ZENO®-3200
User Manual

Version V2.02
June 27, 2003

P/N: 0302116012, Revision C

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<u>Acknowledgements</u>

1.   <u>INTRODUCTION</u>

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1.1.   WHAT IS THE ZENO®-3200?

The ZENO®-3200 is the world's first intelligent, versatile, low-power, 32-bit data acquisition system designed to collect, process, store and transmit data from multiple sensors. Its mechanical versatility and low power requirements allow the ZENO®-3200 to operate independently and remotely in a wide range of environmental extremes that include polar ice sheets, ocean buoys and windy mountaintops.

The ZENO®-3200's advanced firmware, ZENOSOFT®, contains extensive libraries of sensor types, data processes, and data output options that allow each ZENO®-3200 to be configured to meet a variety of requirements. The built-in, help-assisted menus contained in ZENOSOFT® let you configure the ZENO®-3200 with ease. The ZENOSOFT® libraries are continually being expanded. Contact Coastal Environmental Systems if your particular application is not discussed in this User Manual.

The related Intercept™ program[1] collects, displays, and forwards all data from the ZENO®-3200. Through Intercept™, data can be directly shared with other Microsoft Windows™ application programs. for further information, please refer to Coastal Environmental Systems' Intercept™ documentation.

1.2.   HOW DOES THE ZENO®-3200 WORK?

The ZENO®-3200 carries out three primary functions via its built-in firmware, ZENOSOFT®, in a regular and timely fashion according to the configuration defined within the ZENO®-3200 memory:

1. Collect data from the sensors.
2. Process the collected data.
3. Log into RAM and/or transmit the processed and collected data.

ZENOSOFT® operates within a Real Time Operating System (RTOS) that is controlled by the ZENO®-3200's built-in clock. The RTOS allows multiple tasks to be performed concurrently and deterministically by the ZENO®-3200's single Central Processing Unit (CPU).   This ensures that the ZENO®-3200 precisely performs its primary functions in accordance with the user's instructions stored in the configuration.

The ZENO®-3200 configuration is a set of information created by the user that tells the ZENO®-3200:

•   How many sensors to collect data from.

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[1] Intercept™, produced by Coastal Environmental Systems, is a Microsoft Windows™ application.

- What each sensor is.
- When to collect the data from each sensor.
- How to process the collected data.
- Which data values define a single data record to be logged into logging memory.
- When to log into memory and/or transmit the data record.
- Whether to generate one or more alarm messages.
- Which telephone numbers to dial (up to 4 telephone numbers), if an alarm message is to be sent via a telephone modem.
- What (if any) types of communication devices are connected to the ZENO®-3200 (a one-way radio, two-way radio, telephone modem, cellular modem, GOES or ARGOS transmitter).

To define the configuration within the ZENO®-3200 (and to retrieve data logged), the user interactively communicates with ZENOSOFT® using its built-in user interface. The user interface contains a set of interactive menus that allow the user to create a new configuration or modify an existing configuration.

1.3.   ZENO®-3200 SPECIFICATIONS

1.3.1. Analog Inputs

Seven (7) differential or fourteen (14) single-ended inputs offer choices for sampling performance.

- Ultra-high resolution: ±18-bit at up to two channels/second with 50/60 Hz noise rejection.
- High resolution: ±15-bit at up to 10 channels/second with 50/60 Hz noise rejection.
- Low resolution: Two (2) channels available at ±12-bit A/D at 10,000 conversions/second.

Accuracy and linearity are provided over a wide temperature range as follows:

- Linearity: ±0.001% (-40°C to +60°C).
- Basic radiometric accuracy: ±0.05% (-40°C to +60°C).
- Wide dynamic input range: ±5 mV to ±5 V in 10 ranges.

All analog inputs are fault-protected against shorts, overvoltages, transients and ESD.

- Up to four multiplexer boards can be added, each allowing 32 additional single-ended or 16 differential inputs.

1.3.2. Digital I/O Ports

- Six (6) Schmidt trigger conditioned inputs.
- Two (2) comparator inputs.
- Six (6) general purpose input or output channels (inputs TTL with pull up resistor, outputs 1 - 5 VDC high impedance).
- One (1) switch closure (event counter).

Digital inputs can be configured for frequency, period, count, or event counting. Digital outputs can provide control or alarm signals.

- Count inputs: Up to 65536 counts at 0.005% accuracy.

- Frequency inputs: Up to 100 kHz at 0.005% accuracy.

1.3.3. Sensor and Auxiliary Power Outputs

- Sensor excitation: Five switched excitation outputs for software selectable voltages of 1.25, 2.50, 5.00, with basic accuracy of 0.01% at up to 100 mA. Long-term stability of 20 ppm over 1000 hours, with most of the drift occurring within the first 100 hours.

- Reference outputs: one fixed, for sensor signal offsets.

- Power outputs (switched).

- Three channels of +12V; one channel at 700 mA; two channels at 150 mA.

- Two channels of +5V at total 600 mA peak, 200 mA mean.

- Other power output: optional.

- Optional digital-to-analog expansion board gives 4 or 8 channels of individually programmable 12-bit analog output at 0 to 5 V. [2]

1.3.4. Serial Communication Ports

- Three serial communication ports labeled as COM1, COM2 and COM3.

- Baud rates: each serial communications port supports baud rates of 300, 600, 1200, 2400, 4800, 9600 and 19,200 bits per second (bps).

- COM1 supports RS232, RS232H [3], and unidirectional and bi-directional radio communications.

- COM2 supports RS232, RS232H, RS485, GOES satellite transmitters[4] and ARGOS satellite transmitters.[5] COM2 is fully multiplexed.[6]

- COM3 supports RS232, RS232H, RS485 and RS422.

1.3.5. ADC Conversion Rates

The ZENO®-3200 has two A/D converters: one referred to as 12-bit, and one referred to as 18-bit. The 12-bit ADC is very fast, with up to 10,000 samples per second. The main limitation on your use of the 12-bit ADC is the fact that only two terminal block connections are available.

A single conversion on the 18-bit ADC requires approximately 100 milliseconds, which equates to 10 samples per second. This always outputs a signed 18-bit value, but the least significant 3 bits are highly susceptible to noise and may not be accurate. Hence, a single sample has 15-bit accuracy. To obtain full 18-bit accuracy, three values must be averaged by setting the Sensor Sample Count in the Sensor Menu to three.[7] This brings the sample rate down to no more than three samples per second.

Therefore, the maximum possible sample rate -- including all sensors -- is a total of 16 samples per second at an effective 15 bits of resolution, or 2 samples per second at a full 18 bits of resolution.

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[2] Other voltage ranges are optional.
[3] RS232H is half-duplex RS232.
[4] Refer to Section 6.7.
[5] Refer to Section 6.8.
[6] Refer to Section 6.1.
[7] Refer to Section 10.3.1.

In practice, the best available sample rate is often rather lower than this. If multiple sensors are being read, with different excitation voltages or powers, the ZENO®-3200 must wait for the system to settle before beginning a conversion. Because the ZENO®-3200 is a multi-tasking system[8], if a great deal of processing or message-transmission is required, then the CPU cannot revisit the ADC task immediately once each conversion is complete. A typical maximum sample rate is 10 samples per second at 15 bits.

[8] Refer to Section 12.1.4.

2.   <u>ZENO®-3200 BASICS</u>

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2.1.   THE ZENO®-3200 FRONT PANEL

The ZENO®-3200 Front Panel, illustrated in , allows easy access to nearly all external connections to the ZENO®-3200.

Only a 1/8-inch screwdriver[9] is required to attach wires to connections along the four terminal strips. The four terminal strips organize the external connections into the following groups:

- Analog Outputs and Grounds
- Analog Sensor Inputs
- Serial Data, Power and Grounds
- Digital Inputs and Outputs

The Serial Communications Port that is usually used for computer access, COM3 (a two-row, 9-pin, DE-9 connector), is located on the top, far right-hand side of the front panel. COM3 is sometimes referred to as the Maintenance Port.

The Auxiliary Serial Port (the two-row, 25-pin, DB-25 connector) is located to the left of COM3. Various connections for radio communication (both RS232 and TTL) as well as standard RS232 communications are available on this port. (Details about this port are located in Section 13.5.2 of this User Manual.)

The Analog Expansion Port, (the two-row, 15-pin, DA-15 connector), located on the top, far left-hand side of the front panel, is currently not in use.

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[9] This is equivalent to a 3-millimeter screwdriver.

Analog outputs

Regulated power and reference sensor drivers.

Data storage

Single on-board, battery-backed memory chip with 64 kbyte to 1 Mbyte memory. Up to 8 Mbyte of flash logging memory is available.

Serial communications

Three hardware UART ports with multi-plexing capability to intelligent sensors, additional linked ZENO®s, other systems or communication devices.

ANALOG OUTPUTS AND GROUNDS

SERIAL DATA, POWER AND GROUNDS

ZENO® 3200

ANALOG SENSOR INPUTS

DIGITAL INPUTS AND OUTPUTS

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A/D inputs/conversions

14 analog inputs with variable (±15 to ±18-bit) conversion increasing accuracy over large dy-namic ranges.

Two additional channels sample with 12-bit resolution at up to 10,000 times per second.

Digital I/O ports

Up to 15 channels.

Control outputs

Using up to 6 control outputs, the ZENO®-3200 makes decisions affecting related devices or signal outputs.

Figure 2-1. ZENO®-3200 Front Panel Diagram

2.2.   COMMUNICATING WITH AND POWERING UP THE ZENO®-3200

You will need four things to begin communicating with ZENO®-3200:

1. Communication with the ZENO®-3200 is done via a PC, a Macintosh or any other computer running a standard, commercially available terminal emulation program (such as Crosstalk, Mirror, Microsoft Windows® Terminal, Microsoft Windows® Hyperterminal, or ProComm®).

2. Using the interface cable supplied by Coastal Environmental Systems, connect the computer's RS-232 serial port to the DE-9 (9-pin, 2-row connector) located at the top of the ZENO®-3200 faceplate and termed COM3 (refer to Figure 2-2).

PC serial port   ZENO port COM3
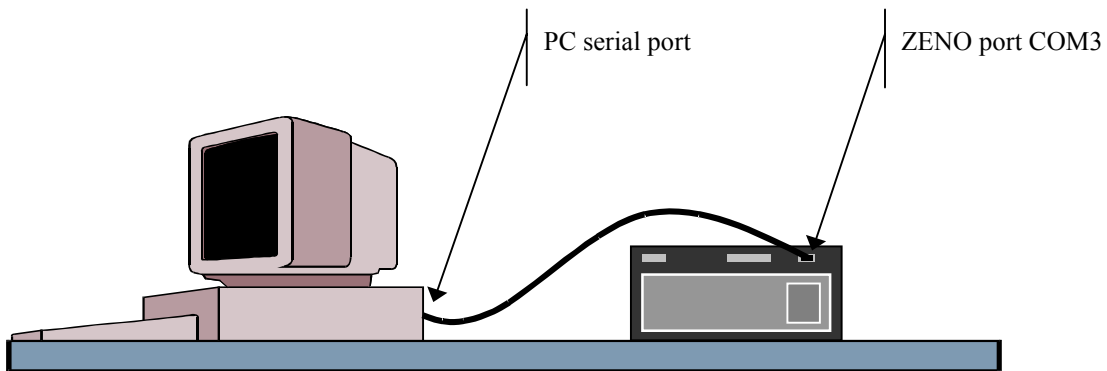
Figure 2-2. Connecting the ZENO®-3200 to your PC.

3. Start the terminal emulation program on your computer and set its communication settings to the ZENO®-3200's COM3 default settings as follows:

Computer's Serial Port Setting	Default ZENO®-3200 Value
Baud Rate	9600
Data Bits	8
Start Bits	1
Stop Bits	1
Parity	None
Flow Control	None

4. The ZENO®-3200 requires a power source of 10 to16 VDC. You can either apply power to the ZENO®-3200 using the 12 VDC power adapter provided by Coastal Environmental Systems, or you can connect to your own 10 to 16 VDC power supply. If you are using your own power supply, connect power to the points labeled "POWER" on the terminal strip labeled "SERIAL DATA, POWER AND GROUNDS" on top of the ZENO®-3200. See Figure 2-3.
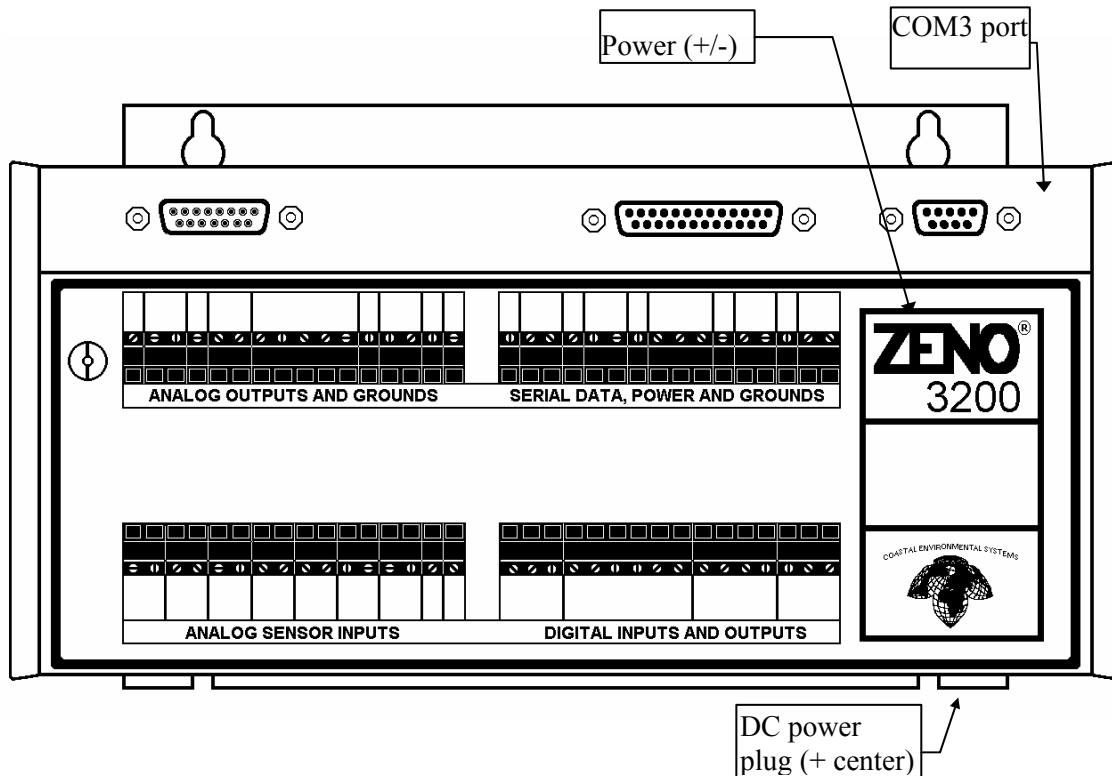
Figure 2-3. ZENO®-3200 Power Connections & Connecting to COM3.

With the ZENO®-3200 properly connected to the computer and the computer is running the terminal emulation program, upon applying power, you will see the following text generated by ZENOSOFT®:

```
Watchdog Reset
Please wait.../
ZENO-3200 using ZENOSOFT V1.964 Jun 28 2001 15:41:01 CS 96CC
(C)opyright 1995-2001, Coastal Environmental Systems, Seattle, WA, USA.
System Time = 01/07/11 13:47:31
Initializing Zeno 3200 .../

Zeno 3200 is Data Sampling. Type 'U'{ENTER} to access the User Interface.
```

2.3.   ZENO®-3200 MEMORY

Before proceeding, a brief discussion is provided to explain the two main types of memory that are used in the ZENO®-3200. The two types of memory are Random Access Memory (RAM) and Electrically Erasable Programmable Read Only Memory (EEPROM).

2.3.1. RAM

Each ZENO®-3200 is shipped with a minimum of 256 kilobytes of static RAM.[10] The RAM is the working memory in the ZENO®-3200. It is used to store the active configuration, the logged data records and the internal data that is used by ZENOSOFT® to perform the operations necessary for the active configuration.

Since the ZENO®-3200 is used in harsh environments, there is a possibility that there will be momentary losses of power to the ZENO®-3200. Since RAM cannot maintain its stored contents during a power loss, the ZENO®-3200 contains a small battery to maintain power to the RAM, allowing it to maintain its contents during the power loss.[11]

The battery used to back up RAM in the ZENO®-3200 lasts approximately 10 years. Eventually, it will discharge to a point where it can no longer provide enough power for the RAM to be maintained during a momentary power disruption and the data stored in RAM will be lost. It is for this reason that the second type of memory, EEPROM, is used in the ZENO®-3200.

2.3.2. EEPROM

Unlike RAM, EEPROM does not require constant power to maintain its contents. Hence, the data stored in EEPROM remains intact regardless of any power loss. The size of the EEPROM is very small, though, in comparison to RAM. A Revision-A ZENO®-3200 will contain 2 kilobytes of EEPROM, but a Revision-D ZENO®-3200 will contain 8 kilobytes of EEPROM.

Because EEPROM is a very safe type of memory storage, EEPROM is used by the ZENO®-3200 to store the configuration. The ZENO®-3200 stores the configuration in a condensed format in the EEPROM since it is much smaller than RAM.

ZENOSOFT® does not use the configuration stored in EEPROM during its normal operations because the condensed configuration stored in EEPROM is not in a useable form.[12]

One of the first things that ZENOSOFT® does when the ZENO®-3200 is turned on is to read and expand the condensed configuration stored in EEPROM, then store the expanded (useable) configuration in RAM for use during normal operations.

When you create a new configuration or modify an existing configuration, you are changing the configuration stored in RAM, not EEPROM.

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[10] Formerly, the minimum amount of installed RAM was 64 kilobytes. Refer to Section 13.4 for the location of the RAM on the main CPU board.
[11] The battery acts like a miniature UPS, or Uninterrupted Power Supply, to the RAM.
[12] This is analogous to a file that has been shrunk on a personal computer using a zip program.

> **Once you are done creating or modifying the configuration, it is recommended that you save your configuration to EEPROM in the event that there is a loss of power. Only those configuration changes that have been stored in EEPROM will be retrieved when the ZENO®-3200 is turned on. Any configuration changes stored only in RAM will be lost when the ZENO®-3200 is turned off.**

2.4.   THE USER INTERFACE

Once communications between your computer and the ZENO®-3200 have been established, you can enter the User Interface. The User Interface is a text-based menu system provided entirely within ZENOSOFT® that allows easy retrieval of logged data, easy creation of a new ZENO®-3200 configuration, or modification of an existing configuration.[13]

2.4.1. The User Interface Menu Structure

The User Interface is divided into two levels: the lower level menus called the User Menus and the upper level menus called the Zeno Program Menus.

When the user accesses the User Menus, the ZENO®-3200 will continue to perform its primary data collection functions unhindered. Some changes to the configuration can be made in submenus of the User Menu, but none that directly impact the definitions of sensors, processes or the contents of logged data records. for this reason, the factory default setting for User Menu access is unprotected--meaning that no password is required to access any of the lower level menus. The functions that can be performed via User Menu and its various submenus include:

- Changing communications settings.
- Changing system settings such as the clock time.
- Changing the data collection schedule.
- Retrieving logged data.
- Inspecting raw sensor data and calibrate sensors.

If the user accesses the Zeno Program Menus, the ZENO®-3200 suspends all primary data collection functions.

> **If your ZENO®-3200 arrives factory-configured, you should never need to enter the Zeno Program Menu.**

The submenus of Zeno Program Menu are designed to directly modify the definitions of sensors, processes and the contents of logged data records. for this reason, the factory default setting for the Zeno Program Menu access requires a password. The functions that can be performed via the Zeno Program Menu and its submenus include:

- Changes to sensor definitions, including addition or deletion of sensors.

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[13] You do not need to install any special software on your computer to use the User Interface. Just use your same terminal emulation program!

- Changes to process definitions, including addition or deletion of processes.
- Changes to logged data record definitions, including addition or deletion of specific data values to the data record.
- Uploading an entire configuration file from a computer, or downloading an entire configuration to a computer.
- Changing User Menu and Zeno Program Menu access passwords.

A complete listing of the User Interface menu structure is provided in Appendix B. An abridged menu listing is provided below.

User Menu	Communications Menu	Modem Menu
	System Functions Menu	Power Control Menu
	Sample Period Menu	GOES Menu
	Data Retrieval Menu	Digital Control Menu
	Test Menu	
	ZENO Program Menu	Sensor Menu
		Processing Menu
		Data Output Menu
		Sensor Timing Loop Menu
		Output Message Timing Menu
		System Load Menu
		Password Menu

2.4.2. Online Help

The full User Interface menu structure contains full access to all parts of the configuration. To aid in understanding specific menu options or menu items contained in the User Interface, several context-sensitive on-line help commands are available in all User Interface menus:

H   Provides general help information.

Hx   Provides information about menu item **x**, where **x** is a letter. for example, type **HC** to obtain information about menu option **C**.

Hn   Provides information about line item **n**, where **n** is a number. for example, type **H2** to obtain information about Line Item #2. This command is only available within menus involving line items; for example, it is available within the Communications Menu, but not within the User Menu.

HPn   Provides information about **PROCESS** Record #**n**, where **n** is the Process Record number. This command is available in any User Interface menu. Processes defined in the Process Menu are numbered. Process Record #1 is the first process in the configuration, Process Record #2 is the second process in the configuration and so on.

HPTn.m   Provides information about specific **PROCESS TYPE** type **m**, in process category **n**; where **m** is a number designating the process category and **n** is the number designating the process type within the category. This command is available within any User Interface menu.

HSn   Provides information about **SENSOR** Record #**n**, where **n** is the Sensor Record number. This command is available in any User Interface menu. Sensors defined in the Sensor Menu are numbered.

Sensor Record #1 is the first sensor in the configuration, Sensor Record #2 is the second sensor in the configuration and so on.

HSTn   Provides information about specific **SENSOR TYPE** number **n**, where **n** is a number designating the sensor type. This command is available within any User Interface menu.

2.5.   ZENO®-3200 FUNCTIONAL BLOCK DIAGRAM

One of the best ways to understand the complete functionality of the ZENO®-3200 Functional Block Diagram is through illustration.
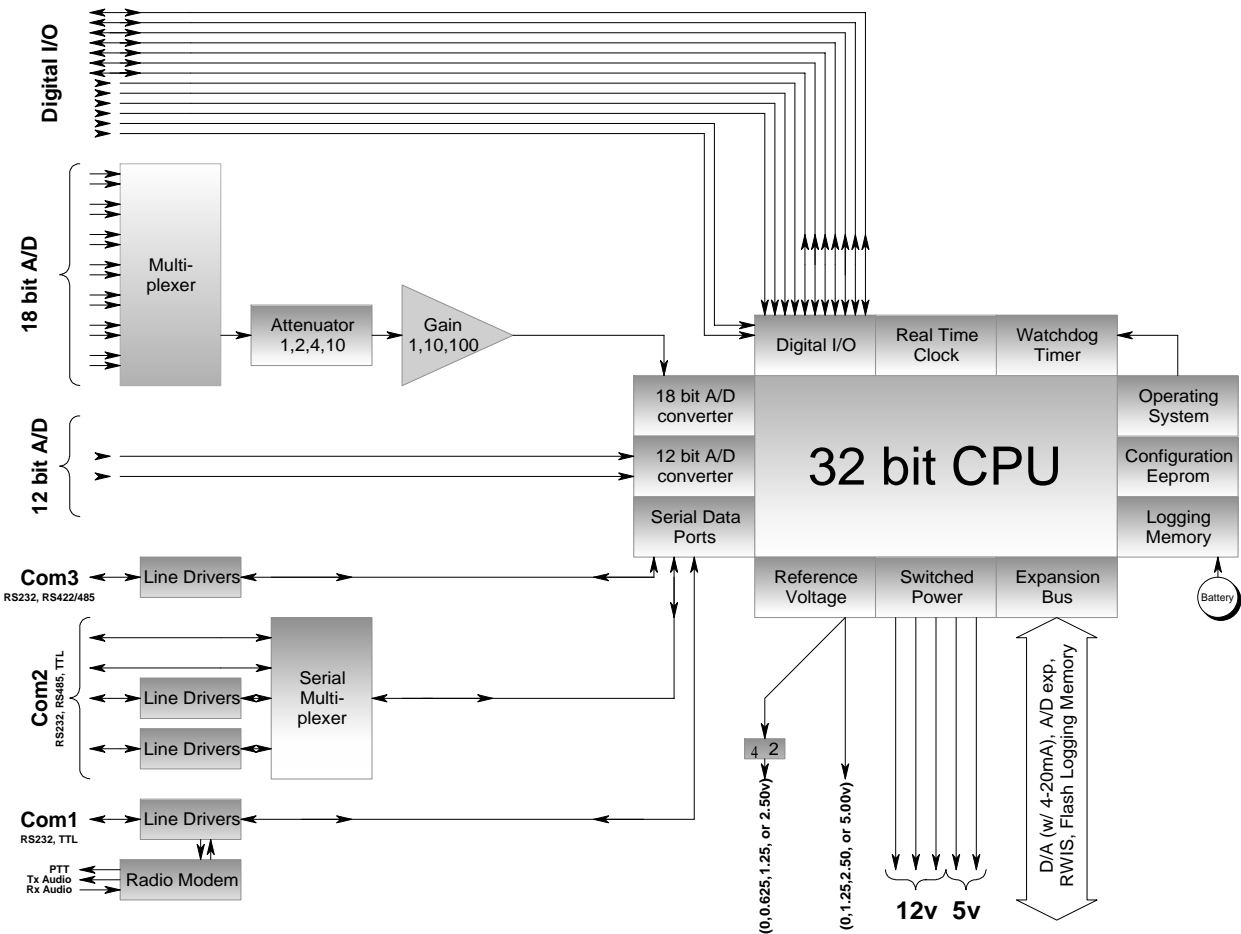
Figure 2-4. ZENO®-3200 Functional Block Diagram.

(This ZENO®-3200 functional block diagram should be referred to throughout this document.)

