger is available in a desktop enclosure, weatherproof outdoor enclosure, or carrying case with space for additional equipment.

110-WS-25DL-D WS-25 Data Logger with desktop enclosure (Exterior: 8.5"w x 4"h x 6"d)
512MB SD™ industrial grade memory card and memory card reader
DB9 Female Serial Cable, (58" | 1.5m) and RS232 output tester
100-240 VAC input / 12 VDC 1A output power adapter (26" | 0.7m)
Screwdriver set

110-WS-25DL-N WS-25 Data Logger with NEMA-4X enclosure (Interior: 10"w x 12"h x 5.27"d)
512MB SD™ industrial grade memory card and memory card reader
DB9 M/F Serial cable (6' | 1.8m) and RS232 output tester
100-240 VAC input / 15 VDC 0.8A output smart battery charger
12V, 7Ah Sealed Lead Acid Battery and 250V 1A slow blow fuse
Lightning arrester/terminal board
Pole mounting kit for NEMA-4X enclosure
Mini digital multimeter, screwdriver set

110-WS-25DL-CC WS-25 Data Logger with carrying case (Interior: 18.6"w × 14.2"h × 7.7"d)
512MB SD™ industrial grade memory card and memory card reader
DB9 M/F Serial cable (6' | 1.8m) and RS232 output tester
100-240 VAC input / 15 VDC 0.8A output smart battery charger
12V, 7Ah Sealed Lead Acid Battery and 250V 1A slow blow fuse
Screw terminal boards for sensor connections
Mini digital multimeter, screwdriver set

5 CONNECTIONS

The location of the various connectors depends on the enclosure in which the logger is mounted. Connection diagrams for each type of enclosure are in **Appendix A**, **Appendix B** and **Appendix C**. An example modular weather station wiring diagram is shown in **Appendix D**.

5.1 Desktop Enclosure Connections

Refer to your sensor documentation and **Appendix A** for wiring information. All connections to the desktop model are on the back of the enclosure. Disconnect power to the logger before wiring the sensors.

The power connection for the desktop model is the AC Adapter. To turn on the logger, simply connect the AC Adapter to a 100-240 VAC receptacle.

The RS232 serial cable may be connected to a Windows PC computer so that real-time data is displayed in a terminal program or in the 110-WS-STR Graphical Display Software (sold separately).

5.2 NEMA-4X Enclosure Connections

Refer to your sensor documentation and **Appendix B** for wiring information. Disconnect power to the logger before wiring the sensors. Connect the sensors to the lightning arrester circuit board inside the enclosure. Be sure to connect the shield wires from each sensor to the earth grounding point inside the enclosure. The earth grounding point is wired to a copper lug located on the bottom of the NEMA box. Provide a large-gauge (#4AWG) wire to connect the copper lug to an earth grounding rod.

The NEMA-4X enclosure includes a 12V 7Ah battery which is capable of running the system several days between charges. To turn on the logger, connect the red battery terminal wire to the positive terminal of the battery.

The battery can be continuously charged by connecting the power cable to a 100-240 VAC receptacle. Use only a GFCI protected circuit, and be sure the connection is made in a weathertight outlet. If AC power is not available the AC charger can be disconnected and a solar panel with regulator connected instead. A suitable solar panel with regulator is the 110-WS-25SP 10-watt panel (sold separately).

A DB9 M/F Serial cable is included to allow connection to the data logger's serial output connector. This can be used to monitor the data output of the station prior to leaving it to operate on its own. The included RS232 output tester can be connected to verify activity on the transmit line, or a laptop with a terminal program can be used to display each set of readings as they are generated in real-time.

5.3 Carrying Case Enclosure Connections

Refer to your sensor documentation and **Appendix C** for wiring information. Usually, any sensors ordered with a logger in a carrying case are pre-wired to the logger. If it is necessary to add or remove sensors, first disconnect power to the logger. Carefully lift the logger out of its foam pocket to access the two breakout boards located underneath the logger. The pin-out of the terminals may vary depending on the sensors chosen, so check the special instructions, if any, included with your system.

The carrying case includes a 12V 7Ah battery which is capable of running the system several days between charges. To turn on the logger, connect the red battery terminal wire to the positive terminal of the battery.

An AC charger is included for recharging the battery, usually after a logging session is done. However, the battery can be continuously charged by connecting the power cable to a 100-240 VAC receptacle. If used out-doors, connect only to a GFCI protected circuit, and be sure the connection is made in a

weathertight outlet. Make sure no un-authorized personnel have access to the unit as there is risk of electrical shock if miss-handled. Do not attempt to use the AC charger if there is any chance of rain during your logging session. A much safer option, if charging is needed while collecting data, is to purchase the 110-WS-25SP 10-watt solar panel/regulator.

The DB9 Serial cable can be used to monitor the data output of the station prior to leaving it to operate on its own. The included RS232 output tester can be connected to verify activity on the transmit line, or a laptop with a terminal program can be used to display the lines of data as they are generated in real-time.

6 OPERATING INSTRUCTIONS

If you are starting your logger for the first time you may wish to remove the SD card (if installed) before applying power to the logger. After setting up any required sensors and setting the clock the card can be inserted to begin logging.

Connect power to your 110-WS-25DL Data Logger by connecting the battery red terminal to the positive battery terminal, or for desktop units, by plugging the AC adapter into a 100-240 VAC receptacle.

The display will briefly show a start-up screen which states the firmware version number (currently *wind2h 31-Jan-18 BUILD*). The next screen begins the menu system for viewing data and programming the logger.* The backlight on the display will turn on and remain on for 30 seconds, unless a key is pressed which will extend the timer.

*NOTE: The logger cannot be programmed by connection to the serial port. Use the display and keys on the front panel to make all programming changes, as required.

6.1 Navigation

The WS-25 Data Logger includes a 16 character by 2 line backlit LCD screen, which displays current information and is used for configuring the data logger.

Button	Functions
▼	**DOWN / LEFT**: Scroll down or decrease value
SELECT	Select sub-menu or set calibration
▲	**UP / RIGHT**: Scroll up or increase value

NOTE: All buttons respond to a single press; holding a button will not cause multiple actions to occur.

A Secure Digital (SD™) card slot makes recording and accessing data easy. The card slot is spring-loaded. To insert a Secure Digital™ (SD™) card, place the card face up into the slot on the front panel and press the card inwards until the card clicks into place. To remove the card, press the card slightly inward and the card will release. **The card should not be removed by pulling it out without first pressing it inwards. If a card is pulled out in this manner, both the memory card and the card socket may be damaged.**

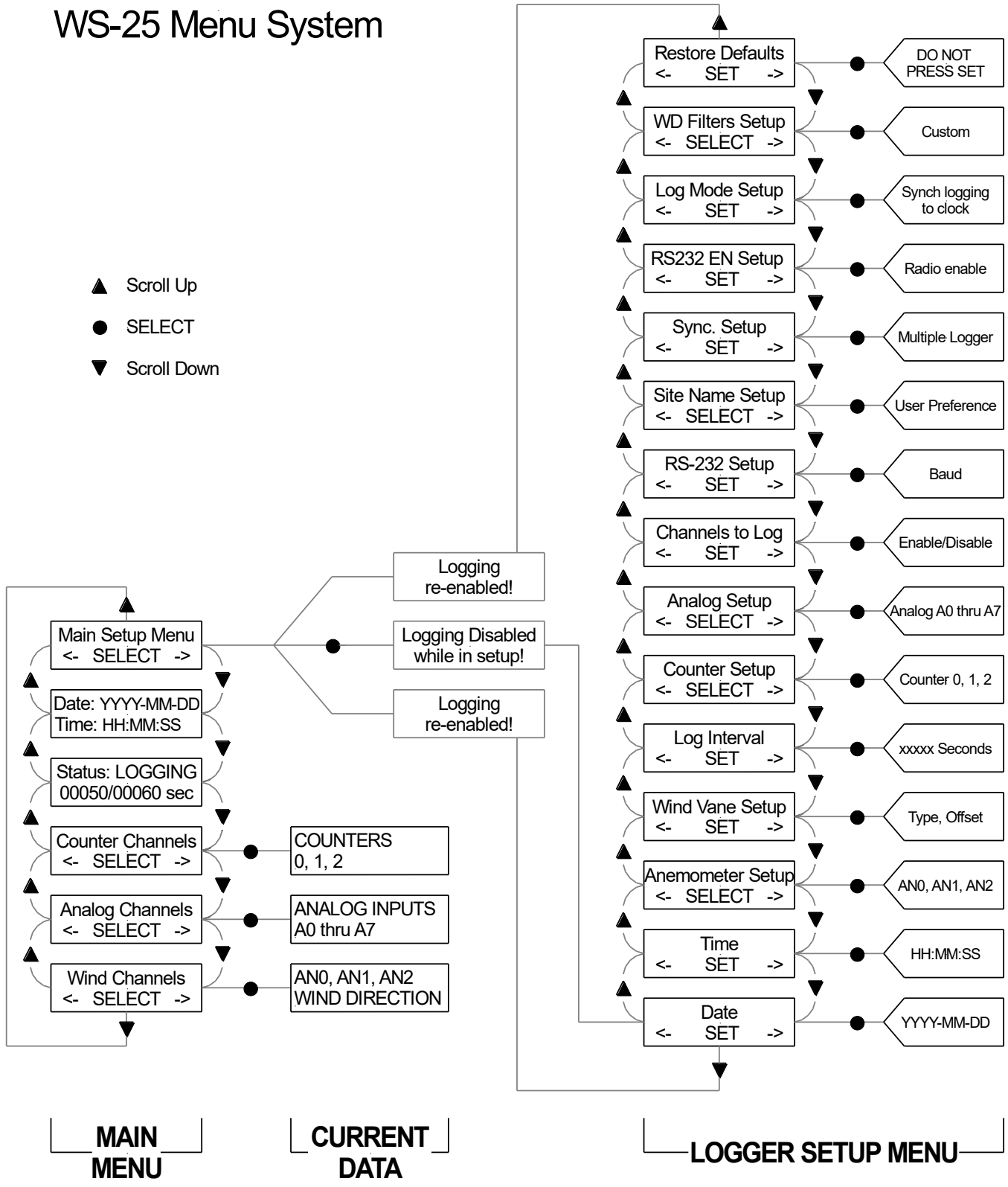
6.2 Main Menu

The Main Menu system begins with the "Wind Channels" display. Pressing the UP and DOWN keys moves through the menu, while pressing the SELECT key leads to the sub-menu for that option if available.

Wind Channels	Press SELECT to view data from AN0, AN1, AN2, and Wind Direction
Analog Channels	Press SELECT to view data from A0, A1, A2, A3, A4, A5, A6, and A7
Counter Channels	Press SELECT to view data from counter 0, 1, and 2
Status	Displays the current status of logging (LOGGING or NOT RDY)
Date & Time	Displays the current clock date and time
Main Setup Menu	Press SELECT to enter the programming sub-menu. Avoid entering this menu unless changes are required.

***CAUTION:** When the **"Restore Defaults"** window is displayed **DO NOT PRESS SELECT.** Instead press the **UP** key to exit the Setup sub-menu. If you do select "Restore Defaults" the logger will be reprogrammed to defaults which will probably not match your sensors.*

WS-25 Menu System



Ordering of Alphanumeric Characters (for use when programming a label field)

A - Z	0 - 9	blank	°	.	@	?	!	%	&	*	+	-	=	/	¥	<	>	:	;	(	)	'	"	#	$	{	}	_	π

6.3 Set the Clock

Many users prefer to set the clock to UTC (Coordinated Universal Time) rather than local time to avoid discrepancies caused by daylight savings time. UTC time is based on the prime meridian and does not change with daylight savings adjustments. Local time is found by adding or subtracting an offset from UTC time.

Please check the clock date and time using the Main Menu **Date & Time** display. The date is displayed in YYYY-MM-DD format. The time is 24-hour format HH:MM:SS. If the clock is incorrect, scroll to the **Main Setup Menu** using the UP key. Press SELECT. A brief note will indicate that logging is disabled while in the Setup sub-menu.

The **Date Set** menu is displayed. If the date needs to be changed, press SELECT to set the date. Notice that the underline bar will appear under the least significant digit of the year YYYY-MM-DD.

YEAR	YYY<u>Y</u>-MM-DD	UP to increase, DOWN to decrease, SELECT to finish
MONTH	YYYY-M<u>M</u>-DD	UP to increase, DOWN to decrease, SELECT to finish
DAY	YYYY-MM-D<u>D</u>	UP to increase, DOWN to decrease, SELECT to finish

After pressing SELECT for the DAY, the underline disappears and the date is set. Press the UP key to switch to the **Time Set** menu. Press SELECT to program the time. Note the least significant digit of the hour is underlined.

HOUR	H<u>H</u>:MM:SS	UP to increase, DOWN to decrease, SELECT to finish
MINUTE	HH:M<u>M</u>:SS	UP to increase, DOWN to decrease, SELECT to finish
SECOND	HH:MM:S<u>S</u>	UP to increase, DOWN to decrease, SELECT to finish

After pressing SELECT for the SECONDS the underline disappears and the time is set. Press the DOWN button twice to return to the Main Menu by the shortest route.

6.4 Start Logging

The WS-25 Data Logger stores data whenever the power is turned on and the memory card is installed (except while programming). Check the Status menu to verify that the data logger is recording. If a memory card is inserted but the data logger shows “NOT READY” then there is a problem and the data logger WILL NOT record anything. Check to be sure the card is fully inserted and meets the memory card requirements.

Real-time data is available at the serial output and on the display even when the memory card is not installed. Please note that only channels that are enabled for logging will appear in the data records on the memory card (Section 7.6 Channels to Log).

6.5 Download Log Files

The WS-25 Data Logger writes Comma-Separated Values (CSV) files to the memory card. CSV data can be used by spreadsheet programs, SQL databases, standard software, and custom software. The logger generates one file per calendar day in the main directory or folder of the SD or MMC. The date is embedded in the file name with the format YYYYMMDD.CSV The data logger also writes two other files that contain meta information about the channels being logged. For most applications these files can be ignored.

The log file consists of a series of records arranged one record per line. The first field of each record is the date and time the readings were taken. Each field after that is indicated by a comma, whether there is data in the field or not. The number of fields is fixed, so that even if some channels are not logged (each channel can be enabled/disabled) the position of the channel in the record does not change.