3.   TUTORIAL: BASIC ZENO®-3200 OPERATION

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This tutorial is divided into two parts:

<u>Part One</u> – Describes how to work with an existing configuration.

1. Viewing logged data from a simple configuration
2. Changing output message format
3. Understanding & changing the Sample Interval and power usage

<u>Part Two</u> – Describes the basics of how to configure the ZENO®-3200.

1. Identify what needs to be done and how the ZENO®-3200 can make it happen
2. Where to begin configuring
3. How to setup two sensors that collect data from the internal temperature and input power voltage sensors
4. How you might process the collected data
5. How you might log the collected & processed data in logging memory

3.1.   PART ONE—HOW TO WORK WITH AN EXISTING CONFIGURATION

3.1.1. Looking At Logged Data

Let's assume that you purchased your ZENO®-3200 with a very simple, factory-installed configuration that causes the ZENO®-3200 to perform the following:

- There are 2 sensors. One monitors internal temperature, the other monitors input battery voltage to the ZENO®-3200. Each of these sensors is read once per second.

- There are 2 processes. One process calculates the average of all the internal temperature readings done during the sample duration. The second does a similar average, but with battery voltage readings.

- Each data record contains the following information: the time when the data record was logged, the average internal temperature over the sample duration and the average input battery voltage over the sample duration.

- The ZENO®-3200 is set to collect and process data for a duration of 55 seconds (the sample duration), and the data collection process is to be repeated every 60 seconds (the sample interval).

- Further, the ZENO®-3200 is set to automatically output each logged data record at the end of each sample duration.

After you connect your ZENO®-3200 to your computer and apply power (as described in Section), you will see the start-up message on your terminal emulation program, followed by a set of measurements generated once a minute. The screen will look something like this:

```
Watchdog Reset
Please wait.../
ZENO-3200 using ZENOSOFT V1.964 Jun 28 2001 15:41:01 CS 96CC
(C)opyright 1995-2001, Coastal Environmental Systems, Seattle, WA, USA.
System Time = 01/07/11 13:47:31
Initializing Zeno 3200 .../

Zeno 3200 is Data Sampling. Type 'U'{ENTER} to access the User Interface.

01/07/11,13:48:55,22.7,13.8,
01/07/11,13:49:55,22.9,13.8,
01/07/11,13:50:55,23.0,13.8,
01/07/11,13:51:55,23.2,13.8,
```

Each data message contains the following comma delimited fields:

- The date and time when the measurement was completed, usually called the timestamp (here, the afternoon of July 11, 2001).
- Two data values: the average internal temperature and average battery voltage.[14]

As this example shows, the ZENO®-3200 can output data messages giving measured data values in real time as well as log the data. Up to four different messages can be defined, each containing different values, outputted at different times and routed to different ZENO®-3200 COM ports.

In our example, the ZENO®-3200 is outputting the data messages on COM3. If you enter the User Interface via COM3, any real time data messages routed to COM3 will be interrupted; but messages to other COM ports (if any) as well as data logging will *not* be affected.

> **The ZENO®-3200 continues to log data records in real time while you view data records via the User Menus.**
>
> **(If you enter the Zeno Program Menus, the ZENO®-3200 will suspend all data collection and logging.)**

To view the logged data records, you first need to enter the User Menu of the ZENO®-3200 User Interface.

> **To enter the User Menu, type U followed by the {ENTER} key in your terminal emulation program.**

Upon entering the User Menu, the ZENO®-3200 will stop sending real-time data messages to your terminal emulation program and, instead, it will display the User Menu. Your screen will look something like this.

---

[14] Since many ZENO®-3200s are factory-configured by Coastal Environmental Systems prior to delivery, the messages sent to your terminal emulation program are likely to differ in the number, type, and format of the measured values.

```
   01/07/11,14:13:55,23.7,13.8,
   01/07/11,14:14:55,23.7,13.8,
   01/07/11,14:15:55,23.7,13.8,

   USER MENU
   (C) Communications Menu              (T) Test Menu
   (F) System Functions Menu            (Z) Zeno Program Menu
   (S) Sample Period Menu               (Q) Quit
   (D) Data Retrieval Menu              (H) Help
   >
```

To view the logged data, you need to enter the Data Retrieval Menu. Type **D**, followed by the **{ENTER}** or **{Return}** key, to bring up the Data Retrieval Menu.[15] The Data Retrieval Menu will appear as follows:

```
   > d

   DATA RETRIEVAL MENU
   (A)  Show Records AFTER Specified Time      (F) Flash Memory Information
   (B)  Show Records BETWEEN Timespan          (D) Delete All Data Records
   (Ln) Show LAST n Records                    (N) Number of Records Logged
   (*)  Show ALL Data Records                  (U) User Menu
   (@n) Show n Unmarked Records                (Q) Quit
   (M)  Mark Recently Shown Data               (H) Help
   (C)  Compute Data Logging Capacity

   Precede Any "Show Data" Command With An 'X' for X-Modem Transfer
   (e.g. Enter 'X*' To Send All Data Sets Via X-Modem)
   >
```

> **When navigating the User Interface, you must type** {ENTER} **or** <RETURN>
> **at the end of every command in order for ZENOSOFT® to execute the**
> **desired command.**

While in the User Menus, if the ZENO®-3200 does not receive a command after 60 seconds, ZENOSOFT® will automatically exit the User Interface. If this happens, simply type **U{ENTER}** to re-enter the User Menu. The screen will look something like this:

```
   >
   WARNING: Timeout on command line input. Exiting user interface!

   01/07/11,14:24:55,23.9,13.8,
   01/07/11,14:25:55,23.8,13.8,
   01/07/11,14:26:55,23.8,13.8,
```

---

[15] Navigation of the menus in the User Interface is not case sensitive: **d** will also work.

If you are curious about the data logging capacity of your ZENO®-3200, it will tell you when you type **C{ENTER}** in the Data Retrieval Menu. Your screen will look something like this:

```
DATA RETRIEVAL MENU
(A)  Show Records AFTER Specified Time       (F) Flash Memory Information
(B)  Show Records BETWEEN Timespan           (D) Delete All Data Records
(Ln) Show LAST n Records                     (N) Number of Records Logged
(*)  Show ALL Data Records                   (U) User Menu
(@n) Show n Unmarked Records                 (Q) Quit
(M)  Mark Recently Shown Data                (H) Help
(C)  Compute Data Logging Capacity

Precede Any "Show Data" Command With An 'X' for X-Modem Transfer
(e.g. Enter 'X*' To Send All Data Sets Via X-Modem)

> c
Total Data Logging Memory (bytes)   = 127420
Maximum Number of Data Records      = 15927
Size of Each Data Record            = 8
Maximum Data Time Span (d:hh:mm:ss) = 11:01:27:00
```

The ZENO®-3200 will accurately tell you:

- The total available space (in bytes) for logging memory
- The number of data records that will fit into the available logging memory space
- The size of each data record (in bytes)
- The maximum time that the ZENO®-3200 will take to fill up the available logging memory

Upon completion of a command internal to a menu, ZENOSOFT® automatically returns you to that same menu, in this case the Data Retrieval Menu.

To find out how much of the available logging memory has been filled, type **N{ENTER}** in the Data Retrieval Menu. ZENOSOFT® will respond with the **NUMBER** of data records currently stored in logging memory.

> **The available logging memory is treated by ZENOSOFT® as a circular buffer. Once the circular buffer is full, each newest data record overwrites the oldest data record currently stored in the buffer.**

If you want to view the 4 most recently logged data records, type **L4{ENTER}** to see the **LAST 4** data records.

```
    DATA RETRIEVAL MENU
    (A)  Show Records AFTER Specified Time        (F) Flash Memory Information
    (B)  Show Records BETWEEN Timespan            (D) Delete All Data Records
    (Ln) Show LAST n Records                      (N) Number of Records Logged
    (*)  Show ALL Data Records                    (U) User Menu
    (@n) Show n Unmarked Records                  (Q) Quit
    (M)  Mark Recently Shown Data                 (H) Help
    (C)  Compute Data Logging Capacity

    Precede Any "Show Data" Command With An 'X' for X-Modem Transfer
    (e.g. Enter 'X*' To Send All Data Sets Via X-Modem)

    > L4

    Hit The Space Bar To Halt The Log Data Output.
      DATE      TIME    AvgTemp AvgBatt
    01/07/11 15:02:55  24.1  13.8
    01/07/11 15:03:55  24.2  13.8
    01/07/11 15:04:55  24.2  13.8
    01/07/11 15:05:55  24.1  13.8
```

When you are done looking at the logged data, you can quit the User Interface by typing **Q{ENTER}** to **QUIT** (exit).

Section 4 provides comprehensive information about viewing logged Data Records.

3.1.2. Changing Output Message Format

If your computer is not connected to the ZENO®-3200, connect your ZENO®-3200 to your computer and apply power.[16] After you see the boot-up message from the ZENO®-3200, type **U{ENTER}** in your terminal emulation program to obtain the User Menu.

There are three types of message formats available from the ZENO®-3200:

- Comma delimited
- Space delimited
- CCSAIL format (comma delimited with CCSAIL addressing)[17]

If you want to change the format of a message, you can do so with absolutely no disruption in ZENO®-3200 data collection. From the User Menu, type the command **F{ENTER}** to enter the System Functions Menu. You will see the following screen.

---

[16] Refer to Section 2.2.
[17] Details about the CCSAIL protocol are discussed in Section 4.6.

```
> f

SYSTEM FUNCTIONS MENU
(Cn/m) Change Item n To Value m              (I) Contact Information
(S)     System Date and Time                 (E) Save Parameters To EEPROM
(T)     Calibrate Internal Temperature       (U) User Menu
(V)     Program Version                      (Q) Quit
(K)     Constants Menu                       (H) Help
(B)     BIT Names Menu

Item  1:  0            (Primary Unit/Experiment ID)
Item  2:  0            (Secondary Unit/Experiment ID)
Item  3:  1            (Data Dump Format)
Item  4:  1            (Real Time Output Format)
Item  5:  0            (Add Compass To Vane)
Item  6:  0            (Compass Offset)
Item  7:  0            (Barometer Elevation)
Item  8:              (Bad Sensor Value Replace)
>
```

Let's say that your ZENO®-3200 is running the same simple configuration as described in the previous subsection. In that subsection, the real-time data messages are comma delimited. The above screen shot is from the same configuration. Line Item #4 in the System Functions Menu sets the real-time message format.[18] To understand what the code of "1" means, type **H4{ENTER}** to get help on this specific item. This is what your screen should look like:

```
> h4

* Select real time output message format, valid options are
        - 0 (real time output message suppressed).
        - 1 (ASCII characters, width dependent, comma separated).
        - 2 (ASCII characters, [see NOTE below], no comma separation).
        - 3 (CCSAIL format, [see NOTE below]).
* NOTE: for option 2, width is specified by 'Field Width' item in Data
  Output Menu; if a data item uses fewer characters than specified,
  leading space characters are inserted.
* NOTE: for option 3, ID numbers are 4 character fixed fields and the
  checksum becomes modulo 100 with no trailing comma.

Hit any key to continue . . .
```

If you want to change the real-time message format to be space delimited, use the **Cn/m** menu option by typing **C4/2{ENTER}**. When you have finished typing, ZENOSOFT® will redisplay the System Functions Menu, but the value for Item 4 will be set to 2. Your screen should look like this:

---

[18] Complete information about this Line Item is provided in Section 4.4.2.

```
> c4/2

SYSTEM FUNCTIONS MENU
(Cn/m) Change Item n To Value m              (I) Contact Information
(S)    System Date and Time                  (E) Save Parameters To EEPROM
(T)    Calibrate Internal Temperature        (U) User Menu
(V)    Program Version                       (Q) Quit
(K)    Constants Menu                        (H) Help
(B)    BIT Names Menu

Item  1:  0           (Primary Unit/Experiment ID)
Item  2:  0           (Secondary Unit/Experiment ID)
Item  3:  1           (Data Dump Format)
Item  4:  2           (Real Time Output Format)
Item  5:  0           (Add Compass To Vane)
Item  6:  0           (Compass Offset)
Item  7:  0           (Barometer Elevation)
Item  8:              (Bad Sensor Value Replace)
>
```

You can now exit the User Interface by typing **Q{ENTER}**. Once you see the next real-time data messages, they will now be space delimited. Your screen should look something like this:

```
> q
Exiting user interface.

01/07/12 10:01:55 22.8 13.8
01/07/12 10:02:55 22.8 13.8
01/07/12 10:03:55 22.8 13.8
01/07/12 10:04:55 22.8 13.8
01/07/12 10:05:55 22.8 13.8
```

An important note about space delimiting: When you want to use space delimiting, it is important that the field widths for each data value are set to a sufficiently large number. This number will allow the full range of the data value to be contained and provide at least one space between it and the preceding data value in the message. Otherwise, the data values will run together with no space in between.[19]

The change you made is currently residing in the ZENO®-3200's RAM only. It will be effective until the ZENO®-3200 powers down. When the ZENO®-3200 powers up again, the settings in EEPROM will be read into RAM again and your change will be lost. If you want configuration changes to be maintained after the ZENO®-3200 powers down, you must save the modified configuration into EEPROM so that the changes will be restored the next time the ZENO®-3200 is turned on.

> **When you want to save a modified configuration in case you power down the ZENO®-3200, type E{ENTER} from any menu that offers the "Save Parameters to EEPROM" option.[20]**

---

[19] Setting the field widths for each data value is done in the Data Output Menu, which is part of the Zeno Program Menu. This is discussed in Section 10.6.6.
[20] Refer to Section 2.3.2.

3.1.3. Understanding & Changing the Sample Interval and Power Usage

One of the most important aspects to understand about the ZENO®-3200 is timing. All data collection done by the ZENO®-3200 is based upon regular timed intervals that are controlled by the ZENO®-3200's internal clock. The main timed interval is called the Sample Interval.

> **The Sample Interval defines the overall, recurring period of time that all data collection, processing, data logging and transmitting occurs.**

Three timing values define the Sample Interval. They are located in the Sample Period Menu. Access to the Sample Period Menu is done through the User Menu. From the User Menu, type **S{ENTER}** to enter the Sample Period Menu. Your screen will look something like this:

```
> s

SAMPLE PERIOD MENU
(Cn/m) Change Item n To Value m          (Q) Quit
(E)    Save Parameters To EEPROM         (H) Help
(U)    User Menu

Item  1:  60          (Sample Interval Time)
Item  2:  55          (Sample Duration Time)
Item  3:  0           (Sample Time Offset)

>
```

The three values are defined as follows:

- **Sample Interval Time** defines the length of each complete Sample Interval (the time between the start of successive Sample Intervals)
- **Sample Duration Time** defines the portion of the Sample Interval Time that the ZENO®-3200 actually performs all data collection, processing, data logging and transmitting
- **Sample Time Offset** defines a time at the beginning of the Sample Interval to delay the start of the actual Sample Duration Time

> **The sum of the Sample Duration Time and Sample Time Offset can be the less than or equal to, but never exceed, the Sample Interval Time.**

If you attempt to set the Sample Duration Time or the Sample Time Offset or a combination thereof to a value greater than the Sample Interval Time, the ZENO®-3200 will respond with an error message and not accept the requested change.

In our example "factory-installed" configuration illustrated above, the Sample Interval Time has been set to 60 seconds and the Sample Duration Time has been set to 55 seconds. No Sample Time Offset is in use. This is illustrated using the following timing diagram:

```
Sample Interval    |--------------------------------------|    60 seconds
Sample Duration    |-----------------------------------| |    55 seconds
```

Physically, when the ZENO®-3200 is collecting data, ZENOSOFT® turns on various internal components in order to read data from the various sensors. Hence, the Sample Duration not only represents the time when data is being collected, but also the time when the ZENO®-3200 is consuming more power. for this reason, the Sample Duration is often referred to being the time when the ZENO®-3200 is "awake."

When the sum of the Sample Duration Time and Sample Time Offset is less than the Sample Interval Time, there will be a time period in which the ZENO®-3200 is not performing any of its primary data collection functions. When the ZENO®-3200 is not performing any of its primary data collection functions, ZENOSOFT® turns off any unnecessary internal components to conserve power. This scheduled gap in data collection is often referred to as the time when the ZENO®-3200 is "asleep."

> **The ZENO®-3200 consumes more power when it is collecting data.**
> **Reducing the Sample Duration Time with respect to the Sample Interval**
> **Time conserves power. This may be very important if the primary source of**
> **power for your ZENO®-3200 is a battery.**

Versatility is one of the essential features designed into the ZENO®-3200. The settings for the Sample Interval Time, Sample Duration Time and Sample Offset Time will create a wide variety of possible data collection scenarios. Power consumption may play a key role in determining your data collection requirements.

Here are three examples that will demonstrate very different ways that you can set up the ZENO®-3200 data collection cycle:

ZENO®-3200 Parameter	Example A Sample sensors continuously (no sleep time), log data once an hour.	Example B Sample sensors for one minute, once per hour; log data once an hour.	Example C Sample sensors during regular business hours every 24 hours, log data once a day.
Sample Interval Time	1 hour (3600 seconds)	1 hour (3600 seconds)	24 hours (86400 seconds)
Sample Duration Time	1 hour (3600 seconds)	1 minute (60 seconds)	10 hours (36000 seconds)
Sample Offset Time	0 seconds	0 seconds	9 hours (start at 8 a.m.) (32400 seconds)

In the following time line, the darkened areas illustrate when the ZENO®-3200 is awake and sensors are being sampled for these three examples over a 24-hour period.

Hour   0   1   2   3   4   5   6   7   8   9   10 11 12 13 14 15 16 17 18 19 20 21 22 23
of the
Day

A.

B. | | | | | | | | | | | | | | | | | | | | | | | |

C.
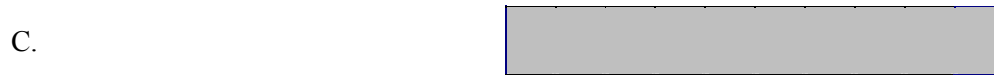
The Sample Interval nearly always begins at a time that is divisible by the Sample Interval Time, whose modulus is zero. Here are some examples:

- If the Sample Interval Time is set to on hour (3600 seconds), each Sample Interval will begin on the hour.
- If the Sample Interval Time is set to fifteen minutes (900 seconds), each Sample Interval will begin on the quarter hour.
- If the Sample Interval Time is set to 30 seconds, each Sample Interval will begin on every half minute.

In our example configuration, if you want the ZENO®-3200 to conserve more power, you could set the Sample Duration Time to 10 seconds by typing **C2/10{ENTER}** in the Sample Period Menu. If you want the ZENO®-3200 to collect data toward the end of the Sample Interval, you can set the Sample Time Offset to 50 by typing **C3/50{ENTER}** also in the Sample Period Menu. You would get the following timing result:

```
Sample Interval     |-------------------------------------| 60 seconds
Sample Duration     |                                |----| 10 seconds
Sample Time Offset  |---------------------------------|    | 50 seconds
```

> **When you change one of the Sample Interval parameters in the Sample
> Period Menu, ZENO®-3200 will stop all data collection until the first newly
> modified Sample Interval is scheduled to begin.**

You can experiment with various values for the Sample Interval Time, the Sample Duration Time, and the Sample Time Offset. You can check the results of your changes by:

- Quitting the User Interface (typing Q{ENTER}), and watching the messages written from COM3 to your terminal emulation program in real time;

- Going to the Data Retrieval Menu (type U{ENTER} D{ENTER}), and looking at the logged data.

It is important to remember that as long as you don't save your configuration changes to EEPROM (by typing **E{ENTER}**), you can always retrieve the original configuration by powering down your ZENO®-3200. When it powers up, the original configuration stored in EEPROM will be copied into RAM and become the working configuration.

An extensive discussion of ZENO®-3200 timing is provided in Section 12.1.

3.2.   PART TWO—LEARNING HOW TO CONFIGURE YOUR OWN ZENO®-3200

3.2.1. How Do I Configure The ZENO®-3200 To Perform My Requirements?

If you purchased your ZENO®-3200 with no factory-installed configuration, it will be shipped with the default configuration.

> **The default ZENO®-3200 configuration contains no sensors, no processes and no data to be logged. It is a blank configuration.**

In this case, you need to configure the ZENO®-3200 to meet your own requirements.

In this section, some simple aspects of configuring sensors, processes and setting up data to be logged and transmitted will be examined.

Before you start to configure your own ZENO®-3200, ask yourself the following list of questions.

> **Identifying what you need the ZENO®-3200 to do and how the ZENO®-3200 can accomplish your requirements will simplify the configuration process.**

1. What do I need to the ZENO®-3200 to measure?
2. What are the types of sensors that I need to collect data from?
3. How do my sensors match each of the sensor types defined in ZENOSOFT®?
4. How often do I need to measure data from each sensor (once every second, twice every 5 seconds, once every 10 seconds, etc.)
5. How do I electrically connect each sensor to the ZENO®-3200?
6. Do I need each sensor to be powered continuously or do I want each sensor powered only when a measurement is to be taken? (This may be very important if your ZENO®-3200 has a limited source of power.)
7. Do I need data that can only be obtained indirectly by processing the collected data?
8. If processing is required, which process (or processes) can I use to obtain the desired results?
9. Which collected and processed data (if any) needs to be logged in each data record?
10. Which collected and processed data (if any) needs to be transmitted? (Is it the same or different from the data that is to be logged?)
11. Do I need the ZENO®-3200 to transmit the data records automatically or do I only plan to view logged data?

12. How much and how often do I want the ZENO®-3200 to perform the configuration; i.e., what Sample Interval, Sample Duration and Sample Offset will be used?

Other questions may arise, or some may not be important; but each of the listed questions should be answered so that "no stone is left uncovered."

For an illustration of creating a simple configuration, let's use the configuration that was used throughout Part One of the Tutorial Section.[21]

First, we must answer the 12 questions asked in the preceding paragraphs:

1. We need the ZENO®-3200 to measure its internal temperature and battery voltage, average the data, and log and transmit the data at the end of each Sample Interval.
2. There are two sensors: internal temperature and battery voltage. Each sensor is an internal (built-in) analog sensor.
3. In this case, each sensor is a built-in analog sensor internally connected to the 12-bit Analog-to-Digital Converter (ADC).
4. Each sensor needs to be read once per second.
5. No external connections to the ZENO®-3200 are necessary since each sensor is built-in.
6. Each internal sensor is powered internally. It is not necessary to control the power to each built-in sensor.
7. We need to view the average value of all the readings taken from each sensor over the course of the Sample Interval.
8. To obtain the average value of all the readings taken from each sensor, two Average Processes will need to be configured. (One Average Process per sensor.)
9. The average internal temperature and average battery voltage need to be logged in each data record at the end of each Sample Interval.
10. The average internal temperature and average battery voltage need to be transmitted at the end of each Sample Interval. This is the same data that is being logged.
11. The ZENO®-3200 needs to transmit each data record at the end of the Sample Duration.
12. We need the ZENO®-3200 to perform all data collection once a minute and to measure the sensors for 55 seconds before logging and transmitting the collected and processed data.

As you can see, answering those 12 key questions will make the creation of this configuration very easy.

3.2.2. Data Flow within the ZENO®-3200

The general flow of the ZENO®-3200 begins with 1) collecting data from sensor, 2) processing the collected data, and 3) logging and transmitting the collected and processed data. This is the best way to create a configuration and is illustrated as a "recipe card" below:

---

[21] Refer to Section 3.1.

```
┌──────────────────────────────────────────────────────────────────┐
│              ZENO®-3200 Configuration Recipe Card                  │
│                                                                    │
│   1. Configure the sensors.                                        │
│                                                                    │
│   2. Configure the processes.                                      │
│                                                                    │
│   3. Configure the data to be logged & transmitted.                │
│                                                                    │
│   4. Set all other configuration settings.                         │
└──────────────────────────────────────────────────────────────────┘
```

Configuring the sensors, processes and data outputs are all done through the Zeno Program Menu.

```
┌──────────────────────────────────────────────────────────────────┐
│   The ZENO®-3200 does not perform any data collection, data        │
│   processing or logging & transmitting while you are in the Zeno   │
│   Program Menu or any of its submenus.                             │
└──────────────────────────────────────────────────────────────────┘
```

Accessing the Zeno Program Menu is done via the User Menu. If you are currently not in the User Interface, follow the instructions in Section 2.2 to access the User Menu.

From the User Menu, type **Z{ENTER}** to enter the Zeno Program Menu. Your screen should look like the following:

```
USER MENU
(C) Communications Menu              (T) Test Menu
(F) System Functions Menu            (Z) Zeno Program Menu
(S) Sample Period Menu               (Q) Quit
(D) Data Retrieval Menu              (H) Help

> Z

Enter Administrator Password:
```

```
┌──────────────────────────────────────────────────────────────────┐
│        Access to the Zeno Program Menu is password-protected![22]  │
└──────────────────────────────────────────────────────────────────┘
```

Unless your ZENO®-3200 password has been modified, the default password is "ZENO". Type **ZENO{ENTER}** to gain access to the Zeno program Menu.

---

[22] Refer to Section 8.1.

```
    Enter Administrator Password: ****

    Waiting for all data acquisition tasks to finish . . .

    ZENO PROGRAM MENU
    (S) Sensor Menu                      (M) Memory Management Menu
    (P) Process Menu                     (W) Password Menu
    (D) Data Output Menu                 (R) Reset System
    (T) Sensor Timing Loop Menu          (E) Save Parameters To EEPROM
    (O) Output Message Timing Menu       (U) User Menu
    (L) System Load Menu                 (Q) Quit
    (G) General Serial Script Menu       (H) Help

    >
```

**Whenever you enter a password to gain access to the Zeno Program Menu,
the characters you type are not shown for security.**

In this tutorial, the three submenus that will be visited in the Zeno Program Menu are 1) the Sensor Menu, 2) the Process Menu and 3) the Data Output Menu. The other submenus contained in the Zeno Program Menu will be discussed in detail in a later section of this manual.