The WS-25 Data Logger does not pre-pend column headings in the data file. If column headings are required you will need to add them manually. In a spreadsheet, after opening the .CSV file, insert enough rows above the data for the headers you want to create. You may copy and save your header to insert in other files.

To retrieve the log file, first remove the memory card from the logger by pressing down to release it. When it pops up you can gently pull it out. Insert the card in the memory card reader, then plug the USB end of the reader into your computer. The contents of the card will be shown in your file menu. Copy the files you wish to examine to your computer. When you are done reading the card you may wish to erase old files from it if there is a chance it will overflow.

It is good practice to right-click the memory card reader drive and "eject" the drive before disconnecting from your computer. You may be prompted to close any open files. If files are open when the reader is disconnected the card could become corrupted.

The .CSV file structure can best be seen in a text program by right-clicking the file and selecting "open with" to access a text program such as Notepad. Below is a sample:

```
2019-09-17 00:00:06,0.0,0.0,0,,,,,,,,0.00,58,12.18,,,,12.9,28.0,5.569,,53
2019-09-17 00:01:06,0.0,0.0,0,,,,,,,,0.00,58,12.18,,,,11.8,27.4,5.530,,25
2019-09-17 00:02:06,0.0,0.0,0,,,,,,,,0.00,58,12.14,,,,10.9,27.0,5.498,,190
2019-09-17 00:03:06,0.0,0.0,0,,,,,,,,0.00,57,12.14,,,,10.3,26.6,5.467,,246
```

As you can see, the data was generated September 17, 2019 at 6 seconds after midnight. A new record was added every minute. Some fields contain data, but others are empty meaning those channels were disabled for logging. The last number in each record is a Cyclic Redundancy Check (CRC), not a data value.

The same data is presented here after opening the .CSV file in a spreadsheet. The commas were automatically replaced by columns.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	9/17/2019 0:00	0	0	0									0	58	12.18				12.9	28	5.569		53
2	9/17/2019 0:01	0	0	0									0	58	12.18				11.8	27.4	5.53		25
3	9/17/2019 0:02	0	0	0									0	58	12.14				10.9	27	5.498		190
4	9/17/2019 0:03	0	0	0									0	57	12.14				10.3	26.6	5.467		246

In this final example, the data was pasted into a spreadsheet that already had titles on each column.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Wind Speed, Wind Gust, Direction, and Pulses														Analog Voltages from a Variety of Inputs								
2		Anemometer 0			Anemometer 1			Anemometer 2			Counter	Counter	Counter	Wind	A0,	A1,	A2,	A3,	A4,	A5,	A6,	A7,	
3	Date Time	Speed	Gust	Pulse-Count	Speed	Gust	Pulse-Count	Speed	Gust	Pulse-Count	0	1	2	Direction	10bits	10bits	10bits	10bits	12bits	12bits	12bits	12bits	CRC
4	9/17/2019 0:00	0	0	0									0	58	12.18				12.9	28	5.569		53
5	9/17/2019 0:01	0	0	0									0	58	12.18				11.8	27.4	5.53		25
6	9/17/2019 0:02	0	0	0									0	58	12.14				10.9	27	5.498		190
7	9/17/2019 0:03	0	0	0									0	57	12.14				10.3	26.6	5.467		246

Create your own titles or use the WS-25 Data Logger Worksheet.xlsx which can be downloaded at www.NovaLynx.com. See **Appendix F** for additional information.

7 PROGRAMMING THE WS-25 DATA LOGGER

Some writers would tell you that programming this logger is a breeze, and with a few simple steps you will be on your way. Forget that. If you have already set the date and time, you have done the easy part. We will not review those steps here, but begin with "Anemometer Setup".

From the Main Menu loop, press the UP button until you get to **Main Setup Menu**, then press SELECT. Press the UP button twice to skip the **Date** and **Time** to get to **Anemometer Setup**. If you do not need to change the Anemometer Setup, then continue to press the up button until you get to the menu you want. Each section below (7.1 thru 7.13) covers a different menu item in the order you will encounter them when pressing the UP button.

7.1 Anemometer Setup (AN0, AN1, AN2)

If you enter Anemometer Setup you will have to toggle through every step of at least one anemometer before you can exit (i.e. press SELECT multiple times). The anemometer channels are actually general-purpose because they will accept any pulse-type input (dry contact, Hall effect, or TTL level signal) up to 159 Hz. Each input signal produces three data points: rate, peak rate, and total. For an anemometer, that relates to wind speed, gust, and total pulses which is proportional to wind run. The WS-25 Data Logger does not calculate averages, but the average can be calculated in a spreadsheet using the total pulses value.

Two constants are needed to scale the frequency of the input pulses to engineering units such as miles per hour (MPH) or meters per second (m/s). The Slope (m) and Offset (b) are used in the formula y=mx+b to scale the channel to the engineering units you choose. The Label and Units are your choice and are spelled out by cycling through A-Z, 0-9 and special characters (Examples in **Appendix E**).

Press SELECT to enter Anemometer Setup. Press UP to select AN0, AN1 or AN2, then SELECT to begin programming.

1. **Program the Slope (m)**
   The "AN_M0" in the illustration to the right indicates that the channel being programmed is AN0, and the parameter is "M" or slope.

   ```
   ±0001.2500 AN_M0
   -      Set       +
   ```

   Notice that the "+" is underlined. To change the "+" to "-" press the DOWN button. Otherwise press SELECT to skip.

   The underline will skip to the next digit each time the SELECT button is pressed. While under a numeral, the value can be increased by pressing UP or decreased by pressing DOWN. Please note that the decimal point position is fixed and the underline will skip past it after the units position is set.

   There is no way to go back if an error is made once a digit is entered. In that case, toggle through the rest of the number and any other screens you need to get through to get back to the beginning and start over.

2. **Program the Offset (b)**
   The "AN_B0" in the illustration to the right indicates that the channel being programmed is AN0, and the parameter is "B" or offset.

   ```
   ±0000.0000 AN_B0
   -      Set       +
   ```

   Program the offset number in the same manner as the slope. Again, the decimal point position is fixed. When the last digit is entered press SELECT to store the offset.

3. **Program the Label**
   The "-> 0" in the illustration to the right indicates channel 0. The underline is below the "W". Spell out any label you want by pressing UP or DOWN to cycle through the available characters, then press SELECT to save the character and advance to the next position. There are 13 positions available. You cannot go back to correct a mistake.

   ```
   WIND SPEED    ->0
   -      Set       +
   ```

4. **Program the Units**
   Program the units in the same way as the label was programmed. There are only 3 positions available for the units. This is the last step in programming the anemometer channel.

   ```
   MPH->             0
   -      Set       +
   ```

7.2 Wind Vane Setup

At the Wind Vane Type screen press the LEFT button to select LINEAR. The other selection is not applicable.

```
Wind Vane Type:
LINEAR*      FASC
```

The Direction Offset applies to Analog Input 1 when it is being used to read the potentiometer of a wind vane. If the wind vane was not installed with its index pointing north, then the offset can be adjusted to compensate.