- The *Sensor Menu* allows you to match ZENO®-3200 hardware and ZENOSOFT® firmware to your specific sensor suite.[23]

- The *Process Menu* allows you to specify any calculations that need to be carried out on the data collected from the sensors.[24]

- The *Data Output Menu* allows you to specify which data from processes and/or sensors is to be included in the output message(s) and/or to be logged into ZENO®-3200 memory for later retrieval.[25]

Since it is likely that you will need to configure multiple sensors, processes, and data output fields, these three submenus have been designed to create various lists of sensors, processes and data output fields.

**Each sensor, process or data output field that is configured is referred to as
a Record. Hence, any ZENO®-3200 configuration will contain a list of one
or more Sensor Records, a list of one or more Process Records and a list of
one or more Data Output Records.**

A list of records implies two things:

1. There will be a known number of records within the list; i.e., a list of "n" records, where "n" is a number.
2. Reference to a specific record within the list will be a numerical index to that record; i.e., first record, second record, third record . . . "n[th]" record.

---

[23] Discussed in Section 3.2.3.
[24] Discussed in Section 3.2.4.
[25] Discussed in Section 3.2.5.

> **A Process Record can refer to any Sensor Record or any *preceding* Process Record. A Process Record cannot refer to itself nor to any Process Record proceeding it.**

> **A Data Output Record can refer to any Process Record or any Sensor Record.**

> **One type of Sensor Record can refer to any Process Record+**
>
> **but is used for a very special case in a configuration.**

An illustration of referencing between Sensor Records, Process Records and Data Output Records in a hypothetical configuration is shown below.

Sensor Menu	Process Menu	Data Output Menu
Sensor Record 1	Process Record 1	Data Output Record 1
Sensor Record 2	Process Record 2	Data Output Record 2
Sensor Record 3	Process Record 3	Data Output Record 3
		Data Output Record 4
		Data Output Record 5
		Data Output Record 6
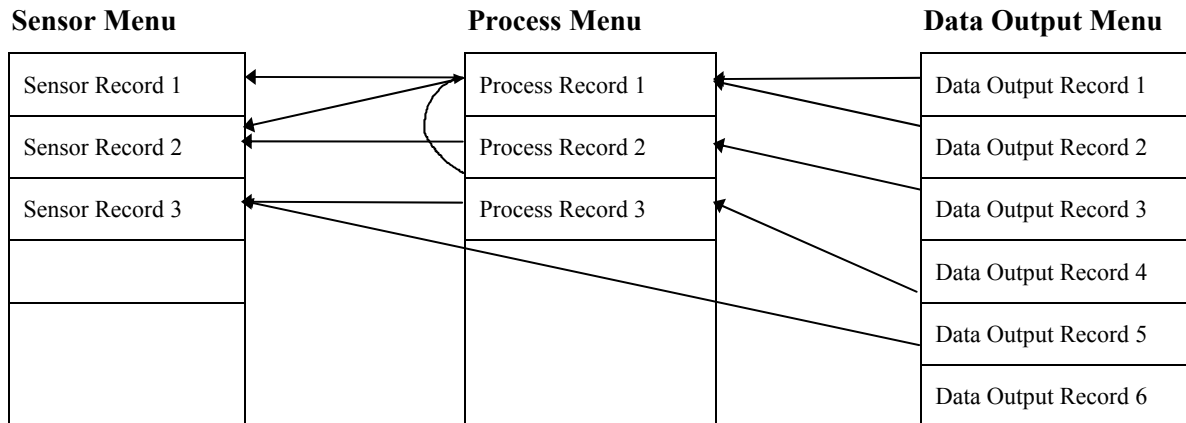
Figure 3-1. ZENO®-3200 Data Flow.*

*The arrows in Figure 3-1 show the direction of the reference. The flow of data is in the opposite.

3.2.3. Learning How To Configure A Sensor

From the Zeno Program Menu, you want to enter the Sensor Menu. To enter the Sensor Menu, type **S{ENTER}** from the Zeno Program Menu. Your screen should look something like this:

```
   ZENO PROGRAM MENU
   (S) Sensor Menu                        (M) Memory Management Menu
   (P) Process Menu                       (W) Password Menu
   (D) Data Output Menu                   (R) Reset System
   (T) Sensor Timing Loop Menu            (E) Save Parameters To EEPROM
   (O) Output Message Timing Menu         (U) User Menu
   (L) System Load Menu                   (Q) Quit
   (G) General Serial Script Menu         (H) Help

   > S

   SENSOR MENU
   (Cn/m) Change Item n To Value m        (Jn) Jump To Record n
   (A)    Insert After This Record        (N)  Go To Next Record
   (B)    Insert Before This Record       (P)  Go To Previous Record
   (X)    Cut Record to Clipboard         (XA) Delete ALL Records
   (C)    Copy Record To Clipboard        (Z)  Zeno Program Menu
   (V)    Paste Record From Clipboard     (H)  Help
   (Sn/m) Search Item n for Value m

   Sensor Items for Record 1 of 1:
   Item  1: Sensor Type Code               0 (No Sensor)

   >
```

As you can see, there are many options available in the Sensor Menu that will help you to navigate through a configuration containing multiple Sensor Records.

When no Sensor Records have been configured, ZENOSOFT® defines a default of one Sensor Record of Sensor Type Code 0, which means "no sensor."

ZENOSOFT® contains a library of Sensor Type Codes.

> **Each type of sensor supported by ZENOSOFT® has a unique, numerical Sensor Type Code for identification.**

The three general categories of sensors supported by ZENOSOFT® include Analog Sensors, Digital Sensors and Serial Sensors:

> **An Analog Sensor generates a voltage within a specified range (0 to 5 volts DC, for example) to represent the measurement it has taken.**
>
> **A Digital Sensor generates a binary condition to represent the measurement it has taken. The binary condition may simply be "on or off," a frequency, or a binary-encoded numeric value.**
>
> **A Serial Sensor communicates its measured data (possibly more than one type of measurement) via a serial communications link.**

Whenever you want to view a summarized version of all Sensor Type Codes supported by the ZENOSOFT® library, just type the command **H1{ENTER}** from the Sensor Menu. Your screen should look something like this:

```
> H1
* Select Sensor Type Code, valid codes are
        -  0 (No Sensor)
        -  1 (12-bit Analog to Digital)
        -  2 (18-bit Single-Ended A to D)
        -  3 (18-bit Differential A to D)
        -  4 (Digital Period, f > 10 KHz)
        -  5 (Digital Frequency, f > 10 KHz)
        -  6 (Digital Period, f < 10 KHz)
        -  7 (Digital Frequency, f < 10 KHz)
        -  8 (Digital State)
        -  9 (Digital Edge)
        - 10 (Tipping Bucket)
        - 11 (Serial Compass)
        - 12 (CCSAIL)
        - 13 (SDI-12 Serial)
        - 14 (Differential Encoder)
        - 15 (GPS Receiver)
        - 16 (General Serial)
        - 17 (Continuous SDI-12 Serial)
        - 18 (Concurrent SDI-12 Serial)
        - 19 (Asynchronous CCSAIL)

Hit any key to continue . . .
```

Our example configuration will use the Internal Temperature Sensor, which is available as a 12-bit ADC sensor, a Sensor Type Code of 1. So, to configure a 12-bit ADC sensor type for the current Sensor Record (in this case, Sensor Record #1), type the command **C1/1{ENTER}** in the Sensor Menu. Once this is done, the number of line items listed will drastically change, as illustrated below:

```
> C1/1

SENSOR MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Sensor Items for Record 1 of 1:
Item  1: Sensor Type Code                 1 (12-bit Analog to Digital)
Item  2: Sensor Name
Item  3: Sensor Input Channel             8
Item  6: Switched Power Code              0 (NO SWITCHED POWER)
Item  7: Sensor Excitation Voltage Code   0 (NO EXCITATION VOLTAGE)
Item  8: Switched Excitation Return       0
Item  9: Switched Power Warmup Time       0
Item 10: Sensor Sample Count              1
Item 11: Maximum Sensor Readings          0
Item 12: Sensor Timing Loop               1 (0.5 seconds)
Item 13: Conversion Coefficient A         0
Item 14: Conversion Coefficient B         1
Item 15: Conversion Coefficient C         0
Item 17: No. of Additional 15-msec Delays 0

>
```

As you can see, the value for Line Item #1 (the Sensor Type Code) has been set to a 12-bit ADC sensor. The other Line Items that have appeared are the relevant fields that can be set for a 12-bit ADC sensor that tell ZENOSOFT® how to collect data from the sensor.

> **The library that ZENOSOFT® maintains about each Sensor Type includes the specific Line Items that fully define the complete Sensor Type Definition.[26]**
>
> **The Line Item numbers that fully describe a complete Sensor Type Definition are always in the same location for any Sensor Type Code.**

The second Line Item is the Sensor Name. The Sensor Name is an optional field that allows you to write up to an 8-character name to uniquely identify a particular Sensor Record.[27]

> **Sensor Names are extremely useful because when a configuration has many Sensor Records with the same Sensor Type Code, they will help you remember which Sensor Record is collecting data from which sensor.**

As an example, you want to collect data from four 18-bit ADC single-ended sensors. The four sensors measure wind speed, wind direction, temperature and humidity. The four Sensor Records that define these four sensors are numbered one (1) through four (4). What happens if you do not look at the configuration for a long period of time? How can you remember which Sensor Record collects which sensor data? You can use the Sensor Record number as identification, or you can assign sensor names such as "WS," "WD," "Temp," and "Humid" for the four Sensor Records. Most people will probably find it much easier to differentiate Sensor Records if they assign unique sensor names.

In our example configuration, Sensor Record #1 is going to measure data from the Internal Temperature Sensor. An appropriate Sensor Name for line item #2 could be "IntTemp". If you want to set the Sensor Name to "IntTemp", type the command **C2/IntTemp{ENTER}** in the Sensor Menu.[28]

Your screen should now look something like this:

---

[26] Refer to Section 10.3 for the complete library of supported sensor types.
[27] Refer to Section 10.3.6.
[28] No quotation marks are used in the command.

```
    > C2/IntTemp

    SENSOR MENU
    (Cn/m) Change Item n To Value m           (Jn) Jump To Record n
    (A)    Insert After This Record           (N)  Go To Next Record
    (B)    Insert Before This Record          (P)  Go To Previous Record
    (X)    Cut Record to Clipboard            (XA) Delete ALL Records
    (C)    Copy Record To Clipboard           (Z)  Zeno Program Menu
    (V)    Paste Record From Clipboard        (H)  Help
    (Sn/m) Search Item n for Value m

    Sensor Items for Record 1 of 1:
    Item  1: Sensor Type Code                 1 (12-bit Analog to Digital)
    Item  2: Sensor Name                      IntTemp
    Item  3: Sensor Input Channel             8
    Item  6: Switched Power Code              0 (NO SWITCHED POWER)
    Item  7: Sensor Excitation Voltage Code   0 (NO EXCITATION VOLTAGE)
    Item  8: Switched Excitation Return       0
    Item  9: Switched Power Warmup Time       0
    Item 10: Sensor Sample Count              1
    Item 11: Maximum Sensor Readings          0
    Item 12: Sensor Timing Loop              1 (0.5 seconds)
    Item 13: Conversion Coefficient A         0
    Item 14: Conversion Coefficient B         1
    Item 15: Conversion Coefficient C         0
    Item 17: No. of Additional 15-msec Delays 0

    >
```

If you aren't sure what the valid characters are for a Sensor Name, type the help command **H2{ENTER}** in the Sensor Menu and your screen should look like something like this:

```
    > H2
    * Select Sensor Name. Valid values are:
           - character string up to 8 characters in length.
    * NOTE: Name is optional.
    * NOTE: Embedded spaces and other non-alphanumeric characters are
      not allowed!. Non-alpanumeric characters MUST be entered in
      hexadecimal and placed inside brackets: <xx>, where 'xx' is a
      2-digit hexadecimal number (00 to FF).

    Hit any key to continue . . .
```

Line Item #3 is a very important Line Item in the Sensor Record: the Sensor Input Channel.

> **The Sensor Input Channel tells ZENOSOFT® where the sensor is physically connected to the ZENO®-3200.**

Different sensor types have different physical channels located primarily on the ZENO®-3200 Front Panel.[29]

---

[29] Refer to Section 2.1.

> **No exterior physical connections are required to measure the Internal Temperature Sensor or Battery Voltage.**

To measure the Internal Temperature Sensor or the Battery Voltage, you only need to specify which one to use in the Sensor Input Channel for the 12-bit ADC Sensor type. Type the help command for line item #3: type **H3{ENTER}** in the Sensor Menu and your screen should look like something like this:

```
> H3
* Define 12-bit Analog to Digital Sensor Input Channel. Valid values are:
      - 8, 9, BATTERY VOLTAGE, INTERNAL TEMPERATURE SENSOR, GND,
        A1+ to A16+, A1- to A16-, B1+ to B16+, B1- to B16-,
        C1+ to C16+, C1- to C16-, D1+ to D16+ and D1- to D16-

Hit any key to continue . . .
```

As the help information indicates for Line Item #3, the available channels for the 12-bit ADC sensor type are channels 8, 9, BATTERY VOLTAGE, INTERNAL TEMPERATURE SENSOR and GND. The other listed channels are only available on Analog Expansion Boards.[30]

> **When you are finished viewing any help information, typing any key in your terminal emulation program will instruct the ZENO®-3200 to display the previous menu. If you don't type any key, the ZENO®-3200 will automatically return to the previous menu after 60 seconds.**

To specify the Internal Temperature Sensor, it is not necessary to completely type out "INTERNAL TEMPERATURE SENSOR" in the command. You can abbreviate it like so: type **C3/INT{ENTER}** in the Sensor Menu, and your screen should look something like this:

---

[30] If you had a single Analog Expansion Board setup for 12-bit ADC, it would be called Analog Expansion Board A and the valid channels would be A1+ through A16+ and A1- through A16-. Up to four Analog Expansion Boards are supported by a single ZENO®-3200, and they would be named boards A through D. Refer to Section 10.3.1 for more information.

```
> C3/INT

SENSOR MENU
(Cn/m) Change Item n To Value m          (Jn) Jump To Record n
(A)    Insert After This Record          (N)  Go To Next Record
(B)    Insert Before This Record         (P)  Go To Previous Record
(X)    Cut Record to Clipboard           (XA) Delete ALL Records
(C)    Copy Record To Clipboard          (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard       (H)  Help
(Sn/m) Search Item n for Value m

Sensor Items for Record 1 of 1:
Item  1: Sensor Type Code              1 (12-bit Analog to Digital)
Item  2: Sensor Name                   IntTemp
Item  3: Sensor Input Channel          INTERNAL TEMPERATURE SENSOR
Item  6: Switched Power Code           0 (NO SWITCHED POWER)
Item  7: Sensor Excitation Voltage Code  0 (NO EXCITATION VOLTAGE)
Item  8: Switched Excitation Return    0
Item  9: Switched Power Warmup Time    0
Item 10: Sensor Sample Count           1
Item 11: Maximum Sensor Readings       0
Item 12: Sensor Timing Loop            1 (0.5 seconds)
Item 13: Conversion Coefficient A      0
Item 14: Conversion Coefficient B      1
Item 15: Conversion Coefficient C      0
Item 17: No. of Additional 15-msec Delays  0

>
```

You have successfully instructed the ZENO®-3200 to collect data from the Internal Temperature Sensor in Sensor Record #1. One more Line Item needs to be examined in the Sensor Menu: Line Item 12, the Sensor Timing Loop. In our example, we want to collect data from the Internal Temperature Sensor once a second.

> **The Sensor Timing Loop tells ZENOSOFT® how frequently to collect data from the defined sensor over the course of the Sample Duration.**

The current setting for Line Item #12, the Sensor Timing Loop, is for Timing Loop #1.

> **There are four available Sensor Timing Loops. Sensor Timing Loop #1 is always a 0.5-second timing loop, but the other three can be modified using a different menu.[31]**

If we keep the Sensor Timing Loop set to 0.5 seconds, ZENOSOFT® will read from this sensor every half-second instead of once per second. The default value for Sensor Timing Loop #2 is 1 second. Type the command **C12/2{ENTER}** in the Sensor Menu, and your screen should look something like this:

---

[31] Modifying Sensor Timing Loops is discussed in Section 10.3.7.

```
> C12/2

SENSOR MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record             (N)  Go To Next Record
(B)    Insert Before This Record            (P)  Go To Previous Record
(X)    Cut Record to Clipboard              (XA) Delete ALL Records
(C)    Copy Record To Clipboard             (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard          (H)  Help
(Sn/m) Search Item n for Value m

Sensor Items for Record 1 of 1:
Item  1: Sensor Type Code                1 (12-bit Analog to Digital)
Item  2: Sensor Name                     IntTemp
Item  3: Sensor Input Channel            INTERNAL TEMPERATURE SENSOR
Item  6: Switched Power Code             0 (NO SWITCHED POWER)
Item  7: Sensor Excitation Voltage Code  0 (NO EXCITATION VOLTAGE)
Item  8: Switched Excitation Return      0
Item  9: Switched Power Warmup Time      0
Item 10: Sensor Sample Count             1
Item 11: Maximum Sensor Readings         0
Item 12: Sensor Timing Loop              2 (1.0 seconds)
Item 13: Conversion Coefficient A        0
Item 14: Conversion Coefficient B        1
Item 15: Conversion Coefficient C        0
Item 17: No. of Additional 15-msec Delays  0

>
```

The Sensor Type Definition for our Internal Temperature Sensor is now complete. Creation of this Sensor Type Definition took four commands. Since the ZENO®-3200 supports multiple, space-delimited commands being sent in a single command line, you could have sent all four commands in this single command line in the Sensor Menu: **C1/1 C2/IntTemp C3/INT C12/2{ENTER}**.

One Sensor Record is now fully configured, but for our example, one more Sensor Record needs to be configured to measure Battery Voltage.

We need to tell the ZENO®-3200 to create another Sensor Record. Two commands in the Sensor Menu are available for this purpose: the "A" and "B" commands. The "A" command instructs ZENOSOFT® to create a new Sensor Record AFTER the current Sensor Record. The "B" command instructs ZENOSOFT® to create a new Sensor Record BEFORE the current Sensor Record.[32]

> **During the Sample Duration, data is collected from sensors based upon the order of the Sensor Records and the Sensor Timing Loop assigned to each sensor.**

From our example configuration, we want the Sensor Record for Battery Voltage to come after the Internal Temperature Sensor. To create a new Sensor Record after the current one, type the command **A{ENTER}** in the Sensor Menu and the screen will look like the following:

---

[32] This is also discussed in Section 10.2.

```
> A

SENSOR MENU
(Cn/m) Change Item n To Value m            (Jn) Jump To Record n
(A)    Insert After This Record            (N)  Go To Next Record
(B)    Insert Before This Record           (P)  Go To Previous Record
(X)    Cut Record to Clipboard             (XA) Delete ALL Records
(C)    Copy Record To Clipboard            (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard         (H)  Help
(Sn/m) Search Item n for Value m

Sensor Items for Record 2 of 2:
Item  1: Sensor Type Code                  0 (No Sensor)

>
```

> **Each time a new Sensor Record is created, the default Sensor Type Code of "0" is used.**

This new Sensor Record looks the same as the first, except for the line above Line Item #1 which reads, "Sensor Items for Record 2 of 2". There are now two Sensor Records in the configuration and you are looking at the second Sensor Record. Notice options "N" and "P" in the Sensor Menu. Option "P" will take you back to the first Sensor Record by typing the command **P{ENTER}**. If there were a third Sensor Record, option "N" would take you to that record. The "J" command can also be used to "jump" any Sensor Record in a configuration.

> **Menu options "N," "P," and "J" allow you to navigate a configuration without making any changes to the configuration.**

To create the Sensor Type Definition for Battery Voltage, we already know that the Internal Battery Voltage sensor is a built-in 12-bit ADC sensor, like the Internal Temperature Sensor. Therefore, the same steps used to configure the first Sensor Record can be used to configure the second:

- The Sensor Type Code needs to be set to 1 to refer to a 12-bit ADC sensor.

- From looking at the help for the Sensor Channel, we know that we can set the Sensor Channel to BATTERY VOLTAGE by using the shorthand "BATT."

- Since we are reading the Battery Voltage once a second (like the Internal Temperature Sensor), we want to use the same Sensor Timing Loop as for the Internal Temperature Sensor.

- We can give the Battery Voltage Sensor the name "Battery."

Therefore, we can send all the commands to read the Internal Battery Voltage Sensor by typing this single, space-limited, multi-command line: **C1/1 C2/Battery C3/BATT C12/2{ENTER}**.

Upon doing so, the screen will look something like this:

```
> C1/1 C2/Battery C3/BATT C12/2

SENSOR MENU
(Cn/m) Change Item n To Value m            (Jn) Jump To Record n
(A)    Insert After This Record            (N)  Go To Next Record
(B)    Insert Before This Record           (P)  Go To Previous Record
(X)    Cut Record to Clipboard             (XA) Delete ALL Records
(C)    Copy Record To Clipboard            (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard         (H)  Help
(Sn/m) Search Item n for Value m

Sensor Items for Record 2 of 2:
Item  1: Sensor Type Code               1 (12-bit Analog to Digital)
Item  2: Sensor Name                    Battery
Item  3: Sensor Input Channel           BATTERY VOLTAGE
Item  6: Switched Power Code            0 (NO SWITCHED POWER)
Item  7: Sensor Excitation Voltage Code 0 (NO EXCITATION VOLTAGE)
Item  8: Switched Excitation Return     0
Item  9: Switched Power Warmup Time     0
Item 10: Sensor Sample Count            1
Item 11: Maximum Sensor Readings        0
Item 12: Sensor Timing Loop             2 (1.0 seconds)
Item 13: Conversion Coefficient A       0
Item 14: Conversion Coefficient B       1
Item 15: Conversion Coefficient C       0
Item 17: No. of Additional 15-msec Delays  0

>
```

The two sensors that needed to be configured for our example are now done.

When you have reached a milestone during the configuration process, it is a good idea to save the configuration to EEPROM in case there is a power surge. To do this, return to the Zeno Program Menu by typing the command **Z{ENTER}** in the Sensor Menu. Once back in the Zeno Program Menu, type the command **E{ENTER}**.   Once you have done that, you will see something like this on your screen:

```
> e

Verifying parameters can be stored in EEPROM . . .
Saving parameters to EEPROM . . .
Saving sensor lists to EEPROM . . .
Saving process lists to EEPROM . . .
Saving data output lists to EEPROM . . .
Saving repeater lists to EEPROM . . .
Saving general serial scripts to EEPROM . . .
Saving constants to EEPROM . . .
665 out of 2048 bytes used in EEPROM.
Total EEPROM Writes = 151, EEPROM Checksum = 102.

ZENO PROGRAM MENU
(S) Sensor Menu                     (M) Memory Management Menu
(P) Process Menu                    (W) Password Menu
(D) Data Output Menu                (R) Reset System
(T) Sensor Timing Loop Menu         (E) Save Parameters To EEPROM
(O) Output Message Timing Menu      (U) User Menu
(L) System Load Menu                (Q) Quit
(G) General Serial Script Menu      (H) Help

>
```

3.2.4. Learning How To Configure A Process

From the Zeno Program Menu, you want to enter the Process Menu. To enter the Process Menu, type
P{ENTER} from the Zeno Program Menu.

Your screen should look something like this:

```
ZENO PROGRAM MENU
(S) Sensor Menu                          (M) Memory Management Menu
(P) Process Menu                         (W) Password Menu
(D) Data Output Menu                     (R) Reset System
(T) Sensor Timing Loop Menu              (E) Save Parameters To EEPROM
(O) Output Message Timing Menu           (U) User Menu
(L) System Load Menu                     (Q) Quit
(G) General Serial Script Menu           (H) Help

> P

PROCESS MENU
(Cn/m) Change Item n To Value m          (Jn) Jump To Record n
(A)    Insert After This Record          (N)  Go To Next Record
(B)    Insert Before This Record         (P)  Go To Previous Record
(X)    Cut Record to Clipboard           (XA) Delete ALL Records
(C)    Copy Record To Clipboard          (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard       (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 1 of 1:
Item  1: Process Category               1  : General
Item  2: Process Number                 1  : Immediate Data Process
Item  3: User-defined Process Name
Item  4: Input for Immediate Data       S0.1

>
```

The Process Menu options should look very familiar because they are same set of menu options used in
the Sensor Menu.[33] When you proceed to the next section about the Data Output Menu, you will find the
same menu options also. The reason is simple: Sensor Records, Process Records and Data Output
Records are each a list of records. Navigation through each list is identical, but the content of each list
differs.

Similar to when no Sensor Records have been configured, when no Process Records have been
configured, the default is one Process Record that is set to an Immediate Data Process.

The number of available types of processes contained in ZENOSOFT® far exceeds the number of types of
sensors. Since there are so many available processes, it is easier to group similar processes into
categories.

> **Each process type is identified by a numerical Process Category and a
> numerical Process Number within the Process Category.[34]**

---

[33] Refer to Sections 3.2.3 and 10.2.
[34] Refer to Section 10.4.1.

To aid in identifying the type of process desired, each numerical Process Category is named to identify the grouping of process types that it contains. All basic versions of ZENOSOFT® contain six Process Categories.[35]

The names of the six Process Categories are listed below:

1. General Processes Category
2. Environmental Processes Category
3. Alarm Processes Category
4. Special Sensor Processes Category
5. Arithmetic Processes Category
6. Output and Control Processes Category

The number of process types contained within each category varies. Details about each individual process type are contained in Appendix D.

For our example configuration, we want to calculate the average of all the Internal Temperature Sensor readings done during the Sample Duration and the similar average of all the Battery Voltage readings.

If we view the information contained in Appendix D, we will find that the Averaging Process, in the General Processes Category, is the best process that we can use for calculating both averages. The Averaging Process has Process Category of 1 and a Process Number of 2.