The offset is added to the reading from the wind vane. The wind direction "wraps" at 360°, so that if the vane reads 350° and the offset is 10°, then the displayed and logged value will be zero. The tens digit is underlined; if you continue to press the UP button the hundreds will eventually increment. After pressing SELECT the underline will move to the units digit. This is the last step in programming the wind vane.

```
Dir Offset: 000°
-      Set       +
```

7.3 Log Interval

Set the logging interval between 10 and 16,000 seconds. The peak (gust) values and totalizer counts are reset at the same interval.

```
Log Sec:    00060
-      Set       +
```

7.4 Counter Setup (Counter 0, 1, 2)

If you enter Counter Setup you will have to toggle through every step of at least one counter before you can exit (i.e. press SELECT multiple times). Use the UP button to select which counter to calibrate. Counter 0 is associated with the input for AN0, Counter 1 is associated with AN1, etc.

1. **Set the count value**
   Set the value of each count on the screen labeled "CNT_M". With the value shown (m = 1) the counter will increment once per pulse on the input. If this channel is to be used for a tipping bucket rain gauge, the value might be m = 0.01 for a rain gauge that measures 0.01" of rain per tip.

```
±0001.0000 CNT_M
-      Set       +
```

2. **Set the offset**
   If there is an offset, enter that in the screen labeled "CNT_B".

```
±0000.0000 CNT_B
-      Set       +
```

3. **Add a label**
   Enter a descriptive label for the counter (11 characters).

```
ANEMO 0    ->CNT0
-      Next      +
```

4. **Add the units**
   Enter the units for the counter (3 characters).

```
CNT->  CNT0_UNIT
-      Next      +
```

7.5 Analog Setup (A0 thru A7)

If you enter Analog Setup you will have to toggle through every step of at least one analog channel before you can exit (i.e. press SELECT multiple times). Use the UP button to select the analog channel you wish to program, then press SELECT.

Plan your analog channel setup carefully to make best use of the WS-25 Data Logger's resources. Each analog input channel (except A0) reads 0-5 volt signals and has transient voltage surge (TVS) protection. Sensors with current output such as 4-20mA can be read provided a suitable resistor is connected between the signal input and ground. The logger provides regulated 5 volts for excitation (not switched).

The values that are displayed and logged are formatted in terms of the number of decimal places that will be displayed:

Channel A0: 0.xx	Channel A1: 0.xx	Channel A2: 0.xx	Channel A3: 0.x
Channel A4: 0.x	Channel A5: 0.x	Channel A6: 0.xxx	Channel A7: 0.xxx

Analog Channel Characteristics

1. Channels **A0** thru **A3** are 10-bit channels suitable for many sensors. However, if better resolution is required consider connecting your sensor to channel A4 thru A7, which are 12-bit resolution. Channels A6 and A7 display up to three decimal places.

2. **A0** is dedicated to reading the logger supply voltage. Do not change the calibration settings (m=8, b=0) otherwise the power supply voltage reading will be incorrect.

3. **A1** is configured to monitor a potentiometer-type wind direction sensor. Channel A1 includes a pull-down resistor (R11, 200k) at the input which ensures that the input is grounded when the wiper of the wind direction sensor is in the "dead band" of its potentiometer. Without the pull-down resistor the input will "float" and a random value will be recorded when the vane points north. Channel A1 is associated with the wind vane direction offset (Section 7.2) and the WD Filters (Section 7.12). If you will be monitoring a wind vane then use A1 in order to have access to the offset feature.

   Channel A1 can be used as a general-purpose input as long as the wind vane direction offset is set to zero. For best accuracy, disable the 200k pull-down resistor by disconnecting the SW2 jumper on the back of the logger input circuit board.

4. **A2** is also factory-configured to monitor a potentiometer-type wind direction sensor. It includes a pull-down resistor (R12, 200k) to ground the input when the vane swings through the "dead band" of the potentiometer. This input is not associated with a programmable wind vane direction offset, so if a wind vane is used it must be properly oriented with reference to North when installed.

   Channel A2 can be used as a general-purpose input for sensors that have a low-impedance output that will not be influenced by the pull-down resistor. However, in some cases the resistor introduces an unacceptable amount of error. For this reason NovaLynx often removes the resistor (R12) from the circuit board, and indicates the fact in the documentation provided with the logger.

   The data output of A2 can be mathematically filtered by the WS-25 Data Logger (Section 7.12).

5. **A3** is configured to read temperature using a precision integrated circuit temperature sensor (NovaLynx part number 200-WS-25T). The sensor range is -40°C to 60°C (-40°F to 140°F). The sensor includes 25' of cable with an RJ-45 connector that plugs directly into the Wind Data Logger. Custom length temperature sensors are available upon request, along with accessories such as a radiation shield.

   Channel A3 can be used as a general-purpose input for sensors with a low-impedance output. For best accuracy the pull-up resistor (R1, 4.7k) should be removed from the circuit board. Please check the documentation provided with your logger to determine whether the resistor was removed when the system was customized to your requirements.

6. **A4**, **A5**, **A6** and **A7** are 12-bit general-purpose 0-5 volt analog input channels. These channels can read current when a suitable resistor is connected from the signal input to ground.

   Each channel has a pull-up resistor (2.2k) that can be independently switched to the 5 volt supply. This provides approximately 2 mA of current which is enough to power certain types of sensors. The default switch setting is OPEN, meaning the resistors have no effect unless the switch is closed. The 4-gang DIP switch is labeled SW1 and is on the back of the logger input circuit board.

7.5.1 Slope & Offset Calculations

The WS-25 Data Logger must be programmed with two calibration factors for each input channel in order to calculate and store the data in engineering units such as MPH or KPH for wind speed, etc. It applies the formula y = mx + b where "m" is the slope of a line and "b" is the intercept (sometimes called the offset).

The equation is linear, and will not work for non-linear sensors such as resistance temperature devices (RTDs). In the case of non-linear sensors, set m=1 and b=0 so that the logger records the raw output of the ADC convertor. Post-process the raw data after you have transferred the log file to a spreadsheet.

The WS-25 Data Logger cannot combine information from two sensors or do other calculations on the data. Instead, the user may post-process the data in a spreadsheet using whatever formulas are required.

Values for "m" and "b" are given for several compatible NovaLynx sensors in **Appendix E**. The calibration values for most sensors may be found in their respective data sheets. If the data sheet provides the information as data points, then calculate the slope and intercept using a spreadsheet program.

Example: Given a temperature sensor that outputs 0 volts at -273.15°C and 2.7315 volts at 0°C.

	A	B
1	**Volts (x-values)**	**Temperature°C (y-values)**
2	0	-273.15
3	2.7315	0
4		
5		
6	Slope (m)	=SLOPE(B2:B3,A2:A3)
7	Intercept (b)	-273.15

	A	B
1	**Volts (x-values)**	**Temperature°C (y-values)**
2	0	-273.15
3	2.7315	0
4		
5		
6	Slope (m)	100
7	Intercept (b)	=INTERCEPT(B2:B3,A2:A3)

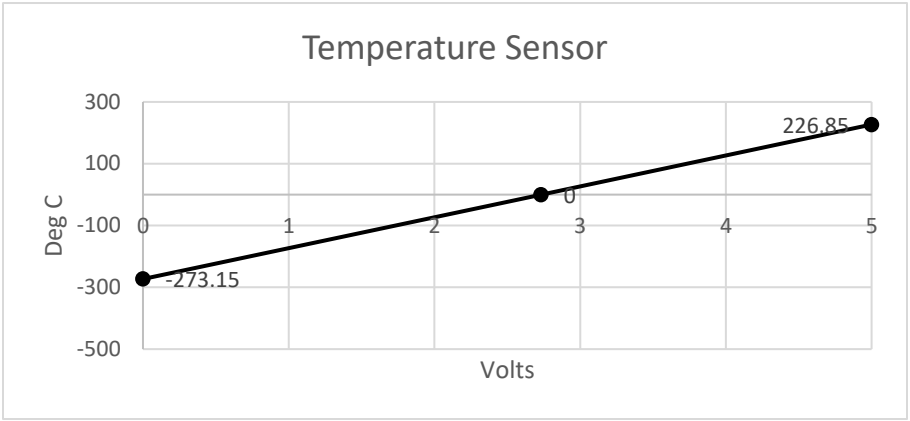
Result: Slope(m) = 100 Intercept(b) = -273.15

A Slope Calculator is included in WS-25 Data Logger Worksheet.xlsx which can be downloaded at www.NovaLynx.com.

If you don't have a spreadsheet handy, the formulas for slope and intercept are:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$b = y - mx$$



7.5.2 Input the Slope, Offset, Label and Units

1. **Program the Slope (m)**

   The "A_M1" in the illustration to the right indicates that the channel being programmed is A1, and the parameter is "M" or slope.

   ```
   ±0072.0000   A_M1
   -      Set       +
   ```

   Notice that the "+" is underlined. To change the "+" to "-" press the DOWN button. Otherwise press SELECT to skip.

   The underline will skip to the next digit each time the SELECT button is pressed. While under a numeral, the value can be increased by pressing UP or decreased by pressing DOWN. Please note that the decimal point position is fixed and the underline will skip past it after the units position is set.

   There is no way to go back if an error is made once a digit is entered. In that case, toggle through the rest of the number and any other screens you need to get through to get back to the beginning and start over.

2. **Program the Offset (b)**

   The "A_B1" in the illustration to the right indicates that the channel being programmed is A1, and the parameter is "B" or offset.

   ```
   ±0000.0000   A_B1
   -      Set       +
   ```

   Program the offset number in the same manner as the slope. Again, the decimal point position is fixed. When the last digit is entered press SELECT to store the offset in memory.

3. **Program the Label**

   The "-> 1" in the illustration to the right indicates channel 1. The underline is below the "W". Spell out any label you want by pressing UP or DOWN to cycle through the available characters, and pressing SELECT to enter the character and advance to the next position. There are 13 positions available. You cannot go back to correct a mistake.

   ```
   WIND DIR      ->1
   -      Set       +
   ```

4. Program the Units

Program the units in the same way as the label was programmed. There are only 3 positions available for the units. This is the last step in programming the anemometer channel.

```
DEG->            1
-      Set       +
```

7.6 Channels to Log

Any combination of channels can be enabled for logging. The position of each channel in a record of data is marked by a comma whether data is recorded or not, so the structure of the record is not affected. Turning off unused channels saves space on the memory card and avoids clutter in your files.

When you enter the Channels to Log sub-menu you must program every channel to either Enable or Disable logging. Unfortunately the SELECT button does not operate to allow you to skip through the menu. It is very easy to turn off a channel by mistake. You cannot step through the menu to see what was programmed because the act of going through the menu is what programs the status.

In the illustrations to the right, notice the location of the "*" character. If it is next to "ENABLE*" then the channel was logging. If it is next to "*DISABLE" then the channel was not logging. This helps remind you what the status was, but what you do next determines the future status.

ENABLE is on the left to remind you to push the LEFT button. ▼

DISABLE is on the right to remind you to push the RIGHT button. ▲

```
00: Anemometer 0
ENABLE*  DISABLE
        …
02: Anemometer 2
ENABLE   *DISABLE
        v
03: Counter 0
ENABLE*  DISABLE
        …
05: Counter 2
ENABLE   *DISABLE
        v
06: Wind Directi
ENABLE*  DISABLE
        v
07: Analog 0
ENABLE*  DISABLE
        …
14: Analog 7
ENABLE   *DISABLE
```

A safe way to verify that the correct channels are enabled is to allow the logger to collect some data and then read the file into a spreadsheet. Put the column headers in the correct columns and make sure there is data in every column that was supposed to be included. Do not enter the Channels to Log sub-menu after this test or you may accidentally turn off a channel.

7.7 RS232 Setup

Select from 1200, 2400, 4800, 9600, 19200 or 57600 baud or disable RS232 by pressing the UP or DOWN keys. The "*" character indicates the current setting. The baud that is selected is the one shown when you press SELECT.

```
Baud: 9600*
-      Set       +
```

The Wind Data Logger sends each data record to the RS-232 port immediately after writing to the memory card, using the same format. Each record is terminated with a \r\n (carriage return, line feed) sequence. Data is sent as 8 bits, no parity, and 1 stop bit (8N1). No hardware handshaking is used.

7.8 Site Name Setup

Enter a name for your logger using up to 9 characters.

```
WS25      -> Site
-      Set       +
```

7.9 Sync Setup

There are three options for synchronization of multiple loggers. If only one logger is being used, select the "no RS-232 sync" option. For systems with 2 or more loggers, the "Send on Log" selection will cause the "master" to transmit a "sync" packet. The other loggers are set to "Log on receive" so that they record data at about the same time as the master. Systems with multiple loggers often communicate via radio. The "*" indicates the current selection.

```
*no RS-232 sync
-      Set       +
```

```
 Send on Log
-      Set       +
```

```
 Log on receive
-      Set       +
```

7.10 RS232 EN Setup

There are three options for RS232 Enable. "Xbee Sleep" is the default. It causes the ENABLE line (a terminal on the same block as the RS232 transmit and receive lines on the mother board) to toggle low for 40 mS before data is transmitted. "Power Blip" has a similar function but with a longer hold time. "GPS to Lock" requires a special circuit board and is not available with the WS-25.

```
*Xbee Sleep
-      Set       +
```

```
 Power Blip (10s
-      Set       +
```

```
 GPS to Lock
-      Set       +
```

7.11 Log Mode Setup

There are five options for Log Mode Setup. An advantage of using a synchronized "Top of …" setting is when daily files are joined into larger files or databases. It can also be used to synchronize loggers without having to network them together. The "*" indicates the current selection.

```
*Free running
-      Set       +
```

```
 Top of 10 sec
-      Set       +
```

```
 Top of Minute
-      Set       +
```

```
 Top of 10 min
-      Set       +
```

```
 Top of Hour
-      Set       +
```

7.12 WD Filters Setup

Three of the data output fields can be filtered mathematically by the WS-25 Data Logger. These are the Wind Direction, Analog 1, and Analog 2. (Spreadsheet columns N, P, Q respectively). It might be rare to have a situation where this type of filter is needed, but for the curious, this is how it works:

ENABLE is on the left to remind you to push the LEFT button.
DISABLE is on the right to remind you to push the RIGHT button.

```
WD Filter
ENABLE  *DISABLE
```

The first number to enter is the value of interest, say 100.

```
±0100.0000 WD RE
-      Set       +
```

The second number is the acceptable + or – range around the number of interest. If you enter 5, for instance, then any value between 95 and 105 is included in the filter.

The third (and last) number to enter is the value to be substituted for the filtered number (example, 25). With this filter set, whenever the logger reads a value between 95 and 100, the number 25 will be substituted into the data.