There are several ways to obtain online help regarding processes. If you type **H2{ENTER}** from the Process Menu, ZENOSOFT® will list the available processes and their associated Process Numbers for the Process Category listed in line item #1. Your screen should look something like this:

```
 > H2
 * Select General Process, valid codes are
         -  1 (Immediate Data)
         -  2 (Averaging)
         -  3 (Running Average)
         -  4 (Block Average)
         -  5 (Accumulation)
         -  6 (Rate of Change)
         -  7 (Differential)
         -  8 (Free Running Avg)
         -  9 (Collect)
         - 10 (Trend Data)
         - 11 (Multiple-Input Min/Max)
         - 12 (Previous Sample Data)
         - 13 (Multiple Data Validation)
         - 14 (Single Data Validation)

 Hit any key to continue . . .
```

---

[35] Some specialized versions of ZenoSoft™ contain an additional seventh Process Category. Refer to Section 10.4.1.

Since the Process Category in Line Item #1 is already set to 1, it doesn't need to be changed; you only need to select the Averaging Process by typing **C2/2{ENTER}**. Your screen should look something like this:

```
 > C2/2

 PROCESS MENU
 (Cn/m) Change Item n To Value m              (Jn) Jump To Record n
 (A)    Insert After This Record             (N)  Go To Next Record
 (B)    Insert Before This Record            (P)  Go To Previous Record
 (X)    Cut Record to Clipboard             (XA) Delete ALL Records
 (C)    Copy Record To Clipboard            (Z)  Zeno Program Menu
 (V)    Paste Record From Clipboard         (H)  Help
 (Sn/m) Search Item n for Value m

 Process Items for Record 1 of 1:
 Item  1: Process Category                   1  : General
 Item  2: Process Number                     2  : Averaging Process
 Item  3: User-defined Process Name
 Item  4: Input for Average Data           S0.1


 >
```

> **For all process types, line items 1, 2 and 3 are always Process Category, Process Number and User-defined Process Name respectively. Any other line items used are unique and specific to that process type.**

Line item #3, the User-defined Process Name has essentially the same as the Sensor Name for all Sensor Type Definitions.[36] It enables you to assign a unique name of your own choosing to each Process Record to aid you in remembering what the function of each Process Record is.[37]

For our configuration example, this Process Record will calculate the average of all the Internal Temperature Readings. We can assign the name "AvgTemp" by typing the command **C3/AvgTemp{ENTER}**. Your screen should look something like this:

[36] Refer to Sections 3.2.3 and 10.3.6.
[37] Refer to Section 10.4.2.

```
    > C3/AvgTemp

    PROCESS MENU
    (Cn/m) Change Item n To Value m          (Jn) Jump To Record n
    (A)    Insert After This Record          (N)  Go To Next Record
    (B)    Insert Before This Record         (P)  Go To Previous Record
    (X)    Cut Record to Clipboard           (XA) Delete ALL Records
    (C)    Copy Record To Clipboard          (Z)  Zeno Program Menu
    (V)    Paste Record From Clipboard       (H)  Help
    (Sn/m) Search Item n for Value m


    Process Items for Record 1 of 1:
    Item  1: Process Category                   1 : General
    Item  2: Process Number                     2 : Averaging Process
    Item  3: User-defined Process Name     AvgTemp
    Item  4: Input for Average Data            S0.1


    >
```

The Averaging Process does use more than the first three standard line items as part of its complete definition. The fourth line item is a reference to a Sensor Record or preceding Process Record from which the Averaging Process will calculate an average.

> **Any Process Record line item that requires a reference to a Sensor Record or a preceding Process Record is called a Data Input to the process.**
>
> **Any Process Record line item that requires a numerical value is called a User Input to the process.**

Line Item #4 in the Averaging Process is a Data Input to the process. To specify a reference to data collected by a particular Sensor Record, the format **Sn.m** is used. To specify a reference to a data processed by a preceding Process Record, the format **Pn.m** is used. for either format, **n** is the record index number and **m** is the data value index number. In our example, you are referencing data collected by a sensor that collects a single data value. You can use the shorthand format **Sn** because the only possible value for **m** would be 1.[38]

In our configuration example, this Averaging Process needs the data collected by the Sensor Record that is collecting data from the Internal Temperature Sensor. That Sensor Record index number is 1 and it only collects a single data value. Therefore, you want to type the command **C4/S1{ENTER}** to reference the collected Internal Temperature Sensor data.   Your screen will look something like this:

---

[38] Refer to Section 10.4.4 for more details.

```
> C4/S1

PROCESS MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 1 of 1:
Item  1: Process Category                    1 : General
Item  2: Process Number                      2 : Averaging Process
Item  3: User-defined Process Name       AvgTemp
Item  4: Input for Average Data              S1 : IntTemp


>
```

You should notice that the Sensor Name "IntTemp" that was specified in Sensor Record #1 is displayed when you reference Sensor Record #1.

> **The user specified name given to a Sensor Record or Process Record is displayed when that particular record is referenced.**

When you leave the Zeno Program Menu and the ZENO®-3200 starts collecting and processing data, Process Record #1 will calculate the average of the data collected by Sensor Record #1, the Internal Temperature Sensor. You are now done defining this Process Record definition.

If you want to see what values are calculated by the Averaging Process that you defined in Process Record #1, you can obtain help about the process by typing the command **HP1{ENTER}**.[39] Your screen will look something like this:

```
> HP1
Process Record 1 specifies the Averaging Process Type.
The Averaging Process produces the following
floating-point output values:
  1 : Average Data, current value = 0.
  2 : Most Recent Sample, current value = 0.
  3 : Standard Deviation, current value = 0.
  4 : Maximum Value, current value = 0.
  5 : Minimum Value, current value = 0.
The Averaging Process produces the following
error output values:
 E1 : Process Error Code, current value = 1.
Hit any key to continue . . .
```

As shown, the Averaging Process does a lot more than just calculate the average. It also calculates the standard deviation, the maximum and minimum values seen during the Sample Duration and a Process

---

[39] Refer to Section 2.4.2.

Error Code.[40] You can view the available outputs of any Process Record at any time by typing this command in any ZENO®-3200 menu.

For our example configuration, one more Process Record needs to be defined that will calculate the average of the Battery Voltage that is read by Sensor Record #2. To do that, we need to insert a new Process Record after the current one using the **A{ENTER}** command. Your screen will look something like this:

```
> A

PROCESS MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard              (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 2 of 2:
Item  1: Process Category                     1  : General
Item  2: Process Number                       1  : Immediate Data Process
Item  3: User-defined Process Name
Item  4: Input for Immediate Data          S0.1

>
```

The same type of Averaging Process will be used to calculate the average of the Battery Voltage readings in this Process Record. As in the previous Process Record, Line Item #1 will be set to 1 and Line Item #2 will be set to 2. A good user name for this Process Record could be "AvgBatt," Since you know that the Sensor Record #2 is where the Battery Voltage data is being collected. Therefore, a single, space-delimited line, setting three line items at once, can be typed: **C2/2 C3/AvgBatt C4/S2{ENTER}**.

Your screen should look something like this:

```
> C2/2 C3/AvgBatt C4/S2

PROCESS MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard              (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 2 of 2:
Item  1: Process Category                     1  : General
Item  2: Process Number                       2  : Averaging Process
Item  3: User-defined Process Name     AvgBatt
Item  4: Input for Average Data            S2  : Battery

>
```

Both Process Records needed for our example configuration are now configured.

---

[40] Refer to Section 10.4.5 and Appendix D.

Since you have reached another milestone during the configuration process, it is a good idea to save the configuration again to EEPROM in case there is a power surge. Return to the Zeno Program Menu by typing the command **Z{ENTER}**, then type the command **E{ENTER}**.

3.2.5. Learning How To Configure A Data Output

From the Zeno Program Menu, you want to enter the Data Output Menu,   and that requirestyping **D{ENTER}** from the Zeno Program Menu.

Your screen should look something like this:

```
ZENO PROGRAM MENU
(S) Sensor Menu                           (M) Memory Management Menu
(P) Process Menu                          (W) Password Menu
(D) Data Output Menu                      (R) Reset System
(T) Sensor Timing Loop Menu               (E) Save Parameters To EEPROM
(O) Output Message Timing Menu            (U) User Menu
(L) System Load Menu                      (Q) Quit
(G) General Serial Script Menu            (H) Help

> D

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 1 of 1:
Item  1: Field Type Code            0 : NULL Field
Item  2: Output Message(s)          1

>
```

Each field, specified as part of a complete Data Record, is defined using the Data Output Menu. There are three types of fields:

1.   Fields that only transmit information
2.   Fields that only log data
3.   Fields that transmit and log data

Similar to the Sensor Record Definition, each Data Output Field (or Data Output Record) is defined initially with a single Field Type Code.[41] To know what the available field types are, type the command **H1{ENTER}** in the Data Output Menu.

Your screen should look something like this:

---

[41] Refer to Section 10.6.3 for a complete list of all Data Output Record Field Type Codes.

```
   > H1
   * Select Field Type Code, valid codes are
           -  0 (NULL)
           -  1 (Checksum)
           -  2 (NMEA Checksum)
           -  3 (Timestamp)
           -  4 (Primary Unit ID Number)
           -  5 (Secondary Unit ID Number)
           -  6 (Literal String)
           -  7 (Transmit Only)
           -  8 (Log Only)
           -  9 (Transmit and Log Data)
           - 10 (Conditional Start)
           - 11 (Conditional Stop)
           - 12 (GOES Binary Format)
           - 13 (ARGOS Binary Format)
           - 14 (Start Checksum)
           - 15 (Selectable Transmit and Log)
           - 16 (Message Number)
           - 17 (Resetable Record Counter)
           - 18 (Backspace)
           - 19 (FAA Wind Transmit Only)

   Hit any key to continue . . .
```

For our example configuration, we will need to use three of the available field types: Timestamp (Field Code Type #3), Literal String (Field Code Type #6), and Transmit and Log Data (Field Code Type #9).[42]

For the Data Output Message that you want, you must tell the ZENO®-3200 exactly what you want it to do. This includes when to insert a carriage return so that the output messages don't all end up on the same line and run into each other. for this reason, it is recommended that the first Data Output Record should be configured to be a Literal String Field specifying a carriage-return and linefeed.

> **The Literal String Field (Field Code Type #6) allows you to specify an exact sequence of characters to be transmitted as part of a Data Output Message.[43]**

Using a Literal String Field as part of a Data Output Message allows you to specify when and where you want to have a carriage return. In our example, let's place a carriage return at the beginning of the Data Output Message. That way, you'll know that every new Data Output Message will always start on the new line of your terminal emulation program. To set the first Data Output Record as a Literal String Field, type the command **C1/6{ENTER}** in the Data Output Menu in the first Data Output Record. Your screen should look like the following:

---

[42] Refer to Section 10.6.3 for a complete list of all Data Output Record Field Type Codes.

[43] Any characters specified in a Literal String Field are not logged. Refer to Section 10.6.5.

```
> C1/6

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m          (Jn) Jump To Record n
(A)    Insert After This Record          (N)  Go To Next Record
(B)    Insert Before This Record         (P)  Go To Previous Record
(X)    Cut Record to Clipboard           (XA) Delete ALL Records
(C)    Copy Record To Clipboard          (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard       (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 1 of 1:
Item  1: Field Type Code             6 : Literal String Field
Item  2: Output Message(s)           1
Item  3: Field Name

>
```

The ZENO®-3200 supports up to four different Data Output Messages and each one is defined in the Data Output Menu.

Line Item #2 allows you to specify which Data Output Message (numbered 1 through 4) that you want this particular data field to be part of, including whether it is to be used in multiple Data Output Messages.[44] In our example configuration, we are only using one Data Output Message (the first one), so the value of line item #2 does not need to be changed in any way.

Line item #3, the Field Name, is where you will specify what characters you want the ZENO®-3200 to print for the Literal String Field. In order to enter "non-printable characters" (any non-alphanumeric or non-punctuation character), ZENOSOFT® allows you to specify the ASCII[45] code of each non-printable character. By using the ASCII table contained in Appendix A, the ASCII code for a carriage return is 13, or D in hexadecimal.

Since not all terminal emulation programs add a line feed to a carriage return, it's a good idea to also add the ASCII code for a line feed, which is 10, or a hexadecimal A. To designate that you are entering character as an ASCII code, you enclose the *hexadecimal* ASCII code in two brackets using the less-than sign and the greater-than sign: "<D><A>". Type the command **C3/<D><A>{ENTER}** in the Data Output Menu and your screen will look something like this:

---

[44] Refer to Section 10.6.4.

[45] ASCII, American Standard Code for Information Interchange, is a coding standard for characters, numbers, and symbols.

```
 > C3/<D><A>

 DATA OUTPUT MENU
 (Cn/m) Change Item n To Value m              (Jn) Jump To Record n
 (A)    Insert After This Record             (N)  Go To Next Record
 (B)    Insert Before This Record            (P)  Go To Previous Record
 (X)    Cut Record to Clipboard              (XA) Delete ALL Records
 (C)    Copy Record To Clipboard             (Z)  Zeno Program Menu
 (V)    Paste Record From Clipboard          (H)  Help
 (Sn/m) Search Item n for Value m

 Data Items for Record 1 of 1:
 Item  1: Field Type Code               6 : Literal String Field
 Item  2: Output Message(s)             1
 Item  3: Field Name                    <D><A>

 >
```

This first Data Output Record will cause the ZENO®-3200 to output each Data Output Message starting with a carriage return/line feed so that they are easy to read.

The example configuration also needs to have the date and time displayed before any data is displayed in the Data Output Message. Thus, another Data Output Record is created by typing **A{ENTER}**.[46] After the ZENO®-3200 displays the new, default Data Output Record (it should be the second record of two), type the command **C1/3{ENTER}** to set the Field Type Code to the Timestamp Field.

Your screen should look something like this:

```
 > A C1/3

 DATA OUTPUT MENU
 (Cn/m) Change Item n To Value m              (Jn) Jump To Record n
 (A)    Insert After This Record             (N)  Go To Next Record
 (B)    Insert Before This Record            (P)  Go To Previous Record
 (X)    Cut Record to Clipboard              (XA) Delete ALL Records
 (C)    Copy Record To Clipboard             (Z)  Zeno Program Menu
 (V)    Paste Record From Clipboard          (H)  Help
 (Sn/m) Search Item n for Value m

 Data Items for Record 2 of 2:
 Item  1: Field Type Code               3 : Timestamp Field
 Item  2: Output Message(s)             1

 >
```

The date and time will be displayed from this single Data Output Record.

> **When any data is logged, ZENOSOFT® always logs the timestamp of the data whether or not the Timestamp Field is part of the Data Output Message.**

From the example, two more Data Output Records are required to finish the configuration. Each of the two Data Output Records will specify which data to log and transmit by using a Field Type Code of 9.

---

[46] Refer to Sections 3.2.4 and 10.2.

Type the command string **A C1/9{ENTER}** in the Data Output Menu to create a new Data Output
Record and to change the Field Type Code to a 9.

Your screen should look something like this:

```
> A C1/9

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m           (Jn) Jump To Record n
(A)    Insert After This Record           (N)  Go To Next Record
(B)    Insert Before This Record          (P)  Go To Previous Record
(X)    Cut Record to Clipboard            (XA) Delete ALL Records
(C)    Copy Record To Clipboard           (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard        (H)  Help
(Sn/m) Search Item n for Value m


Data Items for Record 3 of 3:
Item  1: Field Type Code              9 : Transmit and Log Data Field
Item  2: Output Message(s)            1
Item  3: Field Name
Item  4: Input Record                P1.1 : AvgTemp
Item  5: Field Decimal Places        0
Item  6: Field Width                 0
Item  7: Data Storage Class Code     1 : 1-byte signed integer


>
```

More Line Items make up the Data Output Definition for a data field that transmits and logs data so that
you can specify data formatting.

The Field Name, line item #3, in the Transmit and Log Data Field will be used when you view data in the
Data Output Menu. Whatever name you assign to this Data Output Record will be shown in the column
above the data that is sent when you view a number of logged data records.

For our example, set the Field Name to the same as the User-defined Process Name from which this Data
Output Record will get its data: "AvgTemp."

When you create a new Transmit and Log Data Field,[47] the default value for line item #4 is always
"P1.1," which means "get the first data value from Process Record #1." In our example, that is exactly
the data we want to transmit for this Data Output Record, so it does not have to change.

Line item #5 defines the Field Decimal Places, or the precision of the data to be viewed. for our example,
set the number of decimal places to 1, so that we have a precision of a tenth of a degree Celsius.

Line item #6 defines the total Field Width for this Data Output Record. When we use comma-delimited
formatting, this field won't be used, but if the output message format is space-delimited, then this field
will specify how many characters this field will have in the Data Output Message. If this value is set too
low, this field may run into the previous field if space delimiting is required. Therefore, it's a good idea to
set it to an appropriate field width. In our example, we know that temperature should range anywhere
from -20.0 to 50.0 degrees Celsius. To allow for at least one space between this field and the previous
field and to account for the possible total number of characters, the Field Width should be set to 6.

---

[47] Refer to Section 10.6.6 for comprehensive details to create a Data Output Record to transmit or log data or both.

Line item #7 specifies the Data Storage Class Code. If we type **H7{ENTER}** in the Data Output Menu, we will see what the different Data Storage Class Codes are. Your screen should look something like this:

```
> h7
* Select Data Storage Class Code, valid codes are
        -  1 (1-byte signed integer (-127 to 127))
        -  2 (1-byte unsigned integer (0 to 255))
        -  3 (2-byte signed integer (-32767 to 32767))
        -  4 (2-byte unsigned integer (0 to 65535))
        -  5 (4-byte signed integer (-2147483647 to 2147483647))
        -  6 (4-byte unsigned integer (0 to 4294967295))
        -  7 (2-byte compressed float (-3276.2 to 3276.2, 1 place prec'n))
        -  8 (4-byte floating point (-3.40e38 to 3.40e38, 7 place prec'n))
        -  9 (n-byte character string (length 'n' defined by Field Width))

Hit any key to continue . . .
```

From viewing this help, you should see two possible choices that best fit the type of floating-point data that will be logged by this Data Output Record. Namely, these are Data Storage Class Codes 7 and 8. Since the precision of tenths of a degree Celsius has been selected, storing this value a full 4-byte floating-point number will waste logging memory. Storing this value as a compressed floating point number will best utilize existing logging memory by using the smallest number of bytes to store the floating-point number. Therefore, you want to set the value of line item #7 to a value of 7.

For a single, space-delimited multiple command line: type **C3/AvgTemp C5/1 C6/6 C7/7{ENTER}** in the Data Output Menu for this Data Output Record.

Your screen should look the following:

```
> C3/AvgTemp C5/1 C6/6 C7/7

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 3 of 3:
Item  1: Field Type Code            9 : Transmit and Log Data Field
Item  2: Output Message(s)          1
Item  3: Field Name                 AvgTemp
Item  4: Input Record               P1.1 : AvgTemp
Item  5: Field Decimal Places       1
Item  6: Field Width                6
Item  7: Data Storage Class Code    7 : 2-byte compressed float

>
```

This Data Output Record Definition is now complete.

You now need to set up the last Data Output Record to log and transmit the average battery voltage. If you examine the range of data that will come from the average battery voltage calculation, you will find that it is very similar to the range set for average internal temperature. You can save yourself some typing by using Data Output Record #3 to partially create Data Output Record #4, which will log and transmit the average battery voltage. To save yourself some more typing, you can "copy and paste" Data Output Record #3 into Data Output Record #4 by using menu options "C" for copy and "V" for paste.[48]

When you create a new Data Output Record using the "A" command, you will be taken immediately to the new Data Output Record. You can first type the "C" command to copy the contents of Data Output Record #3. Then type the "A" command to create the new Data Output Record. Then type the "V" command to copy the contents of the clipboard into Data Output Record #4. Rather than sending them one at a time, you can send all three commands on a single command line to the ZENO®-3200. Type **C A V{ENTER}** in the Data Output Menu for this Data Output Record.[49]

Your screen should look the following:

```
> C A V

Record copied to clipboard.

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 4 of 4:
Item  1: Field Type Code            9 : Transmit and Log Data Field
Item  2: Output Message(s)          1
Item  3: Field Name                 AvgTemp
Item  4: Input Record               P1.1 : AvgTemp
Item  5: Field Decimal Places       1
Item  6: Field Width                6
Item  7: Data Storage Class Code    7 : 2-byte compressed float

>
```

Now, all you have to do is change the Field Name to "AvgBatt" and the Input Record to "P2.1" so that this Data Output Record will log and transmit the average battery voltage calculated by Process Record #2. Type **C/AvgBatt C4/P2.1{ENTER}** in the Data Output Menu for this Data Output Record.

---

[48] Refer to Section 10.2.
[49] Refer to Section 10.2.

Your screen should look the following:

```
> C3/AvgBatt C4/P2.1

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 4 of 4:
Item  1: Field Type Code             9 : Transmit and Log Data Field
Item  2: Output Message(s)           1
Item  3: Field Name                  AvgBatt
Item  4: Input Record                P2.1 : AvgBatt
Item  5: Field Decimal Places        1
Item  6: Field Width                 6
Item  7: Data Storage Class Code     7 : 2-byte compressed float

>
```

This Data Output Record will log and transmit the average battery voltage that is calculated by Process Record #2.

You are now done configuring the Data Record!

Since you have reached another milestone in your configuration, you should return to the Zeno Program Menu and type **E{ENTER}** to save the configuration changes to EEPROM. That way, the changes you have made won't be lost if there is a power surge or outage.

3.2.6. Other Configuration Changes

Since all the sensors, processes, and data output records are now configured, you can go back to the User Menu and do any other configuration changes that are required. In particular, you might want this example configuration to behave like the one illustrated in Section 3.1.1. In that case, you can go to the Sample Period Menu and set the Sample Interval, Sample Duration and Sample Time Offset to the settings that match the first part of the tutorial.[50]

When you create your own configuration, other things may need to be set in the configuration beyond what was described in the examples within this tutorial. These will be covered in the next sections of this User Manual.

---

[50] Refer to Section 3.1.3.

4.   RETRIEVING LOGGED DATA

Coastal Environmental Systems

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When you use your ZENO®-3200 for retrieving logged Data Records, ZENOSOFT® stores the Data Records in sequential order. Each Data Record consists of a timestamp (the date and time) as well as the data values to be logged. The data values being logged are defined in the Data Output Menu.

> **The time interval between successive, regularly logged Data Records is always the same as long as:**
>
> **1. There is no power loss to the ZENO®-3200.**
>
> **2. There are no changes in the Sample Interval, Sample Duration, Sample Time Offset, internal ZENO®-3200 clock or other time related information in the configuration.**
>
> **3. There are no Alarm Messages being logged.**
>
> **4. A user does not enter the Zeno Program Menu in the User Interface.**

If the ZENO®-3200 suffers a loss of power, there will be a gap in your logged Data Records. The size of the gap will depend upon the duration of the power loss.

> **A "gap" in logged Data Records is not a physical gap in memory, but a longer difference in timestamps between successive Data Records than your configuration specifies.**

If you make any changes to the Sample Interval, Sample Duration Time, Sample Time Offset, internal ZENO®-3200 clock or any other time-related information in your configuration, there will probably be a gap in your logged Data Records.

> **If you change the internal ZENO®-3200 clock to a time prior to its most recent logged data record, there will be data records whose timestamps are overlapping.**

> **If you need to adjust the internal ZENO®-3200 clock backward, to avoid
> data records with overlapping timestamps, Coastal Environmental Systems
> recommends that you either:**
>
> 1. **Only set the clock back to a time not earlier than the timestamp of the
>   most recent logged data record, or**
>
> 2. **If you need to set the internal clock to a time earlier than the timestamp
>   of the most recent logged data record, first download all logged data
>   records to your computer, then delete all the logged data records.**

4.1.   DATA RETRIEVAL OPTIONS

There are several different ways you can retrieve logged data records from your ZENO®-3200. The
various options include:

- Retrieve the most recently logged data records
- Retrieve the oldest (unmarked) logged data records
- Retrieve all logged data records at once
- Retrieve logged data records after a specific date and time
- Retrieve logged data records between two consecutive dates & times
- View the logged data records in your terminal emulation program
- Download the logged data records into a computer using simple ASCII or the X-modem protocol

From the User Interface Menus, all logged data retrieval is done via the Data Retrieval Menu. Type
D{ENTER} from the User Menu to enter the Data Retrieval Menu.

Your screen will look something like this:

```
DATA RETRIEVAL MENU
(A)  Show Records AFTER Specified Time   (C) Compute Data Logging Capacity
(B)  Show Records BETWEEN Timespan       (D) Delete All Data Records
(Ln) Show LAST n Records                 (N) Number of Records Logged
(*)  Show ALL Data Records               (U) User Menu
(@n) Show n Unmarked Records             (Q) Quit
(M)  Mark Recently Shown Data            (H) Help

Precede Any "Show Data" Command With An 'X' for X-Modem Transfer
(eg. Enter 'X*' To Send All Data Sets Via X-Modem)
```

When you retrieve logged Data Records using the Data Retrieval Menu, all Data Records displayed will
include the timestamp (date & time) when the Data Record was logged followed by the actual data
contained in each Data Record.

> **The content of each Data Record is defined in the Data Output Menu.[51]**

> **The Field Name defined for any Data Output Record that logs a data value is displayed as a columnar heading above the retrieved Data Records. If no Field Name is defined for a particular Data Output Record, then the columnar heading will be blank.**

4.1.1. Communications Settings Affect How Data Records Are Viewed

The communications interface to your ZENO®-3200 affects how you can view logged Data Records:

Communications Interface	Affect To Viewing Logged Data Records
Unidirectional	You cannot view logged data records in this case. Only real-time data messages can be viewed as the ZENO®-3200 transmits them.
Bi-directional, full-duplex	Full access to all ZENO®-3200 functions, including data retrieval. When viewing large amounts of logged data, you can interrupt the transmission by pressing any key in your terminal emulation program.
Bi-directional, half-duplex	Full access to all ZENO®-3200 functions, including data retrieval. When viewing large amounts of logged data, the ZENO®-3200 will transmit up to 20 records at a time, then prompt you to continue. This is especially critical in radio communications since too much data transmission can damage the radio.

Detailed information about different communications interfaces is provided in Section 6.

4.1.2. Viewing The Most Recently Logged Data Records

Option **L** in the Data Retrieval Menu shows up to "n" **LAST**, most recently logged data records. If you are logging the average internal temperature and the average battery voltage once a minute and you want to view the last 5 Data Records.

---

[51] Refer to Section 10.6.

You would type the command **L5{ENTER}** in the Data Retrieval Menu and your display will look something like this:

```
DATA RETRIEVAL MENU
(A)  Show Records AFTER Specified Time        (F) Flash Memory Information
(B)  Show Records BETWEEN Timespan            (D) Delete All Data Records
(Ln) Show LAST n Records                      (N) Number of Records Logged
(*)  Show ALL Data Records                    (U) User Menu
(@n) Show n Unmarked Records                  (Q) Quit
(M)  Mark Recently Shown Data                 (H) Help
(C)  Compute Data Logging Capacity

Precede Any "Show Data" Command With An 'X' for X-Modem Transfer
(e.g. Enter 'X*' To Send All Data Sets Via X-Modem)

> L5

Hit The Space Bar To Halt The Log Data Output.
  DATE      TIME    AvgTemp AvgBatt
01/07/31 07:54:55   22.0  13.8
01/07/31 07:55:55   22.0  13.8
01/07/31 07:56:55   22.1  13.8
01/07/31 07:57:55   22.2  13.8
01/07/31 07:58:55   22.3  13.8
```

The displayed Data Record format (e.g., whether comma or space separation between the data values is used) can be changed from the System Functions Menu.

4.1.3. Viewing & Marking The Oldest Data Records

Option "**@**" in the Data Retrieval Menu shows up to "n" oldest, unmarked Data Records. This option is very similar to the "L" option but shows the oldest and unmarked Data Records as opposed to the most recently logged Data Records. After you have viewed the oldest Data Records using the "**@"** option, you can "mark" them as having been read by typing **M{ENTER}** in the Data Retrieval Menu.

> **If you mark the most recently viewed oldest Data Records, you cannot view them again using the @ option; but you can still view them using other data retrieval options.**

The next time you enter the **@n** command, ZENOSOFT® will display the next oldest unmarked **n** records.

Here is something you can try, to understand how the marking mechanism works:

- View the 5 oldest unmarked Data Records by typing @5{ENTER} in the Data Retrieval Menu.
- Repeat the previous command and you will view the same oldest Data Records.
- Now type M{ENTER} to mark the viewed oldest Data Records.
- View the 5 oldest unmarked Data Records again, and you will see that they are the next 5 oldest Data Records as previously viewed.

> **NOTE: The M command will work regardless of when the last @n command was used, even if you have left and re-entered the user interface in the mean time.**

4.1.4. Viewing All of The Logged Data Records

Option "*****" in the Data Retrieval Menu shows all of the logged Data Records starting from the oldest and continuing through to the most recently logged Data Record. Because viewing all logged data can involve a huge amount of information, the type of communications interface to your ZENO®-3200 will determine how the ZENO®-3200 sends that data.[52]

4.1.5. Searching for Logged Data Records Based Upon Their Timestamps

There are two options in the Data Retrieval Menu that cause ZENOSOFT® to search through all logged Data Records for Data Records that were logged at specified times. These options are the **A** and **B** options.

OPTION A   This option shows a specified number of Data Records **AFTER** a specified time.

For example, you may wish to examine the three Data Records logged after 3 p.m. Type **A{ENTER}** in the Data Retrieval Menu. You will be prompted to enter the date and time of the earliest Data Record that you wish to view. After you enter the date and time in the format "YY/MM/DD HH:MM:SS", you will then be prompted for the number of Data Records to be displayed. ZENOSOFT® will then search all of the logged Data Records based upon these requirements. When it finds the first Data Record that meets your criteria, it will display that Data Record plus any more consecutive Data Records that meet the number of Data Records that you specified. If ZENOSOFT® cannot find any Data Records that meet your criteria, it will simply respond with "EOF." If ZENOSOFT® finds the first Data Record, but there are fewer consecutive Data Records than the number you specified, all of the found Data Record will be displayed, followed by "EOF."

OPTION B   This option shows all Data Records BETWEEN two different dates and times.

When you type **B{ENTER}** in the Data Retrieval Menu, you will be prompted to enter a date and time of the earliest Data Record that you wish to view. After you enter the date and time in the format "YY/MM/DD HH:MM:SS," you will be prompted again to enter the date and time of the latest Data Record that you want to view (using the same format as before). ZENOSOFT® will then search all of the logged Data Records based upon these requirements. When it finds the first Data Record that meets your criteria, it will search for the last Data Record that meets your criteria and display all the Data Records from first to last that it finds. If ZENOSOFT® cannot find any Data Records meeting your criteria, it will simply respond with "EOF."

The date & time format "YY/MM/DD HH:MM:SS" is defined as follows:

- YY is the last two digits of the current year (valid from 1970 through 2037)
- MM is the month (1 to 12)

---

[52] Refer to Section 4.1.1.

- DD is the day (1 to 31)
- HH is the hour of day (00 to 23)
- MM is the minute (00 to 59)
- SS is the seconds (00 to 59)

4.1.6. Downloading Data Records Into A File As A Text Dump

When you want to download Data Records from the ZENO®-3200 into a computer, there are two ways you can retrieve data:

- Using a simple text dump
- Using the X-modem protocol

> **To download Data Records into a file, your terminal emulation program needs to be equipped with a "File Capture" mode.**

To do a simple text dump, you need to start the "File Capture" function of your terminal emulation program before you enter any data retrieval command.

The procedure is as follows:

1. Enter the Data Retrieval Menu of the ZENO®-3200 User Interface.
2. Start the "File Capture" function in your terminal emulation program.
3. Enter the desired data retrieval command.
4. Wait for all of the requested Data Records to be transmitted by the ZENO®-3200.
5. After the ZENO®-3200 has finished sending all of the requested Data Records, stop the "File Capture" function of your terminal emulation program.

Using a simple text editor, you can remove any unwanted information at the beginning of the captured text file that will be there before the actual Data Records.

4.1.7. Downloading Data Records Into A File Using The X-Modem Protocol

Unlike a simple text dump, the X-modem file transfer protocol[53] uses built-in error-checking algorithms to verify that the messages being transmitted by the ZENO®-3200 are readable by your computer. Whereas you can directly view the content of a simple text dump, you cannot readily view contents of an X-modem communication because it is binary and broken up into chunks for error checking.

---

[53] The X-modem file transfer protocol was developed by Ward Christensen in 1977 and is a public domain. It is a simple send-and-wait ARQ (automatic repeat request) protocol using a fixed-length data field and uses either a simple single-byte checksum or CRC checksum for error detecting. For a complete description of the X-modem file transfer protocol, refer to pages 100-112 of the book **C Programmer's Guide to Serial Communications, 2nd Edition**: Joe Campbell, 1994, Sams Publishing.

> **The X-modem protocol should be used on any communications interface that is prone to noise.**
>
> **The X-modem protocol is limited to bi-directional communication interfaces only.**
>
> **To use the X-modem protocol, your terminal emulation program needs to support X-modem file retrieval.[54]**

The X-modem protocol can be used when downloading Data Records from the ZENO®-3200 using any of the data retrieval options available in the Data Retrieval Menu. To use the X-modem protocol, simply prefix the character **X** to any of the data retrieval commands in the Data Retrieval Menu. Before the ZENO®-3200 begins to transmit the Data Records in X-modem protocol, it will prompt you to open a file on your computer where the Data Records will be stored. Your terminal emulation program should have an "X-modem File Capture" that you will need to start. As soon as you start the "X-modem File Capture" in your terminal emulation program, the ZENO®-3200 will start sending the Data Records in X-modem protocol. At the completion of the transmission, your terminal emulation program will automatically stop capturing the data. Once the transmission is complete, you can view the data file on your computer using any text editing or spreadsheet program.

4.2.   DATA LOGGING CAPACITY INFORMATION

Option **C** in the Data Retrieval Menu will cause ZENOSOFT® to display the data logging capacity ZENO®-3200. Several factors determine the total data logging capacity of your ZENO®-3200:

- Amount of installed memory (RAM and Flash Logging Memory)
- The memory partitioning in your version of ZENOSOFT®
- Memory allocated in the Memory Management Menu
- The size of each Data Record

The total amount of available data logging memory in your of your ZENO®-3200 and the size of each Data Record will determine how many Data Records can be logged. When you type C{ENTER} in the Data Retrieval Menu to see what the data logging capacity is, your screen will look something like this:

```
> C
Total Data Logging Memory (bytes)   = 127420
Maximum Number of Data Records      = 15927
Size of Each Data Record            = 8
Maximum Data Time Span (d:hh:mm:ss) = 11:01:27:00
```

---

[54] Many terminal emulation programs refer to an X-modem file transfer as a ***binary file*** transfer. If you don't see X-modem file transfer specified, try the binary file transfer. If your terminal emulation program does not support X-modem file transfer, you might want to find a different terminal emulation program that does. (Contact Coastal Environmental Systems for assistance.) Note: X-modem file transfer ***is not the same as*** Z-modem file transfer or Kermit file transfer.

In this particular case, the total amount of memory for data logging is 127,420 bytes. The size of each Data Record is 8 bytes. Therefore, the total number of Data Records that can be stored is 15,927, which is the whole-number quotient of 127,420 ÷ 8.

The Maximum Data Time Span is the maximum amount of time that the maximum number of Data Records will fill the available data logging memory. From the example configuration described in Section 3.1, the Sample Interval is 60 seconds. The product of 60 seconds and 15,927 Data Records is 955,620 seconds, which is the same as 11 days, 1 hour, 27 minutes and 0 seconds. (If Alarm Messages are also being logged, then the data time span will be less than the maximum calculated value.)

As described in Section 3.1.1:

> **The available logging memory is treated by ZENOSOFT® as a circular buffer. Once the circular buffer is full, each newest Data Record overwrites the oldest Data Record currently stored in the buffer.**

Therefore, in this example, once 15,927 Data Records have been logged, the circular buffer will "wrap" and the newest Data Records will overwrite the oldest Data Records stored in memory.

> **Another way to think of the Maximum Data Time Span: It is the maximum time that any single Data Record will be stored by the ZENO®-3200.**

You can monitor how many Data Records have been logged at any given time by typing menu option **N{ENTER}** in the Data Retrieval Menu. The value that ZENOSOFT® reports will be a number between 0 and the maximum number of logged Data Records. Before the first circular buffer memory wrap, the number will be less than the maximum number of logged Data Records. Once the circular buffer has wrapped, the value returned will always be the maximum number of logged Data Records.

4.3.   DELETING LOGGED DATA RECORDS

When you no longer want the ZENO®-3200 to store the set of current Data Records, you can delete all of the logged Data Records by typing **D{ENTER}** in the Data Retrieval Menu. You will be prompted to verify that you want to delete all of the logged Data Records.

> *IMPORTANT*: **You cannot undo deletion of logged Data Records.**

4.4.   DATA OUTPUT MESSAGE FORMAT OPTIONS

There are two types of Data Output Messages: real-time data output messages and retrieved data output messages. You can set the format of each Data Output Message type using two line items available in the System Functions Menu.

```
    SYSTEM FUNCTIONS MENU
    (Cn/m) Change Item n To Value m            (I) Contact Information
    (S)    System Date and Time               (E) Save Parameters To EEPROM
    (T)    Calibrate Internal Temperature      (U) User Menu
    (V)    Program Version                     (Q) Quit
    (K)    Constants Menu                      (H) Help
    (B)    BIT Names Menu

    Item  1:  0            (Primary Unit/Experiment ID)
    Item  2:  0            (Secondary Unit/Experiment ID)
    Item  3:  1            (Data Dump Format)
    Item  4:  1            (Real Time Output Format)
    Item  5:  0            (Add Compass To Vane)
    Item  6:  0            (Compass Offset)
    Item  7:  0            (Barometer Elevation)
    Item  8:               (Bad Sensor Value Replace)

    >
```

4.4.1. Retrieved Data Output Message Format

Each Data Record retrieved in the Data Retrieval Menu is displayed with a particular format. The format can be either space delimited, comma delimited or the same as the real-time output message format. Line item #3 (Data Dump Format) in the System Functions Menu allows you to specify which format you want to use.

From the User Menu, type **F{ENTER}** to enter the System Functions Menu. To know what each of the numerical codes are for line item #3, type **H3{ENTER}**. Your screen should look something like this:

```
    > H3

    * Select data dump (logging) message format, valid options are
            - 1 (space delimited).
            - 2 (comma delimited).
            - 3 (real time format option 1, see help for item 4, 'H4').

    Hit any key to continue . . .
```

As this screen shot shows, the Data Dump Format is currently set to space delimited. In this case, all retrieved Data Records will be space delimited. If the Data Dump Format is set to 2, all retrieved Data Records will be comma delimited. In the case when the Data Dump Format is set to 3, all retrieved Data Records will have the same format as the real-time output messages.

> **Data Output Records that specify Literal Fields[55] are only transmitted for real time output messages _unless_ you specify Data Dump Format with a code of 3.**

---

[55] Refer to Section 10.6.5.

4.4.2. Real Time Data Output Message Format

Real time output messages are messages automatically transmitted by the ZENO®-3200 without being polled for any information. There are several different formatting options available for the real time output messages.

Line item #4 in the System Functions Menu sets the Real Time Output Message Format. If you type the command **H4{ENTER}** in the System Functions Menu, you will see the following list of options appear on your screen:

```
> h4

* Select real time output message format, valid options are
        - 0 (real time output message suppressed).
        - 1 (ASCII characters, width dependent, comma separated).
        - 2 (ASCII characters, [see NOTE below], no comma separation).
        - 3 (CCSAIL format, [see NOTE below]).
* NOTE: for option 2, width is specified by 'Field Width' item in Data
  Output Menu; if a data item uses fewer characters than specified,
  Leading space characters are inserted.
* NOTE: for option 3, ID numbers are 4 character fixed fields and the
  checksum becomes modulo 100 with no trailing comma.

Hit any key to continue . . .
```

These options are similar in meaning to those for the Data Dump Format, but with several differences:

Real Time Message Format Code	Action that ZENO®-3200 Will Take	Why To Use This Option
0	Suppress all real time output messages.	If you are using Intercept™ to poll the ZENO®-3200 for data, the ZENO®-3200 should not be generating any real-time output messages.
1	Comma delimited	Personal choice or because computer being used to read data requires this type of delimiter.
2	Space delimited	
3	CCSAIL Format[56]	If you are using Intercept™ and the ZENO®-3200 only has unidirectional communication, the ZENO®-3200 needs to automatically output its data in CCSAIL format.

4.5.   BAD SENSOR VALUE REPLACEMENT

Whenever the ZENO®-3200 is unable to collect data from a sensor, the ZENO®-3200 will output a value of -1,000,000 as the measured value for that sensor.

---

[56] The CCSAIL Format is explained in a Section 0. Section 4.6 should be read in its entirety to fully understand the CCSAIL protocol.

> **-1,000,000 is referred to as the Bad Sensor Value.**

If you do not want the Bad Sensor Value to appear in any of your data output messages, you can set a replacement string using line item #8 in the System Functions Menu:

```
SYSTEM FUNCTIONS MENU
(Cn/m) Change Item n To Value m                  (I) Contact Information
(S)    System Date and Time                      (E) Save Parameters To EEPROM
(T)    Calibrate Internal Temperature            (U) User Menu
(V)    Program Version                           (Q) Quit
(K)    Constants Menu                            (H) Help
(B)    BIT Names Menu


Item  1:  0           (Primary Unit/Experiment ID)
Item  2:  0           (Secondary Unit/Experiment ID)
Item  3:  1           (Data Dump Format)
Item  4:  1           (Real Time Output Format)
Item  5:  0           (Add Compass To Vane)
Item  6:  0           (Compass Offset)
Item  7:  0           (Barometer Elevation)
Item  8:              (Bad Sensor Value Replace)

>
```

The replacement string can be any string of up to 8 characters. If, for example, you wanted the string "N/A" to appear in place of the Bad Sensor Value, you would type the command **C8/N/A{ENTER}** in the System Functions Menu. Then, in either the real time or data dump output messages, anytime a Bad Sensor Value is encountered, ZENOSOFT® will transmit **N/A** instead of **–1000000**.

If you decide to not use the Bad Sensor Value Replacement set in line item #8, type the command **C8/<0>{ENTER}** in the System Functions Menu.

4.6.   THE CCSAIL COMMUNICATIONS PROTOCOL

When you plan to have a computer automatically retrieve Data Records from a ZENO®-3200, a computer can use an alternate and more efficient means of entering the User Interface using the CCSAIL Communications Protocol.[57]

The CCSAIL Communications Protocol is an ASCII-based messaging system using consistent structure and built-in error checking. Because it has built-in error checking, it is very useful in communication interfaces that are prone to noise. Since it is ASCII based, CCSAIL messages can be easily interpreted using a terminal emulation program. The consistent structure of CCSAIL messages makes it ideal for use with automated communications.

---

[57] The CCSAIL Communications Protocol is an extension of the ANSI/IEEE Standard 997-1985 "Serial ASCII Instrumentation Loop (SAIL) Shipboard Data Communication". CCSAIL extends SAIL by including message checksums and acknowledgements/non-acknowledgements responses.

> **Coastal Environmental Systems' PC application, Intercept™ uses the CCSAIL Communications Protocol to communicate with one or more remote ZENO®-3200s.**

The CCSAIL Communications Protocol provides a set of specific commands that can retrieve Data Records, change internal ZENO®-3200 settings and even change an existing ZENO®-3200 configuration.

4.6.1. The Structure of a CCSAIL Framed Message

All CCSAIL messages utilize the following frame structure:
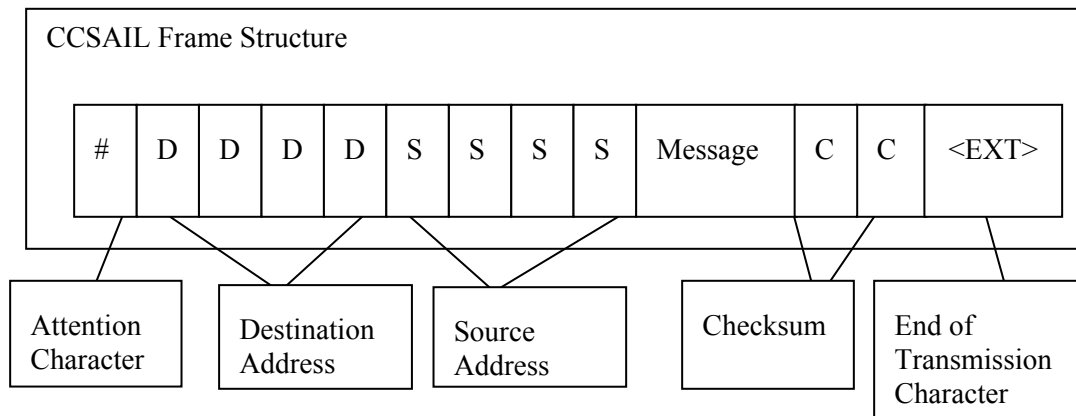
The minimum possible size for a CCSAIL message is 13 characters, but it is usually longer because the "*message*" portion normally contains more than 1 character.

The following table explains the different fields of a CCSAIL message:

Start of Field	Number of Characters	Field Designation	Purpose
1ST	1	Attention Character (ATN)	Indicates beginning of CCSAIL message. (Always a # sign.)
2ND	4	Destination Address (DST)	Identifies intended recipient of the message. Valid values are 0000 to 9999.
6TH	4	Source (Return) Address (RTN)	Identifies who sent the message. Valid values are 0000 to 9999.
10TH	At least 1	Command (CMD)	Action to be carried out by recipient of message or contents of one or more Data Records.
3RD to Last	2	Checksum (CHK)	Error checking for message validation. Valid values are 00 to 99.
Last	1	End of Transmission (ETX) Character	Indicates end of CCSAIL message. (Always an <ETX>, or ASCII 3. Keyboard would be Ctrl-C.)

The Destination and Source Addresses must each be four characters in length. The range of valid values for each character is 0 through 9. (This is the same as the ASCII characters ranging from 48 to 58.) Therefore, the four-character range of each address is 0000 to 9999.

> **9999 is the universal CCSAIL address.**
>
> **When the intended recipient of a CCSAIL message is a ZENO®-3200, the Destination Address must match the Primary Unit ID defined in the System Functions Menu (refer to Section 5.5), or the Destination Address can be 9999.**

> **Any ZENO®-3200 will respond to a valid CCSAIL message whose Destination Address is 9999.**
>
> **Using a Destination Address of 9999 is NOT recommended when more than one ZENO®-3200 is on the same communications link.**

When a ZENO®-3200 is sending a CCSAIL message to another device, the Source Address of the CCSAIL message becomes the Primary Unit ID defined in the System Functions Menu.[58]

Normally, when the intended recipient of a CCSAIL message is a ZENO®-3200, the "*message*" portion of a CCSAIL message will be the command for the ZENO®-3200 to perform. When a ZENO®-3200 sends a CCSAIL message, the "*message*" portion of the CCSAIL message is usually one or more Data Records, but it can also be some other type of requested information or even just an acknowledgement.[59]

The Checksum is calculated by adding the decimal ASCII values of all characters contained in the Destination Address, Source Address and "*message*" fields. Only the two least significant decimal values of the Checksum are incorporated into the CCSAIL message and are often referred to as the modulo-100 checksum.

4.6.2.   The ZENO®-3200's Response to a CCSAIL Message

> **A ZENO®-3200 can receive a CCSAIL message only when the User Interface is NOT active. If you are communicating with the ZENO®-3200 through the User Interface Menus, no CCSAIL message will be interpreted by the ZENO®-3200.**

---

[58] Refer to Section 5.5.
[59] Refer to Section 10.6.7 for Coastal Environmental System's recommended procedures for configuring output messages in CCSAIL format.

> **The ZENO®-3200 only responds to a validated CCSAIL message. The response is in the form of another CCSAIL message.**

The following table shows what steps a ZENO®-3200 performs when it receives a potentially valid CCSAIL message.

Step	Action ZENO®-3200 Carries Out
1	A **#** character is identified by the ZENO®-3200 indicating the possible start of a CCSAIL message.
2	The ZENO®-3200 waits until it receives the **\<ETX\>** End Character of the CCSAIL message. Once received, it moves on to Step #3; otherwise, it no further action is taken until Step #1 is repeated.
3	The ZENO®-3200 calculates a checksum of all but the last 3 characters of the received message. It compares the modulo-100 checksum with the characters stored in the Checksum Field of the received message. If the checksums match, the ZENO®-3200 moves on to Step #4; otherwise, no further action is taken until Step #1 is repeated.
4	The Destination Address of the received message is compared to the ZENO®-3200's Primary Unit ID, if the addresses match or the received Destination Address is 9999, The ZENO®-3200 **has received a valid CCSAIL message** and moves on to Step #5; otherwise no further action is taken until Step #1 is repeated.
5	The ZENO®-3200 examines the "*message*" portion of the validated message. If it identifies the command, it carries out the command and responds with the appropriate information within another CCSAIL message.. If it can neither identify nor carry out the command, it responds with a CCSAIL "NACK" or CCSAIL "ERROR" message.

> **When the ZENO®-3200 transmits a response to a received CCSAIL message, the Source Address of the received message becomes the Destination Address of the transmitted response.**

4.6.3. CCSAIL Data Retrieval Commands

The CCSAIL data retrieval commands match those available in the Data Retrieval Menu. The available CCSAIL data retrieval commands are listed in Appendix E

Let's say that you want to retrieve the five (5) most recently stored Data Records from a ZENO®-3200 whose Primary Unit ID is set to 1025 and your location is referred to as 100.

You would create the CCSAIL command that would retrieve these Data Records as follows:

Destination Address	= 1025
Source Address	= 0100
Command	= DL5 (from Appendix E)
Sum of all ASCII characters	= 49 + 48 + 50 + 53 + 48 + 49 + 48 + 48 + 68 + 76 + 53
	= 590
Checksum	= 90
CCSAIL Message	= **#10250100DL590<ETX>**

If you send this CCSAIL command to the ZENO®-3200, you might see something like this on your screen:[60]

```
#01001025
01/08/01,13:42:55,25.2,13.8,

01/08/01,13:43:55,25.2,13.8,

01/08/01,13:45:55,24.8,13.8,

01/08/01,13:46:55,24.9,13.8,

01/08/01,13:47:55,24.9,13.8,
18
```

Since the <ETX> character is not printable, it won't show up on your screen. It would not be easy to perform a checksum verification by hand on this received CCSAIL message since it is long and there are carriage returns and line feeds contained within it. It would be easy for any computer to perform the checksum verification though.

From the above example, you should notice that the Source and Destination Addresses are reversed, as compared to the command that was sent, because the message is being sent in the opposite direction. You should also notice that the *message* portion of the CCSAIL response contains all five Data Records.

> **When the ZENO®-3200 is polled by a CCSAIL command for multiple Data Records, the ZENO®-3200 will respond by framing all of the requested Data Records within a single CCSAIL response.**

4.6.4. Intercept™ and Data Records Transmitted In CCSAIL Format

When the Real Time Output Format, Line Item #4 in the System Function Menu, is configured for CCSAIL Format[61], the ZENO®-3200 will transmit data fields each Data Record with comma-delimiting.

---

[60] Refer to Section 10.6.7 for Coastal Environmental System's recommended procedures for configuring output messages in CCSAIL format.
[61] Refer to Section 4.4.2.