±0005.0000 WD RA
- Set +
±0025.0000 WD RE
- Set +

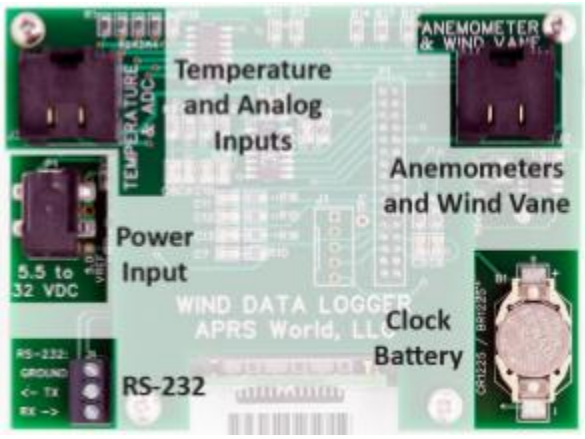
Be sure to leave the filters Disabled when not in use.

7.13 Restore Defaults

DO NOT PRESS SELECT when the "Restore Defaults" window is displayed. Instead press the UP key to exit the Setup sub-menu. If you do select "Restore Defaults" the logger will be reprogrammed to defaults which will probably not match your sensors.

8 CLOCK BACKUP BATTERY

The data logger's real-time clock uses a 3-volt lithium coin cell battery to maintain the clock while power is disconnected. CR1225, BR1225, or any 3-volt 12.5 by 2.5 mm battery may be used.
The clock battery has an estimated 10 to 15 year life span in the Wind Data Logger. If your data logger "freezes" or does not retain its date and time without power, then the battery likely needs to be replaced. To replace the battery, use a small screwdriver or toothpick to pop the old battery out of the battery holder. Insert a new battery with the writing side up.



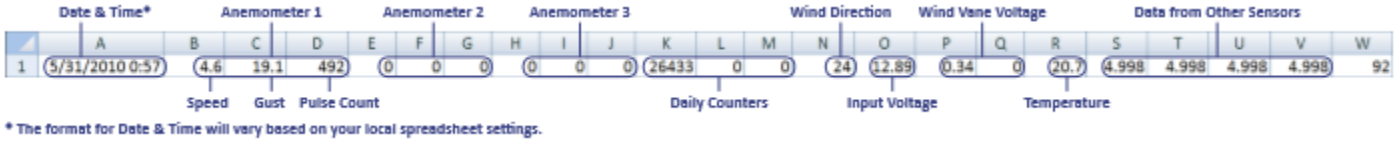
9 NOTES FOR PROGRAMMERS

The WS-25 Data Logger sends each data record to the RS-232 port immediately after writing to the memory card. The record is in the same format as that which is stored on the memory card, with some additional information tacked on the end. The additional information includes the site name and card status.

Normal records contain the following characters: 0 1 2 3 4 5 6 7 8 9 . , - : and \r\n characters, where "\r" (ASCII 13) is a carriage return and "\n" (ASCII 10) is a line feed character. The logger may also transmit debugging messages which begin with the "#" character. Such messages should be discarded by the parsing code.

Data is sent as 8 bits, no parity, and 1 stop bit (8N1). No hardware handshaking is used. The serial port baud rate is set in the serial port sub-menu.

Each record consists of data fields separated by commas. The format is fixed, so that if a data field is not filled because that channel has been turned off, the commas still mark the location. When data is imported to a spreedsheet the commas are removed and the data placed in columns. Spreadsheets usually title the columns in alpabetic order, so it is easy to locate data in the record by referring to the spreadsheet's column designations. The illustration below shows a typical record with labels indicating the type of data in each column.



The additional information (not shown above) is:

Column X:	Site Name
Column Y:	SD Card Status
Column Z:	reserved
Column AA:	CRC of each byte from column X thru the comma before column AA.

There are actually two CRC's embedded in the serial message;

Column W:	CRC of each byte from column A thru the comma before column W.
Column AA:	CRC of each byte from column X thru the comma before column AA.

The CRC is calculated one byte at a time beginning with the first character of the data through the comma immediately proceeding the CRC value. Here is a sample algorithm:

CRC Calculation Algorithm

```
int8 calc_crc(int8 old_crc,int8 newbyte) {
  int8 ctr;
  int1 fbbit;
  for (ctr=0;ctr<8;ctr++) {
      fbbit=((newbyte & 0x80)==0x80)^old_crc;
      newbyte<<=1;
      old_crc>>=1;
      if (fbbit==1)
          old_crc^=0x83;
  }
  return(old_crc);
}
```

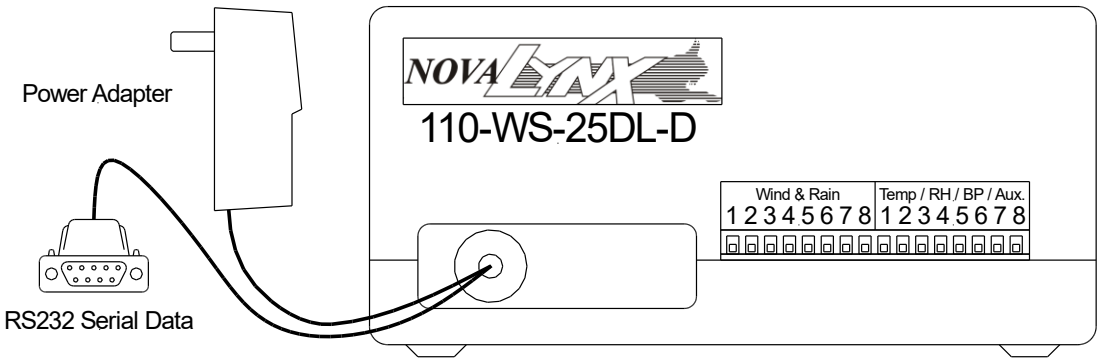
APPENDIX A (DESKTOP ENCLOSURE DIAGRAM)

110-WS-25DL-D

WS-25 Sensor Input PCB RJ-45 Connector Pinouts			Patch Cord	Backside of Logger RJ-45 Connector	Backside of Logger Screw Term	
Anemometer & Wind Vane	1	An0 (freq)	8-wire RJ45 Patch Cord	Breakout Board 200-6573	1	An0
	2	An1 (freq)			2	An1
	3	An2 (freq)			3	An2
	4	Ground			4	GND
	5	5 Volt Ref			5	5 Vref
	6	A1 (10-bit, 0-5V)			6	A1
	7	A2 (10-bit, 0-5V)			7	A2
	8	Ground			8	GND
Temperature & ADC	1	A3 (10-bit, 0-5V)	8-wire RJ45 Patch Cord	Breakout Board 200-6573	1	A3
	2	Ground			2	GND
	3	5 Volt Ref			3	5 Vref
	4	A4 (12-bit, 0-5 volt)			4	A4
	5	A5 (12-bit, 0-5 volt)			5	A5
	6	A6 (12-bit, 0-5 volt)			6	A6
	7	A7 (12-bit, 0-5 volt)			7	A7
	8	Ground			8	GND

USER CONNECTIONS

WS-25 Motherboard				
Power	Barrel	7 to 32 VDC	RED	100-240 VAC Input 12 VDC Output Adapter
		Ground	BLACK	
RS232	Screw Term	Tx ->	RED	2
		Rx <-	ORANGE	DB9 (F) Serial Cable 3
		Ground	GREEN	5
		Enable		



APPENDIX B (NEMA ENCLOSURE DIAGRAM)

110-WS-25DL-N

WS-25 Sensor Input PCB

RJ-45 Connector Pinouts

			Patch Cord
Anemometer & Wind Vane	1	An0 (freq)	8-wire RJ45 Patch Cord
	2	An1 (freq)	
	3	An2 (freq)	
	4	Ground	
	5	5 Volt Ref	
	6	A1 (10-bit, 0-5V)	
	7	A2 (10-bit, 0-5V)	
	8	Ground	
Temperature & ADC	1	A3 (10-bit, 0-5V)	8-wire RJ45 Patch Cord
	2	Ground	
	3	5 Volt Ref	
	4	A4 (12-bit, 0-5 volt)	
	5	A5 (12-bit, 0-5 volt)	
	6	A6 (12-bit, 0-5 volt)	
	7	A7 (12-bit, 0-5 volt)	
	8	Ground	

Lightning Arrester PCB

RJ-45 Connector: Lightning Arrestor PCB 200-6720

TVS	Screw Terminals	
Wind Sensors	1	An0
	2	An1
	3	An2
	4	GND
	5	5 Vref
	6	A1
	7	A2
	8	GND
Temp & ADC	1	A3
	2	GND
	3	5 Vref
	4	A4
	5	A5
	6	A6
	7	A7
	8	GND
	Earth Ground Point	
	+12V	
	GND	

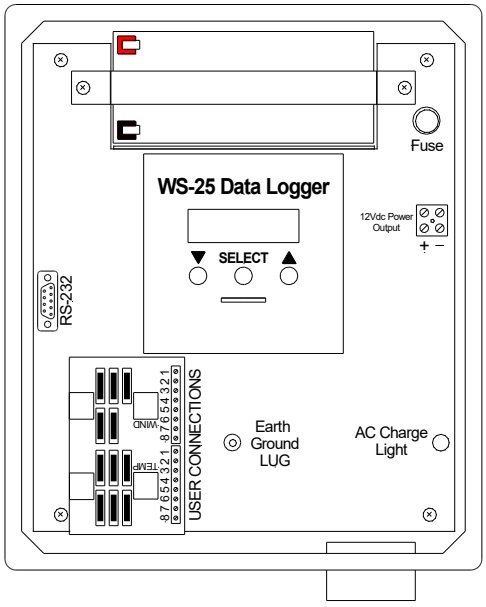
USER CONNECTIONS

WS-25 Motherboard

Power	Barrel	7 to 32 VDC	RED
		Ground	BLACK
RS232	Screw Term	Tx ->	RED
		Rx <-	ORANGE
		Ground	GREEN
		Enable	

Battery Charger
100-240 VAC Input
12 VDC Output

DB9 Bulkhead Connector
2
3
5



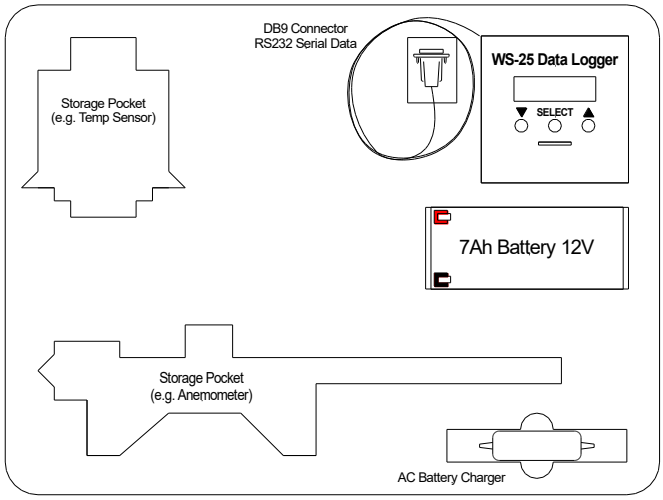
APPENDIX C (CARRYING CASE DIAGRAM)

110-WS-25DL-CC

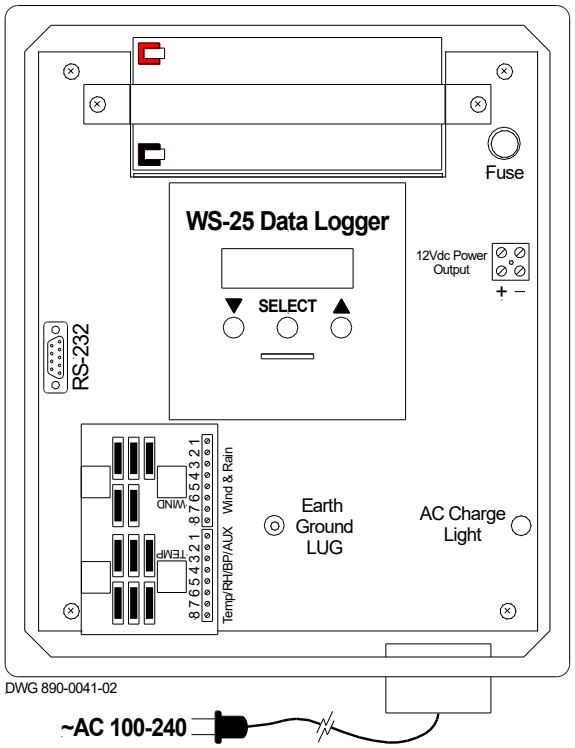
WS-25 Sensor Input PCB RJ-45 Connector Pinouts			Patch Cord	Below Logger RJ-45 Connector	Below Logger Screw Term	
Anemometer & Wind Vane	1	An0 (freq)	8-wire RJ45 Patch Cord	Breakout Board 200-6573	1	An0
	2	An1 (freq)			2	An1
	3	An2 (freq)			3	An2
	4	Ground			4	GND
	5	5 Volt Ref			5	5 Vref
	6	A1 (10-bit, 0-5V)			6	A1
	7	A2 (10-bit, 0-5V)			7	A2
	8	Ground			8	GND
Temperature & ADC	1	A3 (10-bit, 0-5V)	8-wire RJ45 Patch Cord	Breakout Board 200-6573	1	A3
	2	Ground			2	GND
	3	5 Volt Ref			3	5 Vref
	4	A4 (12-bit, 0-5 volt)			4	A4
	5	A5 (12-bit, 0-5 volt)			5	A5
	6	A6 (12-bit, 0-5 volt)			6	A6
	7	A7 (12-bit, 0-5 volt)			7	A7
	8	Ground			8	GND