┌───┐
│ **Coastal Environmental Systems' PC application Intercept™ expects data** │
│ **fields within each Data Record to be comma-delimited.** │
└───┘

The CCSAIL Format will also cause the ZENO®-3200 to transmit each Data Record within the full CCSAIL framing protocol by adding the following to each Data Output Message:

- The Attention Character
- The Destination Address using the Secondary Unit ID[62]
- The Source Address using the Primary Unit ID[63]
- The End of Transmission Character

The Checksum must be added as a separate Data Output Record using the Data Output Menu.[64]

If you are using Intercept™ to poll the ZENO®-3200 to retrieve its Data Records, it is likely that the real-time, automatic transmission of Data Records will be suppressed in Line Item #4 of the System Functions Menu.[65] Therefore, Coastal Environmental Systems recommends that the Data Dump Format, Line Item #3 of the System Functions Menu, be configured for comma-delimited data fields.[66]

4.7.   OPTIONAL FLASH LOGGING MEMORY

If you purchased your ZENO®-3200 to include optional flash logging memory, then all Data Records will be stored in the flash logging memory instead of RAM.

┌───┐
│ **1 MB to 8 MB of flash logging memory can be installed in a ZENO®-3200, in** │
│ **increments of 1 MB.** │
└───┘

4.7.1.   How Flash Logging Memory Differs From RAM

Differences between RAM and flash logging memory are summarized in the following table.

Type of	RAM	Flash Logging Memory

---

[62] Refer to Section 5.6.
[63] Refer to Section 5.5.
[64] Refer to Section 10.6.7 for Coastal Environmental Systems' recommended procedures for configuring output messages in CCSAIL format.
[65] Refer to Section 4.4.2.
[66] Refer to Section 4.4.1.

Difference		
Internal connection.	Connected directly to the CPU via 32 address lines.	Connected via an internal high-speed serial communications link.
Access rate to CPU	Operates virtually at the same rate as the CPU clock speed.	Operates at a speed slower than the CPU clock speed. Access is slower than RAM.
Memory architecture	Continuous memory within valid address range.	Memory that is segmented between 2048 sectors in each 1-MB chip. Access to some sectors is restricted.[67] Each sector is 536 bytes in length.
Temperature range	-55°C to +85°C.	-40°C to +85°C. The ZENO®-3200 will STOP logging Data Records when the internal temperature goes below -40°C.[68]
Lifespan	Indefinite.[69]	Limited to 10,000 write-cycles for each sector.
Initialization	None required.	A new flash logging memory board will be initialized by the ZENO®-3200 at power up.
Effect on ZENO®-3200 timing	None.	May retard access to the User Interface in complex configurations.[70]
Data Retrieval	Retrieving Data Records from flash logging memory is no different than from RAM.	

> **If you plan to use a ZENO®-3200 in an environment where the temperature can go below -40°C, Coastal Environmental Systems DOES NOT recommend use of flash logging memory.**

> **Since flash logging memory requires more time by the CPU and ZENOSOFT® to operate, Coastal Environmental Systems DOES NOT recommend use of flash logging memory with configurations that require logging Data Records faster than once every 10 seconds.**

---

[67] Not all of the 2048 sectors on a flash memory chip can be written to. Some sectors contain specific manufacturer's information and some are not write-able due to problems in manufacturing. The ZENO®-3200 maintains and continually updates a table of all restricted sectors. It will not write any Data Records to any restricted sectors.

[68] The flash logging memory can be physically damaged if written to when the temperature goes below -40°C.

[69] RAM can be disrupted by radioactive materials or cosmic radiation, but this is an extremely low probability.

[70] Refer to Section 12.1.9.

4.7.2. Retrieving Flash Logging Memory Status

If you want to retrieve the current status information about the flash logging memory, type **F{ENTER}** in the Data Retrieval Menu. The ZENO®-3200 will respond with information something like this on your screen:

```
DATA RETRIEVAL MENU
(A)  Show Records AFTER Specified Time        (F) Flash Memory Information
(B)  Show Records BETWEEN Timespan            (D) Delete All Data Records
(Ln) Show LAST n Records                      (N) Number of Records Logged
(*)  Show ALL Data Records                    (U) User Menu
(@n) Show n Unmarked Records                  (Q) Quit
(M)  Mark Recently Shown Data                 (H) Help
(C)  Compute Data Logging Capacity

Precede Any "Show Data" Command With An 'X' for X-Modem Transfer
(e.g. Enter 'X*' To Send All Data Sets Via X-Modem)

> F

ZENOSOFT found 1 flash memory chips,
    of which 1 can be supported with available RAM.
    1 chips are identical 1-megabyte chips.
There are 2048 total sectors.
There are 48 bad sectors:
    31     40     44     82    199    206    207    251    272    289    352    356    370
   390    410    457    532    607    643    746    792    800    801    837    960    972
  1155   1191   1354   1367   1411   1424   1462   1473   1488   1530   1603   1604   1631
  1715   1720   1732   1741   1771   1846   1894   1963   2011
2000 sectors are available for data logging.
Hit any key to continue . . .
```

The ZENO®-3200 will report the number of flash logging memory chips installed, the memory size of each chip, the number of restricted (or bad) sectors and the index number of each restricted sector.

> **The ZENO®-3200 will not write any new Data Records or attempt to retrieve any Data Records from sectors that are restricted.**

Since individual sectors can go bad over time through use of the chip (up to 10,000 write-cycles per sector), the ZENO®-3200 will add any sector that goes bad to its table of restricted sectors. Any Data Records written to a sector that goes bad later are not retrievable.

5. INTERNAL ZENO®-3200 SETTINGS

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There are several internal ZENO®-3200 settings that can be viewed and/or modified in the System Functions Menu. The settings include the following:

- ZENO®-3200 System Data and Time
- Internal Temperature Sensor Calibration
- ZENOSOFT® Version Number
- Contact Information
- Primary & Secondary Unit Identification (ID) Numbers
- Compass Offset
- Barometer Elevation

To obtain access to the System Functions Menu, type **F{ENTER}** from the User Menu. Your screen should look something like this:

```
SYSTEM FUNCTIONS MENU
(Cn/m) Change Item n To Value m              (I) Contact Information
(S)    System Date and Time                  (E) Save Parameters To EEPROM
(T)    Calibrate Internal Temperature        (U) User Menu
(V)    Program Version                        (Q) Quit
(K)    Constants Menu                         (H) Help
(B)    BIT Names Menu

Item  1:  0           (Primary Unit/Experiment ID)
Item  2:  0           (Secondary Unit/Experiment ID)
Item  3:  1           (Data Dump Format)
Item  4:  1           (Real Time Output Format)
Item  5:  0           (Add Compass To Vane)
Item  6:  0           (Compass Offset)
Item  7:  0           (Barometer Elevation)
Item  8:             (Bad Sensor Value Replace)

>
```

5.1.   ZENO®-3200 SYSTEM DATE AND TIME

Option **S** in the System Functions Menu lets you inspect and/or change the current ZENO®-3200 system date and time. If you type **S{ENTER}**, ZENOSOFT® will display the current date and time to the nearest second using the format "YY/MM/DD HH:MM:SS" where:

- YY is the last two digits of the current year (valid from 1970 through 2037)

- MM is the month (1 to 12)

- DD is the day (1 to 31)

- HH is the hour of day (00 to 23)

- MM is the minute (00 to 59)

- SS is the seconds (00 to 59)

Your screen will look something like this:

```
> S
Current Date and Time:   01/07/20 09:34:56
Enter new Date and Time:
```

If you do not want to enter a new date and time, simply press **{ENTER}** once the current date and time have been displayed. If you do want to set the clock, *you must set the new date and time using the same format as shown above*. The new data and time is saved immediately after you hit the **{ENTER}** key (you do not have to type **E** to save the new setting).

> **When you change the system date and time, the current Sampling Interval may be disrupted.**

If this happens, the ZENO®-3200 will resume normal data collection and processing when the time for new Sample Interval is reached.

> **It is not advisable to reset the system date and time more than once a day.**

> **The ZENO®-3200 clock is battery backed; it will continue to keep time even if all external power is removed.**

5.2.   CALIBRATING INTERNAL TEMPERATURE SENSOR

Option **T** in the System Functions Menu lets you calibrate the Internal Temperature Sensor readings. The temperature transducer is a solid-state temperature transducer with an accuracy of about 1ºC, manufactured by National Semiconductor.

The Internal Temperature Sensor is part of the ZENO®-3200, and it does more than allow the user to measure internal temperature. The most important use of the Internal Temperature Sensor is for real-time clock correction. If your ZENO®-3200 came with Flash Logging Memory installed, the Internal

Temperature Sensor is also used to know when the internal temperature falls below -40ºC. (Below -40ºC, the ZENO®-3200 will not write Data Records to Flash Logging Memory because the circuitry may be damaged.)

When you type **T{ENTER}** in the System Functions Menu, you will be prompted to enter the current ambient air temperature. Ideally, you will be measuring the current ambient air temperature with an accurate temperature transducer located very near your ZENO®-3200. If you need to move the ZENO®-3200 to be near the transducer (or the transducer near the ZENO®-3200), it is recommended that you wait 15 minutes before entering the calibration temperature. This will allow either the Internal Temperature Sensor or your external temperature transducer sufficient time to settle and provide an accurate reading.

When you enter the new temperature reading, you must include the temperature scale. The choices are **FAHRENHEIT** (example input: **72.5F**), **CELSIUS** (**23.2C**), or **KELVIN** (**295.6K**). The new temperature that you type is automatically saved internally by the ZENO®-3200.

You do not need to save the configuration to EEPROM after entering the new temperature; ZENOSOFT® automatically saves the calibration settings to EEPROM automatically.

5.3.   GETTING CURRENT ZENOSOFT® VERSION NUMBER

Option **V** in the System Functions Menu will display the version of ZENOSOFT® in use in your ZENO®-3200.

> **If you need to call the Customer Service Department at Coastal Environmental Systems, please note your version ZENOSOFT® before calling.**

5.4.   CONTACT INFORMATION

Option **I** in the System Functions Menu will display information as to how to contact Coastal Environmental Systems should the need arise.

5.5.   ZENO®-3200 IDENTIFICATION NUMBER, THE PRIMARY UNIT ID

Many ZENO®-3200 users have more than one ZENO®-3200 collecting data in different locations, but download the data from a central location. To identify the data coming from a particular ZENO®-3200, a unique identification number can be set in the ZENO®-3200's configuration.

> **The Primary Unit ID is the unique identification number that can be configured into your ZENO®-3200.**
>
> **The Primary Unit ID can be set to any whole number within the range 0 to 9998.**
>
> **If more than one ZENO®-3200 is being used in your application, each ZENO®-3200 should have a different Primary Unit ID.**

Coastal Environmental Systems' PC application, Intercept™, also uses the Primary Unit ID to identify which ZENO®-3200 it is collecting data from, using the CCSAIL message protocol.[71]

The Primary Unit ID is contained in line item #1 of the System Functions Menu. for example, to change your ZENO®-3200's Primary Unit ID to 1011, type the command **C1/1011{ENTER}** in the System Functions Menu. Your screen will look something like this:

```
> C1/1011

SYSTEM FUNCTIONS MENU
(Cn/m) Change Item n To Value m               (I) Contact Information
(S)    System Date and Time                   (E) Save Parameters To EEPROM
(T)    Calibrate Internal Temperature         (U) User Menu
(V)    Program Version                        (Q) Quit
(K)    Constants Menu                         (H) Help
(B)    BIT Names Menu

Item  1:  1011       (Primary Unit/Experiment ID)
Item  2:  0          (Secondary Unit/Experiment ID)
Item  3:  3          (Data Dump Format)
Item  4:  1          (Real Time Output Format)
Item  5:  1          (Add Compass To Vane)
Item  6:  0          (Compass Offset)
Item  7:  0          (Barometer Elevation)
Item  8:             (Bad Sensor Value Replace)

>
```

5.6.   A DESTINATION IDENTIFICATION NUMBER, THE SECONDARY UNIT ID

The Secondary Unit ID, defined in line item #2 of the System Functions Menu, is used within real-time data output messages to identify the destination for the real-time output messages. You would use this, for example, when you want Coastal Environmental Systems' PC application Intercept™ to retrieve data messages from a ZENO®-3200 that can only transmit real-time data messages if, for example, unidirectional communication is in use.[72]

---

[71] Refer to Section 4.6.
[72] Refer to Sections 4.6 and 10.6.7.

> **The Secondary Unit ID is a unique identification number that can be configured into your ZENO®-3200 as the destination address for data output messages.**
>
> **The Secondary Unit ID can be set to any whole number within the range 0 to 9998.**
>
> **The Secondary Unit ID cannot be the same as the Primary Unit ID.[73]**

To use the Secondary Unit ID, you also need to setup a Data Output Record (using the Data Output Menu) with Field Type Code #5 in the appropriate location of your Data Output Message.

5.7.   COMPASS SENSOR USAGE

If you are using a compass sensor as part of your sensor suite, two parameters are specified in the System Functions Menu that affects its usage:

System Functions Menu Line Item No.	Parameter Name	Valid Range
5	Add Compass To Vane	0 = NO or 1 = YES
6	Compass Offset	-180 to 180 degrees

Line item #5, *Add compass to vane*, controls whether or not the ZENO®-3200 will add the measured compass value to the measured wind direction (the vane) when executing a Wind Vector Average Process[74] or Running Wind Vector Average Process.[75]   If you are not measuring the wind direction, if you have no compass, or if you are not processing the wind measurements using a Wind Vector Average Process or Running Wind Vector Average Process, this option has no effect.

Line item #6, *Compass offset*, is a value that is added to the compass sensor measurement to compensate for local variations in magnetic North. The value is added directly to the compass sensor reading[76]. If you have no compass sensor in your sensor suite, this option has no effect.

5.8.   BAROMETER ELEVATION SETTING

In the System Functions Menu, Line Item #7, the Barometer Elevation is used to correct the barometric pressure reading to sea level, if your sensor suite includes a barometric pressure sensor and you are using the Barometric Pressure Process.[77] The valid range of values for the Barometer Elevation line item is 0 to 5000 meters. If the Barometric Pressure Process[78] is not specified in your configuration, this line item has no effect.

---

[73] Refer to Section 5.5.
[74] Refer to Appendix D, Category #2, Process #1.
[75] Refer to Appendix D, Category #2, Process #2.
[76] Refer to Section 10.3.4.
[77] Refer to Appendix D, Category #2, Process #5.
[78] Refer to Appendix D, Category #2, Process #5.

6.   COMMUNICATION INTERFACES

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Many communication interface options are available with the ZENO®-3200. Deciding the type of communication interface you need depends upon where and how you intend to use the ZENO®-3200.

The following table summarizes the various supported communication interfaces, their uses and where you can use them.

Type of Communication	Usage	Where	Connection Reliability	Direction
Direct Terminal Access	Full access.	Close proximity to computer. (Up to 50 feet with RS232.)	Most reliable.	Bi-directional
Telephone Modem	Full remote access.	Telephone landlines are available.	Usually reliable.	Bi-directional
Cellular Modem	Full remote access.	No telephone landlines available, but inside a cellular network service area.	Dependent upon cellular network activity and RF interference.	Bi-directional
One-way Radio	Real-time data collection only.	No telephone landlines available, outside of cellular network service area. Must be within line of site of receiver. 5 to 10 mile range with omni-directional antenna, 10 to 30 mile range with directional antenna (yagi-antenna).[79]	Dependent upon RF interference and line-of-sight	Unidirectional
Two-way Radio	Full remote access.			Bi-directional
Satellite Communication	Real-time data collection only.	No telephone landlines available, outside of cellular network service area, distance to receiver is beyond 12 miles. Satellite provider account may be required.	Dependent upon RF interference, line-of-sight with satellite, condition of satellite.	Unidirectional

Once you know the type of communication you intend to use (which could be combination of two or three types), you can configure the communication settings using the Communications Menu and its submenus.

---

[79] Placement and alignment of the antenna is critical. The quality of a signal between a transmitter and receiver is highly dependent upon line of sight, which encompasses antenna location, height and direction as well as obstructions. Any obstruction between a transmitter and receiver can severely attenuate a radio signal, effectively reducing the range.

After connecting and powering up the ZENO®-3200 as described in Section 2.2, type **U** to enter the **USER** Menu. You should see the User Menu in your terminal emulation program.

```
USER MENU
(C) Communications Menu              (T) Test Menu
(F) System Functions Menu            (Z) Zeno Program Menus
(S) Sample Period Menu               (H) Help
(D) Data Retrieval Menu              (Q) Quit
```

6.1.   BASIC COMMUNICATIONS SETTINGS

The ZENO®-3200 contains three independent UARTs.[80] Each UART is referred to as COM1, COM2 and COM3. The settings and use of each UART (or COM port) are completely independent. COM1 and COM3 are dedicated ports, but COM2 is multiplexed[81] so that it can communicate with up to four different devices without interference between them.[82]

> **Only COM2 can be used for both data collection from serial sensors and as a unidirectional communications link simultaneously.**
>
> **Conversely, COM1 and COM3 can only be used as one or the other.**

> **If you require COM2 to both collect data and perform as a general communications link, Coastal Environmental Systems recommends that you use COM2 to transmit data _only_ for the communications link.**
>
> **Bi-directional communication will interfere with data collection to the serial sensor(s) because two or more actions cannot share the same resource simultaneously. (Refer to Section 12.1.8.)**

> **If COM2 is set up to collect data from a serial sensor(s) AND act as a communications link, it cannot do both at exactly the same time.**

---

[80] A UART (Universal Asynchronous Receiver/Transmitter) is a single integrated circuit chip that contains circuitry for both receiving and transmitting asynchronous serial communication.

[81] A multiplexer is a switching device that allows a single communications port to view multiple streams of data without interference between the different streams. It can only view one stream at a time. As an example, the channel selector on a television set is a multiplexer.

[82] This is illustrated in Section 2.5.

The Communications Menu lets you change the communications settings of the ZENO®-3200's three communication ports COM1, COM2 and COM3. Enter **C{ENTER}** from the User Menu to enter the Communications Menu. You will see something like the following.

```
> C

COMMUNICATIONS MENU
(Cn/m) Change Item n To Value m          (R)  Repeater Menu
(M)    Modem Menu                        (Tn) Terminal Mode On COM Port n
(P)    Power Control Menu                (E)  Save Parameters To EEPROM
(G)    GOES Menu                         (U)  User Menu
(A)    ARGOS Menu                        (Q)  Quit
(D)    Digital Control Menu              (H)  Help

Item  1:  9600       (COM1 Baud Rate)
Item  2:  9600       (COM2 Baud Rate)
Item  3:  9600       (COM3 Baud Rate)
Item  4:  RS232      (COM1 Port Type)
Item  5:  RS232      (COM2 Port Type)
Item  6:  RS232      (COM3 Port Type)

>
```

Line items #1 through #3 specify the Baud rates for each COM port. Line items #4 through #6 specify the physical port wiring type. To change a specific setting, type **Cn/m** to change the value of Line Item #**n** to value **m**.

> **The communications port that you use to communicate with the ZENO®-3200 is called the User Interface COM Port.**

> **Changes to communication settings do not take effect until after you exit the User Interface, including changes to the User Interface COM Port settings.**

> **After you change the User Interface COM Port settings and you do not communicate again with the ZENO®-3200 using that same COM port within 24 hours, ZENOSOFT® will assume that you cannot communicate using the new settings. ZENOSOFT® will change the communication settings of that COM port to their previous settings.**

The following table summarizes the available settings for each communications port.

Communication Settings		
Line Item No.	Quantity	Available Values
1	COM1 Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200
2	COM2 Baud Rate	
3	COM3 Baud Rate	
4	COM1 Port Type	RS232, RS232H, RADIO, TW-RADIO
5	COM2 Port Type	RS232, RS232H, RS485, GOES, CGOES, ARGOS
6	COM3 Port Type	RS232, RS232H, RS485, RS422

The different port types are summarized in the following table:

Port Type	Directionality	Mode	Brief Description
RS232[83]	Bi-directional	Full-duplex	Common computer interface, up to 50 feet of cable.
RS232H	Bi-directional	Half-duplex	Required for devices that don't support full-duplex communication.
RS485[84]	Bi-directional	Half-duplex	Common interface when more than two nodes are required, up to 4000 feet of cable.
RS422[85]	Bi-directional	Full-duplex	Used for greater distance than RS232, up to 4000 feet of cable.
RADIO	Unidirectional	N/A	Allows short wireless data transmissions for several miles.
TW-RADIO	Bi-directional	Half-duplex	Allows full wireless communication for several miles.
GOES	Unidirectional	N/A	Used with Telonics TGT-1 GOES transmitter.
CGOES	Unidirectional	N/A	Used with Campbell Scientific SAT HAT HDR GOES transmitter.
ARGOS	Unidirectional	N/A	Used with Telonics ST-5 & ST-13 ARGOS transmitters.

The mode "full-duplex" means there is uninterrupted, bi-directional communication. Half-duplex means there is bi-directional communication, but only one device can transmit at one time.

When using half-duplex, bi-directional communication, you cannot break into a data stream being sent by the ZENO®-3200. for example:

In half-duplex mode, data output from the Test Menu quits after 5 screens.

---

[83] As defined by Engineering Department, Electronic Industries Association, ANSI/EIA-232-D-1986. Electronic Industries Association: Washington D.C, 1987.
[84] As defined by Engineering Department, Electronic Industries Association, EIA-485. Electronic Industries Association: Washington D.C, 1983.
[85] As defined by Engineering Department, Electronic Industries Association, EIA-422-A. Electronic Industries Association: Washington D.C, 1978.

In half-duplex mode, when data are being dumped from the Data Output Menu, you will be prompted to confirm that you require new data after every 20 data records.

However, in full-duplex operation you must break into the output data streams in both cases.

Different types of communication are supported on different ZENO®-3200 communication ports. The following table shows which ZENO®-3200 communication ports can be used with each type of communication and how you to set that port's settings.

Type of Communication	ZENO®-3200 COM Port Availability	Port Type to Specify	Baud Rate
Direct Terminal Access	COM1, COM2 & COM3	RS232, RS232H or RS485	Any (Depends on other end.)
Telephone Modem		RS232	
Cellular Modem			
One-way Radio	COM1 Only	RADIO	1200 Only
Two-way Radio		TW-RADIO	1200 Only
Satellite Communications	COM2 Only	GOES, CGOES or ARGOS	Depends on Satellite Transmitter

Electrical connections to the various ports are mostly accessible from the ZENO®-3200 Front Panel.[86] Refer to Section 13.5.3 for a detailed wiring description. An abridged wiring description is shown in the following table:

Port	Electrical Signal Type	Electrical Connections On ZENO®-3200 Front Panel
COM1	RS232	Terminal Strip[87] COM1 pins
	FSK modulator (radio or two-way radio)	AUX Serial Port pin 9 TXA AUX Serial Port pin 10 RXA AUX Serial Port pins 4, 11 PTT
COM2	RS232	AUX Serial Port pin 2 TX AUX Serial Port pin 3 RX
	RS485	Terminal Strip[88] COM2 pins
	GOES (TTL)	AUX Serial Port pin 5 for RX AUX Serial Port pin 6 for TX AUX Serial Port pin 4 for PTT
COMPASS INTERFACE (multiplexed with COM2)	TTL	Internal on ZENO®-3200 CPU board.[89]
COM3	RS232	COM3 pin 2 RX COM3 pin 3 TX
	RS485	AUX Serial Port pin 22 for B AUX Serial Port pin 23 for A

---

[86] Refer to Section 2.1.
[87] Terminal strip labeled SERIAL DATA, POWER AND GROUNDS.
[88] Terminal strip labeled SERIAL DATA, POWER AND GROUNDS.
[89] Refer to Sections 13.4 and 13.5.3.

6.2.   DIRECT TERMINAL ACCESS

The following is the schematic of the ZENO®-3200-to-PC cable (Revision B). This is a reversible cable DE-9F to DE-9F.[90]
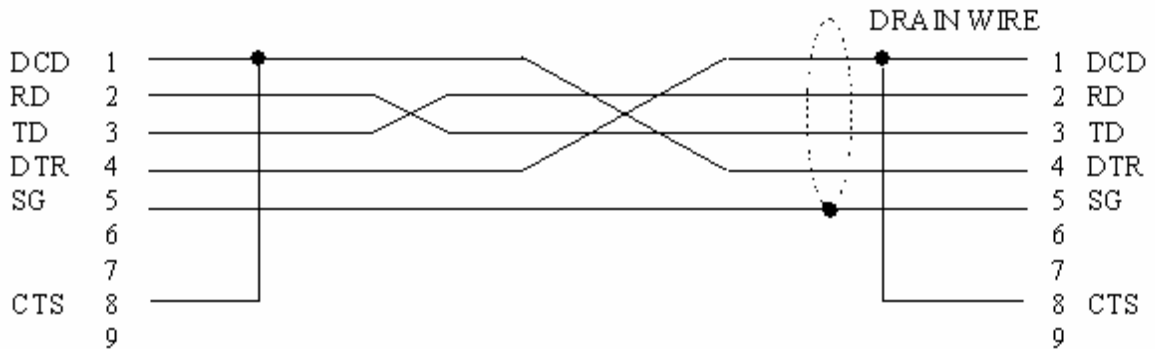
Figure 6-1. 9-pin to 9-pin ZENO®-3200-to-PC cable (Revision B).

6.3.   HARDWARE HANDSHAKING

The ZENO®-3200 always monitors the DCD line, whether or not it is set up for modem communications.

> **To conserve power, the ZENO®-3200 only sets its serial ports to receive commands when DCD is asserted.[91]**

The ZENO®-3200 will continue to monitor the serial ports for up to two seconds when DCD is lost in the event that the loss of connection is momentary.

> **DCD is considered asserted if the voltage supplied by the receiving end is within the range +3 to +25 VDC.[92]**

The ZENO®-3200 also monitors CTS if the ZENO®-3200 is configured for telephone modem communication as specified in the Modem Menu. In this case, it will not transmit any data unless CTS is asserted.[93] The reason for this is to avoid collisions between modem handshaking and regular messages transmitted from the ZENO®-3200.

---

[90] Pins 1 and 9 are tied together internal to the ZENO®-3200.

[91] Monitoring the serial ports continuously draws a significant amount of power.

[92] As defined by Engineering Department, Electronic Industries Association, <u>ANSI/EIA-232-D-1986</u>. Electronic Industries Association: Washington D.C, 1987; Section 2.1.4.

[93] It will, however, respond to user commands.

The ZENO®-3200 does not actively assert/de-assert RTS. Instead, the cables are specified to make RTS follow CTS at all times. If your modem can be set to ignore RTS, you can use a standard straight-through cable to connect the ZENO®-3200 to a modem.[94]

6.4.   TELEPHONE MODEMS

The ZENO®-3200 can connect to most standard, off-the-shelf telephone modems. Telephone modem communications can operate in two modes:

You can dial in to the ZENO®-3200 to obtain logged data or to carry out configuration changes remotely.

You can configure the ZENO®-3200 to automatically dial out when an alarm occurs. It will dial up to four different telephone numbers, transmit the alarm data message, and then hang up the modem.

For low-power consumption, the ZENO®-3200 can be configured to control telephone modem power. In this case, the ZENO®-3200 turns modem power on before dialing out and monitors the ring-detect line to turn on modem power to answer an incoming call. The ZENO®-3200 then turns the modem off when dial-out is complete or when the caller hangs up. The low-power modems are typically customized modems where the ring detect line is diverted from the modem itself and made available to the ZENO®-3200 front panel.[95]

This section is divided into three parts:

1. Configuring the ZENO®-3200 for both dial-in and dial-out communications and for a low-power (power controlled) modem
2. Configuring the modem to be connected to the ZENO®-3200
3. Handshaking between the ZENO®-3200 and the modem[96]

6.4.1. ZENO®-3200 Modem Configuration

You can configure the ZENO®-3200 either by connecting the ZENO®-3200's COM3 port directly to your computer, or over an existing telephone modem link.

> **The communications cable used for a ZENO®-3200-to-telephone modem link is different from the one used for a direct ZENO®-3200-to-computer link.[97]**

Once you have connected, break into the User Menu using the `U{ENTER}` command one or (over a communication link) a few times. You will see the following menu.

---

[94] Refer to Section 6.4.3.
[95] The low-power modem is incapable of answering calls on its own since the ring-detect line is rerouted from the modem to the ZENO®-3200.
[96] Unless you have trouble with your modem communications, you do not need to understand the handshaking issues in detail.
[97] Please contact Coastal Environmental Systems if you do not have the correct cables.

```
USER MENU
(C) Communications Menu                    (T) Test Menu
(F) System Functions Menu                  (Z) Zeno Program Menus
(S) Sample Period Menu                     (H) Help
(D) Data Retrieval Menu                    (Q) Quit
>
```

To set up the ZENO®-3200 for telephone modem operation, type **C{ENTER}** to enter the Communications Menu. You will see the following menu items.

```
> C

COMMUNICATIONS MENU
(Cn/m) Change Item n To Value m          (R)  Repeater Menu
(M)    Modem Menu                        (Tn) Terminal Mode On COM Port n
(P)    Power Control Menu                (E)  Save Parameters To EEPROM
(G)    GOES Menu                         (U)  User Menu
(A)    ARGOS Menu                        (Q)  Quit
(D)    Digital Control Menu              (H)  Help

Item  1:  9600        (COM1 Baud Rate)
Item  2:  9600        (COM2 Baud Rate)
Item  3:  9600        (COM3 Baud Rate)
Item  4:  RS232       (COM1 Port Type)
Item  5:  RS232       (COM2 Port Type)
Item  6:  RS232       (COM3 Port Type)

>
```

The relevant parameters needed to configure the desired COM port for telephone modem operation are the following.

Set the baud rate to 9600 Baud

Set the port type to RS232

> **Coastal Environmental Systems recommends that you NOT change the Baud rate while communicating via a modem.[98]**
>
> **Changes to communications settings should be done over a direct terminal connection.**

Next, type **M{ENTER}** to go from the Communications Menu to the Modem Menu. You will see the following menu items.

---

[98] If you cannot communicate with a ZENO®-3200 following a change in communications settings, the ZENO®-3200 will restore the previous communication settings after 24 hours. Refer to Section 6.1.

```
   MODEM MENU
   (Cn/m) Change Item n To Value m          (Q) Quit
   (E)    Save Parameters To EEPROM         (H) Help
   (U)    User Menu

   Item  1:  1                 (System Modem Type)
   Item  2:  COM3              (Modem COM Port)
   Item  3:  90                (Modem Retry Period)
   Item  4:  0                 (Modem Hangup Delay)
   Item  5:  9,123-4567        (Modem Telephone Number 1)
   Item  6:  NONE              (Modem Telephone Number 2)
   Item  7:  NONE              (Modem Telephone Number 3)
   Item  8:  NONE              (Modem Telephone Number 4)
   Item  9:  NONE              (Modem Initialization String)
   Item 10:  3                 (Modem Switched Voltage)
   Item 11:  22                (Modem Ring Detect Channel)

   >
```

The relevant line items here are the following:[99]

- Line item 1, set the modem type to 1 (standard modem)

- Line item 2, set the modem COM port to COM3

The first two line items must be set for both dial-in and dial-out modem communications. If a low-power (power-controlled) modem is used, the last two items must also be set for either dial-in or dial-out modem communications:

- Line item 10: set the modem switched voltage (0 = none, 3 = 12 V switched A, 4 = 12 V switched B, 5 = 12 V switched C, 18-23 = digital output).

- Line item 11: set the modem ring detect channel (0 = none, 12-23 = digital input[100]).

Line Item 9 (Modem Initialization String) is used only if the modem requires an initialization string to be sent before each use. The string would consist of the "AT" commands used by the modem.

The rest of the line items are needed only if you wish the ZENO®-3200 to dial out and send a message string when an alarm condition occurs.

Once you have set these parameters, save the settings to EEPROM by typing **E{ENTER}**, and leave the User Interface. You may then receive a message such as the following.

---

[99] Note that help is available on each line item. Refer to Section 2.4.2.
[100] ZENOSOFT® versions prior to V2.00 only support digital output channels 18-23 for the ring detect line.

```
A modem connection to COM3 has been specified in the Modem Menu but the COM3
CTS signal is not present.  This may prevent the ZENO-3200 from transmitting
characters.

Check that the Modem COM Port and/or the Modem Type items in the Modem Menu
are set up properly.
```

This message simply indicates that the ZENO®-3200 is monitoring communication lines and has determined that it is not connected to an active telephone modem. Regular messages will therefore not be transmitted.[101] Ignore this message if you receive it when the ZENO®-3200 is connected directly to a computer. If you receive the message while the ZENO®-3200 is connected to a modem, you should check the cable and the modem settings as discussed in the next section.

6.4.2. MODEM SETTINGS

This section discusses settings to a telephone modem itself, NOT the ZENO®-3200.

The settings for a modem that is connected to a ZENO®-3200 are quite tightly constrained.

REMEMBER: There may be no human operator at the ZENO®-3200's end to reset the modem if communications are lost!

To set up a modem, connect the modem serial port to a terminal emulation package such as Windows™ 3.1 Terminal or Microsoft Windows™ 95/98/NT HyperTerminal. We recommend that you set the communications rate for your terminal emulation package to 9600 Baud – the same as the Baud rate that the ZENO®-3200 will use to communicate with the modem.

When you set up the modem configuration, set your terminal communication rate to 9600 baud.

You should match the baud rate that the ZENO®-3200 will use to communicate with the modem

Enter **AT{ENTER}**. You will normally see **AT** on the screen, followed by **OK** on the next line. If you do not see **OK**, it may be that the modem is already set up for ZENO communications because the setup suppresses most responses from the modem.

If you do not receive the **OK** response, enter **ATI0{ENTER}**. You should receive a response which identifies the modem (typically a 3 or 4 digit number). If you still receive no response, check that the modem is powered on, that you have selected the right COM port on your computer, and that you have

---

[101] The reason for this is to avoid transmissions from the ZENO®-3200 interfering with modem handshaking. Handshaking is discussed later in this section.

the correct cable (typically the manufacturer's modem cable). If you still receive no response, refer to the modem manufacturer's troubleshooting guide.

Once you have established communications with your modem, you need to change the settings listed in the following table. Give the commands in the order listed, with each command followed by **`{ENTER}`**.

Coastal Environmental Systems typically uses one of three following modems: the US Robotics Sportster, the Zoom Pocket FaxModem, and the IDC MOM14400. If you have a different modem, some of the commands may differ from those given below.

Setting	US Robotics Sportster	Zoom Pocket FaxModem and IDC MOM14400
Baud (or bit) rate fixed at 9600	AT&N6	ATN0, ATF8 or ATS37=9
Auto-Answer On		ATS0=1
Suppress result codes*		ATQ1*
DCD follows remote carrier		AT&C1
Echo off		ATE0
Save settings to non-volatile RAM		AT&W0 ATY0

> ***WARNING!**
>
> **The configuration must be slightly different if you are dialing out from the ZENO®-3200 using an alarm message. To dial out, you must enable a restricted set of result codes. Use commands ATQ0 followed by ATX, rather than ATQ1, in this case.**

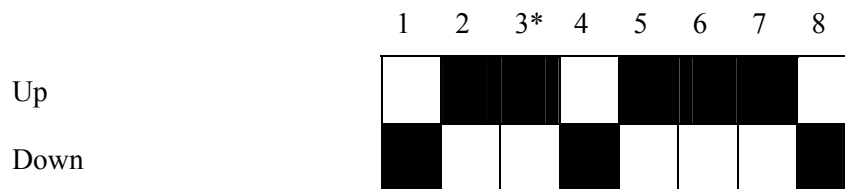The following DIP switches need to be set on the US Robotics Sportster for consistency with the above settings.[102]

Figure 6-2. DIP switch settings for US Robotics Sportster telephone modem.

---

[102] Black fields symbolize the positions of each DIP switch.

> ***WARNING: If you wish the ZENO®-3200 to dial out, DIP switch #3 must be Down, rather than Up as shown here.**

The ZENO®-3200 monitors CTS; however, it does not set RTS. The cable forces RTS to follow CTS at all times. The ZENO®-3200 monitors the DCD line, and does not transmit any characters, or respond to any commands unless DCD is asserted. This hardware handshaking will be handled correctly if you use the correct cables as provided by Coastal.

Baud Rate at 9600

There are actually three different baud rates (communication speeds) to be considered when a ZENO®-3200 communicates with a PC or other computer over a modem link.
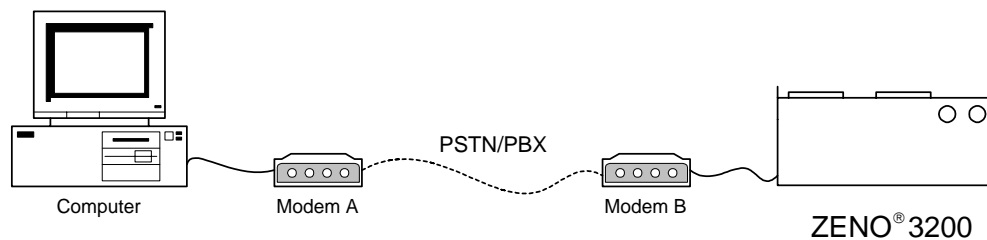
Figure 6-3. Connecting a PC to a ZENO®-3200 via telephone modems.

You could have different baud rates for the three links: Computer to Modem A; Modem A to Modem B, over the telephone network; and Modem B to the ZENO®-3200.

Normally, you do not have to worry about baud rates when connecting a modem to your computer, for the following reasons:

When your computer sends a command to Modem A, the modem automatically determines the baud rate, and sets its rate to match your computer's rate.

When Modem A connects with Modem B, the two modems negotiate to decide the fastest baud rate they are both capable of using, and which will give reliable communications over the phone line that is available.

The remote modem is typically set up by an experienced operator.

When you send a command from your computer to the ZENO®-3200 by way of two modems, Modem B at the ZENO®-3200 end sends the command to the ZENO®-3200 at the baud rate defined for Modem B. The ZENO®-3200 has no way of knowing what this baud rate is. Unless it matches the ZENO®-3200's baud rate, the ZENO®-3200 will simply see a stream of rubbish—and it will not respond. To avoid this, you must set Modem B and the ZENO®-3200 to have the same baud rate. We recommend 9600 baud in most situations. This will be set when you configure your modem with the computer set to 9600 baud. If the telephone line is very noisy, you may wish to try a lower baud rate.

We also recommend that you force the baud rate between the two modems to 9600 baud. This is the first command in the table above. This ensures that there can be no data overruns.[103]

Auto-Answer On

Auto-Answer is the parameter that describes whether and when the modem picks up incoming calls.

For modems that are on continuously, in order to dial up the ZENO®-3200 and communicate with it, you must switch Auto-Answer on.[104]

For low-power (power-controlled) modems, this is unimportant since the ring-detect line is connected directly to the ZENO-3200 and not the modem circuitry itself.

Suppress Result Codes

Typically, when you send a command to a modem, it gives a result code as a response. for example, if you send the attention string **AT**, the modem typically responds with **OK**.

> **When you connect a modem to a ZENO®-3200, it is important to turn the result codes off as the ZENO®-3200 may respond to result codes from the modem.**

If the result codes are not turned off from the modem, a possible infinite loop of communications between the ZENO®-3200 and the modem may occur.

For example, suppose that you hang up a modem connection while in the middle of downloading data from the ZENO®-3200. The ZENO®-3200 continues to send data out from its COM port. The modem receives that data, interprets it as an invalid command, and sends the response **ERROR**. The ZENO®-3200 receives that response, interprets that response as an invalid command, and sends an error message back to the modem. This loop can carry on indefinitely. The solution is to switch off all modem result codes.

DCD follows remote carrier

The modem at the ZENO®-3200 monitors the carrier signal over the telephone lines. This signal indicates that there is a good connection between the two modems. When the carrier signal drops, the modem at the ZENO®-3200 hangs up. The option "DCD follows remote carrier" specifies that the modem also sets the DCD line low at this stage.[105]

The ZENO®-3200 continually monitors the DCD line to determine whether there is a possibility of incoming commands. When DCD is asserted, the ZENO®-3200 wakes up and powers up the serial port. This means that the ZENO®-3200 is drawing several tens of milliamps, rather than the few milliamps it draws in sleep mode. for battery-powered installations, it is important that the ZENO®-3200 remain in its sleep mode when possible. Therefore, the DCD line should be set to drop when the modem hangs up. The command "DCD follows remote carrier" will ensure that it hangs up properly.

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[103] This can be an issue if you use modems of different types at either end, where either one may not have speed detection and/or fall back capability.

[104] Most modems are shipped with the factory setting Auto-Answer off as a security feature. This avoids your computer being unexpectedly called up.

[105] The alternative is that the modem always asserts DCD.

Echo Off

Normally, a modem echoes all commands it receives. for example, if you send the attention string **AT** to a modem, it responds immediately with **AT**, so that you see the command as well as the response **OK** on the screen. It is important to switch off the echo, to avoid indefinite communications loops such as those discussed above.

Non-Volatile Memory

When you set up a modem configuration, typically the settings are held in working memory. When the modem loses power, it reverts to its last saved configuration. Once you have the ZENO®-3200 and the modem working well together, you should save both the ZENO®-3200 configuration[106] and the modem configuration to non-volatile memory so that they will reboot correctly after a loss of power.

6.4.3. CABLE PIN-OUTS

The following schematics reveal which cables, provided by Coastal Environmental Systems, are required to connect a ZENO®-3200 with a computer via a telephone modem. Please note: These cables are **not** standard serial cables. Use only the cables provided by Coastal.[107]

The first schematic illustrates a 25-pin to 9-pin cable. The second illustrates a 9-pin to 9-pin cable.

ZENO®-3200 to Modem: 25-pin (US Robotics)

ZENO COM3 DE-9F   **MODEM DB-25F**
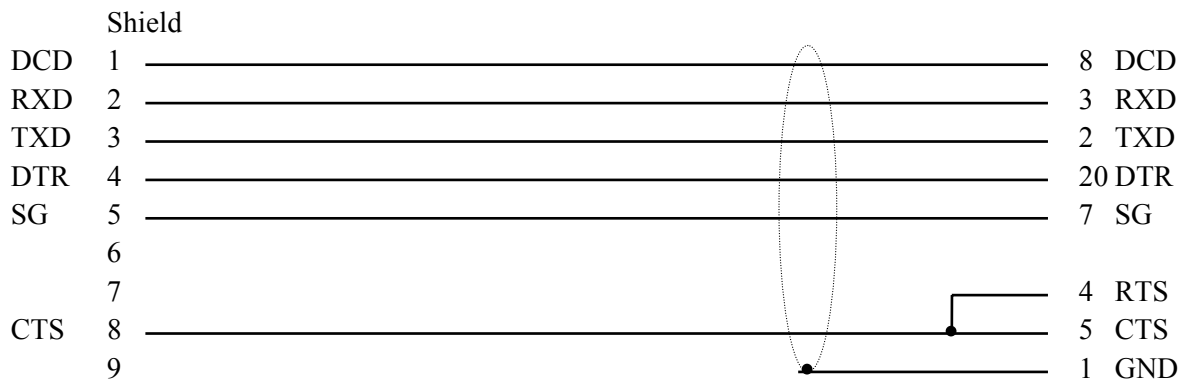
Figure 6-4. 25-pin to 9-pin, modem-to- ZENO®-3200 cable.

ZENO®-3200 to Modem: 9-pin

---

[106] Refer to Section 2.3.2.
[107] For direct communication between a computer and a modem, use the cable provided by the modem manufacturer.

ZENO COM3 DE-9F   **MODEM DE-9F**

shield

```
DCD   1  ─────────────────────────────────────────────────  1  DCD
RXD   2  ─────────────────────────────────────────────────  2  RXD
TXD   3  ─────────────────────────────────────────────────  3  TXD
      4                                                       4
SG    5  ──────────────────────────────────────●──────────  5  SG
      6                                                       6
      7                                               ┌─────  7  RTS
CTS   8  ─────────────────────────────────────●───────┘      8  CTS
      9                                                       9
```
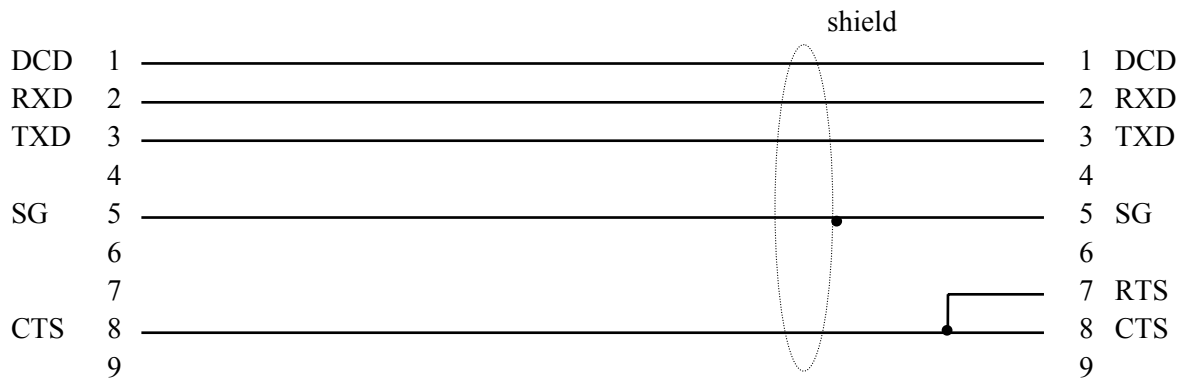
Figure 6-5. 9-pin to 9-pin, modem-to- ZENO®-3200 cable.

In the case of a low-power IDC modem, the ring detect line comes from the ring-indicator (RI) line[108] on the modem and is wired separately to the digital input specified in the ZENO®-3200 configuration.

6.5. CELLULAR MODEMS

Cellular modems are sophisticated radio modems. They require more steps to integrate than a standard telephone modem, such as internal cellular modem configuration and activation.

Configuration of the ZENO®-3200 itself for use with a cellular modem is essentially the same as the telephone modem.

Since wireless communications is prone to noise, Coastal Environmental Systems recommends that the bit rate (baud rate) be set to 4800 BPS throughout the communications interface to provide the best bit rate ratio and link reliability.

This means that the bit rate of the ZENO®-3200 COM port selected for the cellular modem communication should be set to 4800 BPS.[109] Further, the cellular modem will need to be programmed to

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[108] The ring-indicator (RI) line from a modem is wired to pin 9 on a DE-9 connector or pin 22 on a DB-25 connector.
[109] Refer to section 6.1 for setting the COM port baud rate.

connect and communicate at 4800 BPS. This can be accomplished in two ways: (1) either through direct connection between your computer and the cellular modem, or (2) using the ZENO®-3200's Passthrough Mode[110]. The following table shows how you should set up your terminal emulation program or ZENO®-3200's Passthrough Mode in order to communicate with a cellular modem:

Serial Port Setting	Value for Cellular Modem Comm.
Baud Rate	4800
Data Bits	8
Start Bits	1
Stop Bits	1
Parity	None
Flow Control	None

> **Selection of antenna, antenna location, and RF coaxial cable (typically 50-ohm impedance) all play significant roles ensuring a reliable cellular link.**

If your signal strength is less than –90 dBm (-90 dBm through –120 dBm) you are in an area of low signal strength and may experience high bit error rates. Such conditions can be eliminated through proper antenna location or use of higher gain antenna technology.

> **Coastal Environmental Systems recommends use of a directional or omni-directional antenna with at least 3-dB gain.**

> **Coastal Environmental Systems also recommends using RG-8 Low Loss coaxial cables for any cable run longer than ten feet.**

> **Cellular modems typically operate within the 800 – 900 MHz frequency range.**

The ZENO®-3200 data logger can be used with two types of stand-alone cellular modems:

- AMPS (Advanced Mobile Phone System)
- CDPD (Cellular Digital Packet Data)

Coastal Environmental Systems uses two different cellular modems to support the two cellular modem types that are:

---

[110] Refer to Section 6.9.

Cellular Modem Type	Manufacturer
AMPS	StarComm Cellular Modem 1442E-616-C
CDPD	Sierra Wireless MP200

6.5.1. AMPS Cellular Modem Configuration (StarComm Cellular Modem)

First, make sure that there is communication with the cellular modem. From your computer connected directly to the cellular modem or from the ZENO®-3200's Passthrough Mode, type **AT{ENTER}**. The modem should respond with **OK**. If you don't get a response, check the wiring to the cellular modem and make sure it is powered.

If communication is established, type the following command string:

> **AT&FBEMN1Q1X4&DS0=1S7=70S10=50{ENTER}**

At this point the cellular modem will no longer echo or respond to most typed commands. If you wish to see the commands that you type on your computer screen, enable the local echo in your terminal emulation program.

Next, type the following series of commands to the cellular modem:

> **AT%A%C3%E2\A\G\N2\Q{ENTER}**
>
> **AT+MS=10,0,4800,9600{ENTER}**
>
> **AT&W{ENTER}**

These commands will save the configuration within the cellular modem. The configuration can be checked by typing **AT&V{ENTER}.** The modem will respond with the list of parameters in its active profiles (profile zero and profile one).

The cellular modem will respond with **10,0,4800,9600,0,0,300** if you type the command **AT+MS?{ENTER}**.

6.5.2. AMPS Cellular Modem Network Activation

> **In order to operate an AMPS cellular modem, you must establish service with a cellular service provider that offers this type of service.**

You will need to provide the cellular service provider with the following information:

1. The ESN of your cellular modem (Every cellular modem is identified by a unique number called an ESN, or Electronic Serial Number.) is supplied with the modem documentation, or it has to be retrieved from the modem's EEPROM. To retrieve this information from the StarComm Cellular Modem, type the command **AT>I{ENTER}**.

2. Device Type: Your cellular provider may ask you to identify the type of device that you are activating on their network. The device type can be obtained from the modem documentation. Two common types are Motorola Radio and Standard Communications CMR4100 radio.

After you have established an account with your cellular provider, you need to request the following information from your cellular provider:

1. MIN: Mobile Identification Number, a 10-digit number that is your cellular modem/phone number.
2. SID: System ID, 5-digit number that defines the cellular system.
3. CAOC: Carrier Access Overload Class, a 2-digit number that defines the cellular carrier access parameters.
4. CGID: Carrier Group ID, a 2-digit number that defines cellular network characteristics.
5. Network Preference: a parameter that selects the network operating characteristics.

To configure some cellular modems you may not require all of the above parameters. The StarComm Cellular Modem only requires MIN, SID and Network Preference parameters. To input these parameters you need to use the following commands:

Telephone Number: **`AT>M=mmmmmmmmmmm{ENTER}`** (m = telephone number)
System ID: **`AT>S=sssss{ENTER}`** (s = SID)
Network Preference: **`AT>N=n{ENTER}`** (n = preference)

Your cellular modem should now be ready to operate.

> **Using the `AT>Q{ENTER}` command on a StarComm Cellular modem will evaluate the quality of service at your particular location.**

6.5.3. Understanding CDPD Cellular Modems

Cellular Digital Packed Data (CDPD, or Wireless IP[111]) is a superset of the AMPS specifically for sending data over cellular network.

CDPD transmits data in small packets over cellular network using UDP[112] PAD[113]. If a connection is lost during transmission, the CDPD cellular modem reconnects to the network and automatically retransmits or re-receives the message in its entirety. Since it is completely digital, CDPD has low bit error rates at higher speeds. The typical raw speed is 19.2 kbps. Generally, CDPD has lower operational costs than analog wireless connections.

> **To activate and register your CDPD cellular modem with the cellular network, it is necessary to select a CDPD service provider and acquire an NEI (Network Entity Identifier), also known as an IP address.**

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[111] IP is the acronym for Internet Protocol.
[112] UDP (User Datagram Protocol) is a subset of TCP/IP, the standard internet protocol.
[113] PAD is the acronym for Packet Assembly/Disassembly.

> **Configuring and using the UDP PAD service requires familiarity with AT commands. In particular, an understanding of the +WS registers from +WS60 to +WS74 (as described in the AT Command Reference Manual) is essential.**

The Sierra Wireless MP200 has two states: the command state and the data state. When the UDP PAD service is selected (+WS45=0), the modem is in command state. The data state will be entered when a call is originated by dialing or the cellular modem answers an incoming packet (call).