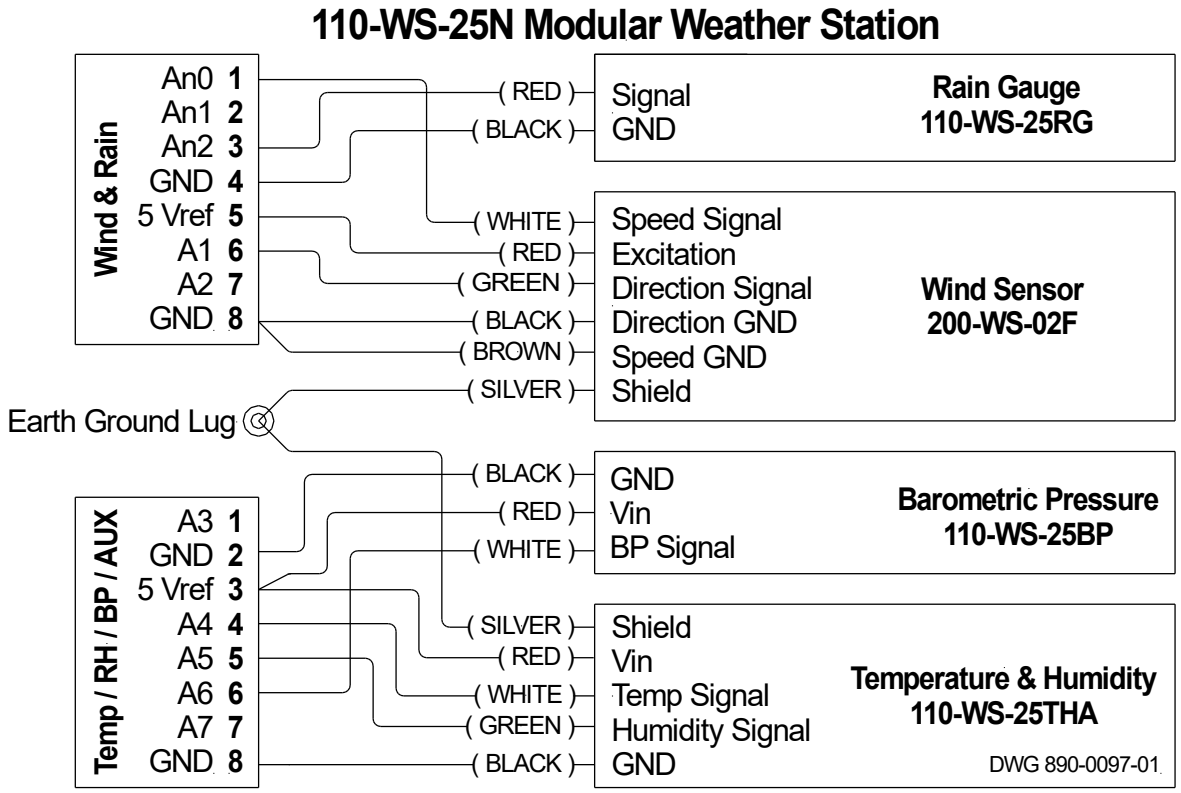
USER CONNECTIONS

WS-25 Motherboard				
Power	Barrel	7 to 32 VDC	RED	Battery Charger 100-240 VAC Input 12 VDC Output
		Ground	BLACK	
RS232	Screw Term	Tx ->	RED	DB9 (F) Serial Cable 2
		Rx <-	ORANGE	3
		Ground	GREEN	5
		Enable		



APPENDIX D (MODULAR WEATHER STATION EXAMPLE)





APPENDIX E (MODULAR WEATHER STATION SENSORS)

Channel	Sensor	Model	Range	Slope(m)	Offset(b)	Label (suggested)	Units
A0	Power Supply Volts	Internal	0-40 Vdc	0008.0000	0000.0000	INPUT VOLTAGE	VDC
A1	Wind Direction	200-WS-02F	0-360 Degrees	0072.0000	0000.0000	DEGREES	DEG
			0-5 Volts	0001.0000	0000.0000	WIND DIR RAW	VDC
A2	Opt: Solar Radiation	110-WS-25SRD	0-2994.012 W/m^2	0598.8024	0000.0000	SOLAR RAD	W/M
A3	Temperature only	110-WS-25T	-459.67° to 440.33°F	0180.0000	-0459.6700	TEMPERATURE	°F
			-273.15° to 226.85°C	0100.0000	-0273.1500	CELSIUS	°C
A4	Temperature	110-WS-25THA	-40° to 140°F	0180.0000	-0040.0000	TEMPERATURE	°F
			-40° to 60°C	0100.0000	-0040.0000	CELSIUS	°C
A5	Humidity	110-WS-25THA	0-100%	0100.0000	0000.0000	PERCENT	%
A6	Barometric Pressure (generic calibration: slope: 0.0224 kPa/mV offset: 9.63 kpa)	110-WS-25BP (SB-110 & 120)	2.8437 to 35.9173 InHg	0006.6147	0003.6027	BARO.PRESSURE	IHG
			72.231 to 912.300 mmHg	0168.0138	0091.5075	BARO.PRESSURE	MHG
			96.3 to 1216.3 mB or hPa	0224.0000	0122.0000	BARO.PRESSURE	MB or HPA
			9.63 to 121.63 kPa	0022.4000	0012.2000	BARO.PRESSURE	KPA
A7	Opt: Evaporation Pan	255-100	0-9.44 inches	0001.8880	0000.0000	EVAP PAN	IN
			0-239.776 mm	0047.9552	0000.0000	EVAP PAN	MM
An0	Wind Speed	200-WS-02F	0-100 MPH	0001.2500	0000.0000	WIND SPEED	MPH
			0-160.93 KPH	0002.0117	0000.0000	WIND SPEED	KPH
			0-44.704 m/s	0000.5588	0000.0000	WIND SPEED	M/S
			0-86.88 knots	0001.0862	0000.0000	WIND SPEED	KTS
Counter2 (Input An2)	Rain Gauge	110-WS-25RG	0.01" / tip	0000.0100	0000.0000	RAIN TODAY	IN
			0.254 mm / tip	0000.2540	0000.0000	RAIN TODAY	MM

Note on Barometric Pressure: The generic calibration can be trimmed by adjusting the offset for the individual sensor. The sensor can be calibrated to sea level or the offset adjusted for the elevation.

APPENDIX F (CHANNEL ALLOCATION)

Column	Channel	Type	Resolution	Name	Format
A	-	Internal Clock	Seconds	Date and Time	YYYY-MM-DD HH:MM:SS
B	AN0	Frequency	32-bit floating point	Rate (i.e. wind speed)	Calculated from slope(m) and offset(b)
C				Peak (i.e. wind gust)	
D			16-bit unsigned	Pulse count	Raw count
E	AN1	Frequency	32-bit floating point	Rate	Calculated from slope(m) and offset(b)
F				Peak	
G			16-bit unsigned	Pulse count	Raw count
H	AN2	Frequency	32-bit floating point	Rate	Calculated from slope(m) and offset(b)
I				Peak	
J			16-bit unsigned	Pulse count	Raw count
K	AN0	Counter	32-bit floating point	Total	Calculated from slope(m) and offset(b)
L	AN1	Counter			
M	AN2	Counter			
N	A1	Analog 0-5V	10-bit	Wind direction	0-359 degrees
O	A0	Analog 0-40V		Input voltage	Internally wired
P	A1	Analog 0-5V		Wind vane / general purp.	Calculated from slope(m) and offset(b)
Q	A2	Analog 0-5V		Wind vane / general purp.	
R	A3	Analog 0-5V		Temperature / general purp.	
S	A4	Analog 0-5V	12-bit	General Purpose	
T	A5	Analog 0-5V			
U	A6	Analog 0-5V			
V	A7	Analog 0-5V			
W	-	Calculated	8-bit	CRC	Integer
The following columns are sent to the RS232 port but are not logged.					
X	-	User Input	-	Site name	9 ASCII characters
Y	-	Status	0 / 1	Card logging status	0 = "NOT READY", 1 = "LOGGING"
Z	-	-	-	Reserved	Always 0
AA	-	Calculated	8-bit	CRC	Integer