Escaping Data State Using TIES

The Time Independent Escape Sequence (TIES) is a method to shift the cellular modem from the data state to the command state. It is enabled by setting register **+WS60=1** (the default).

The escape sequence is the string **AT+++**, ending with the Primary Forwarding Character (defined by register **+WS64**). The complete sequence must fit within the current packet; otherwise, it will not be included in the TIES checking.

CDPD Dialing Out – Client Sessions

The Sierra Wireless MP200 can be used to originate a UDP session by "dialing" an IP address and port using the **ATD[ip_address.port]** command. The modem will only answer calls addressed to port 2100. The modem will go on-line (into data state) and wait for a packet to send or one to arrive. While the session is open, only traffic from the dialed server will be accepted by the MP200.

The local host (the ZENO®-3200) can compose packets and forward them to the network. Packets from the called server will be delivered to the local host.

To close the session, the local host must leave data state by issuing the TIES or toggling DTR (if configured with (**AT&D1** or **AT&D2**) followed by a "hang up" using the **ATH** command.

CDPD Answering a Call – Server Sessions

The Sierra Wireless MP200 cellular modem can be configured to auto-answer incoming packets by opening a session when a packet arrives. This is handled by setting **ATS0=1**. The MP200 will open a session and enter the data state when a packet addressed to the cellular modem's IP address arrives on any port.

When a packet arrives, the modem sends the **CONNECT** message, enters the data state, and sends the packet to the local host (the ZENO®-3200). Again, the cellular modem will remain in the data state until the local host issues the TIES or toggling DTR (if configured with **AT&D1** or **AT&D2**) followed by a "hang up" using the **ATH** command.

CDPD Packet Assembly

A packet is started and buffered when the local host starts sending data to the cellular modem. If the buffer reaches the maximum packet length, the packet is forwarded and a new packet is started.

The modem can echo characters sent from the local host if register **+WS62=1** and, in cases where terminal emulation program is being used, it allows typing and sending messages in real time.

Forwarding a CDPD Packet

The cellular modem closes and sends a packet when one of the following events occurs:

- The maximum packet length, set in register **+WS74** (default 1000 bytes), is reached.
- The modem receives the PAD Primary Forwarding Character set in register **+WS64**. This register defaults to ASCII character **{CR}** (decimal value 13).
- The PAD Inter-Character Timer (register **+WS70**) expires.

If you disable the primary forwarding character (register **+WS63=0**) and the timer (register **+WS70=0**), the only way to forward packets will be to fill the packet buffer.

6.5.4. Sierra Wireless MP200 Sample Configuration

Below is an example configuration and network registration process for the Sierra Wireless MP200 cellular modem.

Start a terminal emulation program and configure your computer's serial communications port as follows:

PC Serial Port Setting	Value to set in Terminal Emulation Program.
Baud Rate	19,200
Data Bits	8
Start Bits	1
Stop Bits	1
Parity	None
Flow Control	Hardware

Connect the cellular modem to your computer's serial communications port as illustrated in the diagram below.
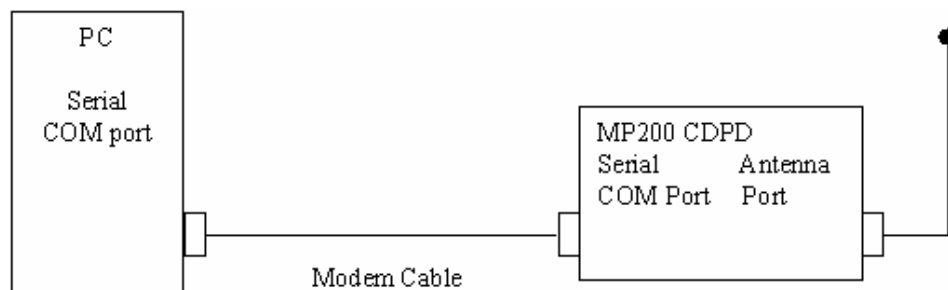

Figure 6-6. PC to cellular modem diagram.

Type **AT{ENTER}** and the cellular modem should respond with **OK**. If you do not get any response from the cellular modem (no echo of the typed characters and/or OK), check the following:

- The terminal emulation program setup
- The cable connection between the modem and the computer
- The power to the cellular modem

Type **AT+WPNEI=aaa.aaa.aaa.aaa{ENTER}** where **aaa.aaa.aaa.aaa** is the TCP/IP address specified for the particular modem NEI[114]. The modem will respond with the question **Change ccc.ccc.ccc.ccc to aaa.aaa.aaa.aaa?** (where **ccc.ccc.ccc.ccc** is the current value for the NEI specified in register **+WS197**). The expected response is **Y{ENTER}** (upper or lower case); otherwise, the NEI will not be changed.

Type **AT+WPREG{ENTER}** to register the new NEI with the network. The expected response after a few seconds is **REGISTERED OK.**

Type **AT+WPNEILIST{ENTER}**. The response to this command should display the four-entry NEI table, with the value and registration status of each NEI:

```
    1  aaa.aaa.aaa.aaa  *  Registered
    2  000.000.000.000     P  No
    3  000.000.000.000     P  No
    4  000.000.000.000     P  No
    OK
```

Type the following command string (NO BREAKS):

AT&F&DS0=1+WS45=0+WS46=4+WS60=1+WS62=0+WS64=126+WS72=0+WS74=512+WS173= 1+WS176=1{ENTER}

Type **AT+IPR=9600{ENTER}**. The cellular modem will respond with **OK**, followed with a short string of garbled characters. This means the modem has changed its serial communications port baud-rate to 9600 BPS. Therefore, in order to continue to communicate with the modem you should change the baud rate of your terminal emulation program to 9600 BPS.

Depending on the modem application, type the following string:

- As a Host Modem (connected to PC, Intercept™):   **ATEQ&W{ENTER}**
- As a Remote Modem (connected to ZENO®-3200):   **ATEQ1&W{ENTER}**

Cycle the power to the cellular modem. After approximately 10 seconds type a test string for a single register, e.g.: **AT+WS64?{ENTER}** (a request for the contents of register **WS64**). If you get the response **126{CR/LF}**, you have successfully configured your cellular modem. If you get no response, redo the listed steps.

6.6.   RADIO COMMUNICATIONS

> **All radio communication is prone to noise!**

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[114] NEI is the Network Entity Identifier that is obtained from your cellular modem service provider.

> **The ZENO®-3200 radio and your host must have good Line of Site (LOS) for effective radio communication.**

The CCSAIL protocol should be used to download data because of its built-in checksum for error checking[115] for either unidirectional or bi-directional communication.

The X-modem file transfer protocol is also good for noisy communications links because it can only be used with two-way radio communication since it is bi-directional.

> **If you are using unidirectional communication, you cannot use the X-modem file transfer protocol!**

> **Radio transmitters use considerably more power than the Zeno®-3200 by itself!**

Coastal Environmental Systems typically uses radios that transmit at 2 Watts, requiring 1 Amp at 12 VDC during transmission. The typical transmitter duty cycle[116] is 30% to 50%.

> **Coastal Environmental Systems does not recommend downloading large amounts of data via radio because the radio transmitter could be damaged.**

6.6.1. Connecting the Radio To The ZENO®-3200

> **It is important to note that your ZENO®-3200 must be equipped with an internal, properly tuned FSK[117] Modem Chip in order to use radio communications.**

Both unidirectional and bi-directional radios are connected to the ZENO®-3200 using COM1. Several pins on the Auxiliary Serial Port[118] are used to connect the radio to the ZENO®-3200:

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[115] Refer to Section 4.6.
[116] Duty cycle is the percentage of time that a radio can transmit before it needs to rest. If a radio transmits for 10 seconds and its duty cycle is 30%, then it must rest for at least 23 seconds.
[117] FSK stands for Frequency Shift Keying.
[118] The Auxiliary Serial Port is located on the ZENO®-3200 Front Panel, refer to Section 2.1.

Auxiliary Port Pin	Pin Function
4	Push-To-Talk (PTT)
9	Audio Transmit (TXA)
10	Audio Receive (RXA)
12	Digital Ground (DGND)
13	+12 VDC Switched Voltage A
25	Input Power (Power supplied to ZENO®-3200 on Front Panel[119])

For a complete listing of the Auxiliary Port Pins, refer to Section 13.5.2.

6.6.2. Power Control Options

> **Coastal Environmental Systems' Standard Indoor Battery Charger DOES NOT supply enough power to supply a radio during transmission.**
>
> **Coastal Environmental Systems recommends use of a battery with sufficient amperage or other power source to supply both the ZENO®-3200 and a radio.**

Since radios require considerable amounts of power, Coastal Environmental Systems designed the ZENO®-3200 so that power to a radio can be controlled in several ways. Depending upon the type of radio used and the amount of available power needed, the following table illustrates radio power control options:

Power Control Option	Reason for Using Option	Typical Source of Power
Leave the radio on at all times.	This is only good when you have unlimited power and you are using a bi-directional radio.	Pin 25 on Auxiliary Serial Port. (This is on whenever the ZENO®-3200 is on.)
Only turn a radio on when it is time to transmit data.	This is done typically with unidirectional radios.	Pin 13 on Auxiliary Serial Port. (+12 VDC Switched Voltage A, controlled using Power Control Menu.)
Turn the radio on for a specified length of time on a regular schedule.	This is done typically with bi-directional radios.	External relay controlled by a Digital Output via the Digital Control Menu.

> **A Switched Voltage can provide enough power to supply a unidirectional radio but not a bi-directional radio.**

6.6.3. Controlling Unidirectional Radio Power (The Power Control Menu)

Typically, you will control power to a unidirectional radio using +12 VDC Switched Voltage A, which is directly available on the Auxiliary Serial Port.[120] To do this, you need to specify which switched voltage

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[119] Refer to Section 2.1.

is to be used to control radio power in the Power Control Menu. To get to the Power Control Menu, you first need to be in the Communications Menu, then type **P{ENTER}** to go to the Power Control Menu. You should see the following on your terminal emulation program:

```
POWER CONTROL MENU
(Cn/m) Change Item n To Value m            (Q) Quit
(E)    Save Parameters To EEPROM           (H) Help
(U)    User Menu

Item  1:  100        (COM1 Push-To-Talk Setup Time)
Item  2:  0          (COM1 Switched Power Code)
Item  3:  0          (COM2 Switched Power Code)
Item  4:  0          (COM3 Switched Power Code)
Item  5:  0          (Response Delay Time (milliseconds)

>
```

Since the radio is connected to COM1, you need to set the value for Line Item #2 (COM1 Switched Power Code) in the Power Control Menu. The options available for Line Items #2 through #4 are as follows:

- 0 (no switched power)
- 1 (+5 VDC Switched Voltage A)
- 2 (+5 VDC Switched Voltage B)
- 3 (+12 VDC Switched Voltage A)
- 4 (+12 VDC Switched Voltage B)
- 5 (+12 VDC Switched Voltage C)

Most commonly used is +12 VDC switched A, since it can deliver the greatest current (750 mA) and is wired directly to the Auxiliary Serial Port. To achieve this in the Power Control Menu, set the value for Line Item #2 to 3 by typing **C2/3{ENTER}**.

6.6.4. Controlling Bi-directional Radio Power (The Digital Output Menu)

Typically, if you want the ZENO®-3200 to control power to a bi-directional radio, you will need to supply a relay to control power to the radio. The relay will be controlled by the ZENO®-3200 using the Digital Output via the Digital Control Menu.

The Digital Control Menu can be used to turn a single Digital Output on and off on a user-defined schedule and is *completely independent of the Sample Interval*. Type **D{ENTER}** from the Communications Menu to enter the Digital Control Menu. You will see a screen similar to the following.

---

[120] +12 VDC Switched Voltage B or C can also be used by wiring to the ZENO®-3200 Front Panel.

```
DIGITAL CONTROL MENU
(Cn/m) Change Item n to Value m        (E) Save Parameters To EEPROM
(U) User Menu                          (Q) Quit
(H) Help

Item  1:  000:00:00           (Power-On Interval)
Item  2:  000:00:00           (Power-On Duration)
Item  3:  96/01/01 00:00:00   (Start of First Power-On)
Item  4:  0                   (Control Channel)

>
```

> **Each Digital Output is active when it is LOW and inactive when it is HIGH.**
> **This is called "negative logic."**

Line items 1, 2, and 3 allow you to set the schedule at which a Digital Output will be set LOW. If connected to a relay, it will control the action of the relay. The schedule is independent of the Sample Interval definition:

Digital Output Menu Line Item No.	Name	Definition
1	Power-On Interval	Defines how frequently the Digital Output will be turned on.
2	Power-On Duration	Defines how long the Digital Output will be on each time it is turned on.
3	Start of First Power-On	Defines when initial starting time of the cycle. Similar to an offset.

For example, the Digital Output could be switched on for the first 5 minutes of every hour to turn on a bi-directional radio, while the Sample Interval calls for a new measurement every 10 minutes. A Power-on Interval and Power-on Duration of up to 168 hours (7 days) can be entered in the format **hhh:mm:ss**. Power-on corresponds to the Digital Output set LOW; power-off to the Digital Output set HIGH.

Valid values for Line Item #4, the Digital Control Output, are 18 through 23, corresponding to the Digital Outputs on the ZENO®-3200 Front Panel[121]. If you set Line Item #4 to 0 (or if you set Line Item #1, the Power-on Interval to 000:00:00), then the Digital Control Output will be disabled (as the above example of the Digital Control Menu shows).

---

[121] Refer to Section 2.1.

> **You may have to send the** U{ENTER} **command several times to enter the User Interface if the ZENO®-3200 is controlling power to a two-way radio or similar communications device using the Digital Control Output.**
>
> **In this case, there is a design tradeoff between how often the ZENO®-3200 can power a two-way radio to check for user commands, and how much its power consumption can be minimized.**

6.6.5. Push-To-Talk (PTT)

Before the ZENO®-3200 can send a message to the radio for it to transmit, it must first assert the radio's PTT line.

> **When a radio's PTT line is NOT asserted, its transmitter is NOT powered.**

Asserting the PTT line forces the radio to turn on its transmitter. Several hundred milliseconds are usually required for the transmitter's power level to reach a steady, normal value. for this reason, the ZENO®-3200 can be configured to wait for the radio's transmitter to warm up before it attempts to send any data through the radio. The "COM1 Push-to-Talk Setup Time" is located in Line Item #1 of the Power Control Menu:

```
POWER CONTROL MENU
(Cn/m) Change Item n To Value m            (Q) Quit
(E)    Save Parameters To EEPROM           (H) Help
(U)    User Menu

Item  1:  100          (COM1 Push-To-Talk Setup Time)
Item  2:  0            (COM1 Switched Power Code)
Item  3:  0            (COM2 Switched Power Code)
Item  4:  0            (COM3 Switched Power Code)
Item  5:  0            (Response Delay Time (milliseconds)

>
```

A good setting of the "COM1 Push-To-Talk Setup Time" will depend upon your radio. The value set is in milliseconds

6.6.6. Response Delay Time

When several two-way radios are being used, it is necessary for a remote two-way radio to provide an adequate delay in response so that the host two-way radio has sufficient time to turn off its transmitter and switch to receive mode. for this reason, the Power Control Menu contains Line Item #5, the Response Delay Time.

When the Response Delay Time in the Power Control Menu is set, the ZENO®-3200 will wait the specified number of milliseconds before it responds to any valid CCSAIL message it receives over the two-way radio link.

6.6.7. Data Packetization

To ensure that a complete message is sent between a ZENO®-3200 and a host with a radio (usually a Coastal Environmental System Base Station), the ZENO®-3200 "packets" each message using bracket characters, **{{{{{** and **}}}}}**, at the beginning and ending of each packet. ZENOSOFT® strips the packeting characters so that you won't see them in any ZENO®-3200 messages.

> **If you are using two-way radio communication and you see the characters {{{{{ or }}}}} appear on your screen, it probably means you are using a Base Station set for one-way radio communication only.**

6.7.   GOES SATELLITE COMMUNICATIONS

The ZENO®-3200 data logger can transmit data through the GOES[122] satellite system operated by the National Environmental Satellite, Data and Information Service (NESDIS) of the National Oceanographic and Atmospheric Administration (NOAA). The GOES system provides 232 channels for users to up-link messages.[123] A typical assigned transmit window of 1 minute allows 355 bytes of data to be sent, allowing for preamble and 15 second guard bands.

> **Data messages sent to the GOES transmitter are limited to 355 bytes.**

Coastal Environmental Systems uses either the Telonics TGT-1 GOES transmitter or the Campbell Scientific SAT HDR GOES transmitter. Both self-timed (regular) and random transmissions are supported in either clear-text (ASCII) or compressed (binary) format. Self-timed transmissions are generally used for routine monitoring, typically every three to four hours. Random (or emergency) transmissions are used to report on unusual or critical conditions.

> **Self-timed and random transmissions cannot be used concurrently.**

6.7.1. Obtaining GOES Channels

Before you can use a GOES radio, NESDIS will assign channels and time windows for self-timed and/or random transmissions to you. Different channels are used for self-timed and random transmissions, so that the self-timed transmissions are not overwritten by the random transmissions.

> **You must send your self-timed or random transmissions within the one-minute time window assigned by NESDIS.**

GOES users are primarily US based government agencies, and private US and non-US users when sponsored by a US government agency.

---

[122] GOES stands for Geostationary Operational Environmental Satellites.
[123] 199 channels are regional, and the other 33 are international.

> **Use of the Data Collection System is limited to the collection of environmental data.**

> **There is currently no charge for use of the GOES system.**

There are two operational GOES satellites, and you will be assigned channels on one or the other satellite:

- The GOES East satellite is stationed 35,000 km above the equator at 75° W longitude.
- The GOES West satellite at 135° W longitude.
- There is also a spare (non-operational) satellite that is normally located at 105º W.

Each channel operates at a specified baud rate of 100, 300 or 1200 baud. The Telonics TGT-1 transmitter is only capable of transmitting at 100 baud. The Campbell Scientific SAT HDR GOES transmitter can be configured for 100, 300 or 1200 baud.

To obtain channels, complete the GOES DCS Program Application and Renewal Form, which is available from:

> DCP Program Manager
> NOAA/NESDIS
> NOAA Science Center, Room 806
> 5200 Auth Road
> Camp Springs, MD 20746
> Phone: (301) 763-8062
> Fax: (301) 763-8449
> Email: satinof@ssd.wwb.noaa.gov
> Website: http://www.oso.noaa.gov/goes/

6.7.2. Data Download

Data relayed from GOES satellites are received and demodulated at the NESDIS ground station in Wallops Island, Virginia. The data may be accessed through telephone lines with use of a modem, and are available through a satellite downlink called DOMSAT.

To access the GOES data directly, you can dial in to the GOES DCS Automatic Processing System, or DAPS. When you are assigned GOES channels, you should also be assigned a user name and password for DAPS.

There are many commands available on the DASP system. Consult the GOES DAPS User Interface Manual for details about these commands. The ZENO®-3200 User Manual provides a basic overview of this software in the following section.

> **Before dialing in to DAPS, set your modem communications to the following parameters: 9600 Baud, 7 Data Bits, 1 Stop Bit, Even Parity.**

The following telephone numbers are available for dial-in access and technical support.

> Main Rotary line: (757) 824-0105

Other lines:	(757) 824-0125	(757) 824-0156
	(757) 824-0126	(757) 824-0162
	(757) 824-0127	(757) 824-0163
	(757) 824-0145	(757) 824-0164
	(757) 824-0149	

Operator Line Monitoring or User Assistance: (757) 824-1064
Operator Voice Lines: (757) 824-3552 (757) 824-3702

6.7.3. DAPS Dial-in Procedure

After setting up your modem communications, and dialing in to one of the dial-in numbers, hit **{ENTER}** a few times, until you are prompted for a user name and password.

Once you have logged in to the DAPS computer system, type the following command:

DOWNLOAD MESSAGE_FILE PLATFORM_ID *platform_id*

You should then prepare for a text file download. Type **BYE** to log out of DAPS and terminate your modem connection.

The following screen illustrates these steps. After receiving a **CONNECT** message, which indicates that the modem connection has succeeded, hit **{ENTER}** a few times. Enter your user name and password when prompted.

```
CONNECT

AOS/VS 7.64.00.00 / EXEC-32 7.64.00.00   4-Oct-97  1:00:17 @CON29
Username: xxxxx
Password: xxxxx
------
        Copyright (C) Data General Corporation, 1980 - 1988
        All rights reserved.
        Licensed material -- property of Data General Corporation

        This software is made available solely pursuant to the
        terms of a DGC license agreement which governs its use.

--------

Most recent logon        7-Aug-97        22:45:14

DISPLAY COMPLETE
>
```

Messages are downloaded in the format that they are received by the DAPS system. The DAPS system inserts a header at the start of each message, indicating the date and time at which the messages were received by the satellite. The most recently received messages are downloaded first.

At the prompt, enter the command to download data from your ZENO. When you are prompted to begin the download, turn on text capture, and type **Y**.

```
> DOWNLOAD MESSAGE_FILE PLATFORM_CE1192D4
BEGIN DOWNLOAD? (Y/N)
>> Y
CE1192D497277004338G46-3NN052WFF00086
#00000003
2446.858,11.6,
#00000003
2446.839,12.9,
#00000003
2447.996,12.8,


CE1192D497276204337G49-3NN052WFF00113
#00000003
2446.871,11.7,
#00000003
2446.878,12.9,
#00000003
2446.856,12.9,
#00000003
2446.852,12.9,

DOWNLOAD COMPLETE; NUMBER OF MESSAGES TRANSFERRED:        2
>
```

Finally, enter **BYE** to log off.

```
> BYE

Process 26 terminated
Connect time 0:02:36
User 'xxxxx' logged off @CON29  4-Oct-97          1:03:02

NO CARRIER
```

Because transmission windows typically occur every 3 to 4 hours—and environmental data are logged more often—you will generally receive more than 1 data set in each message.

Directing The Antenna (For North America Only)

There are two GOES satellites: the GOES East satellite is stationed 35,000 km above the equator at 75° W longitude and the GOES West satellite at 135° W longitude. You should point your antenna at the satellite on which you have channels assigned.

You can determine the direction of the satellite from the following figures. The full lines give the elevation angle at which you should point the GOES antenna, and the broken lines give the azimuth at which you should point the antenna. (Use true rather than magnetic azimuth values.)
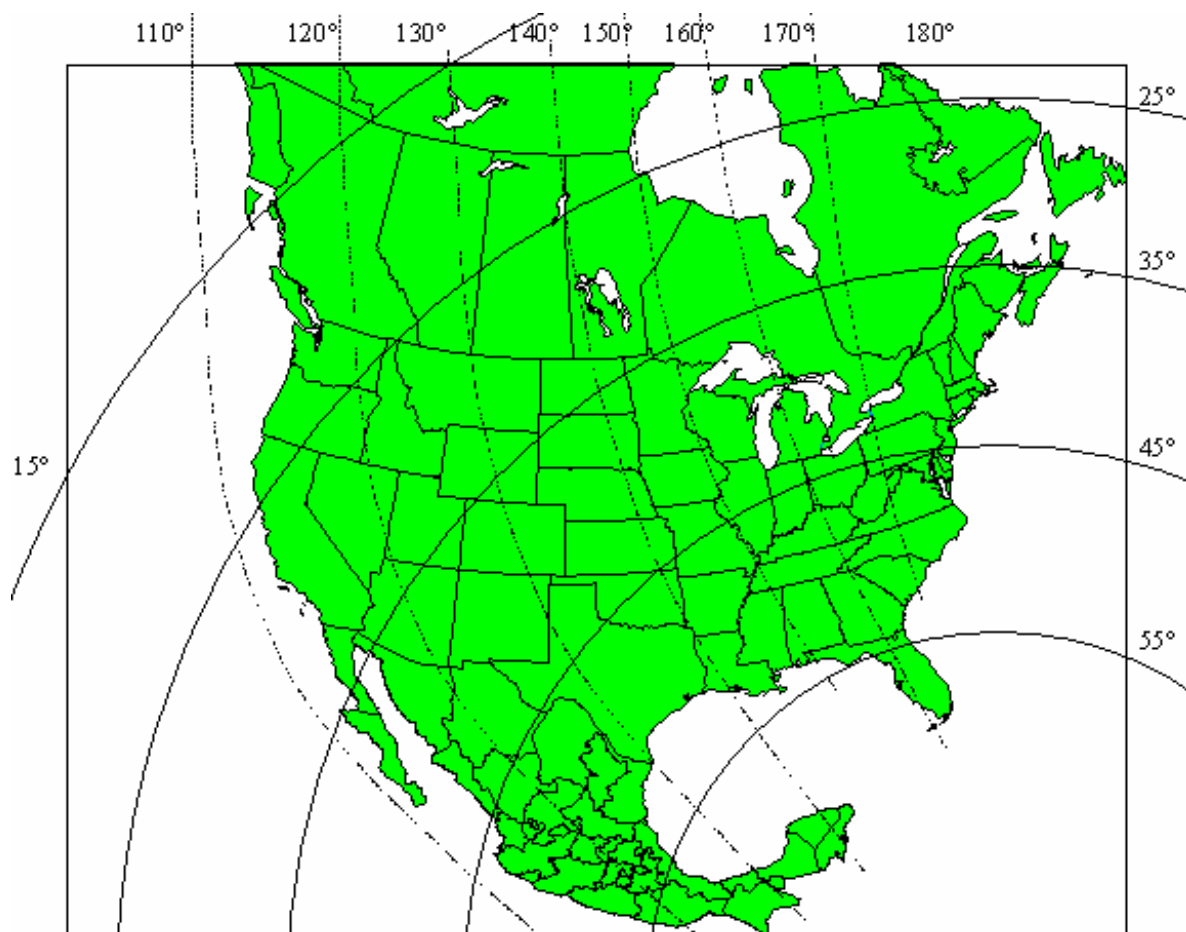
Figure 6-1. Eastern satellite pointing angles (azimuth: broken lines; elevation: full lines)
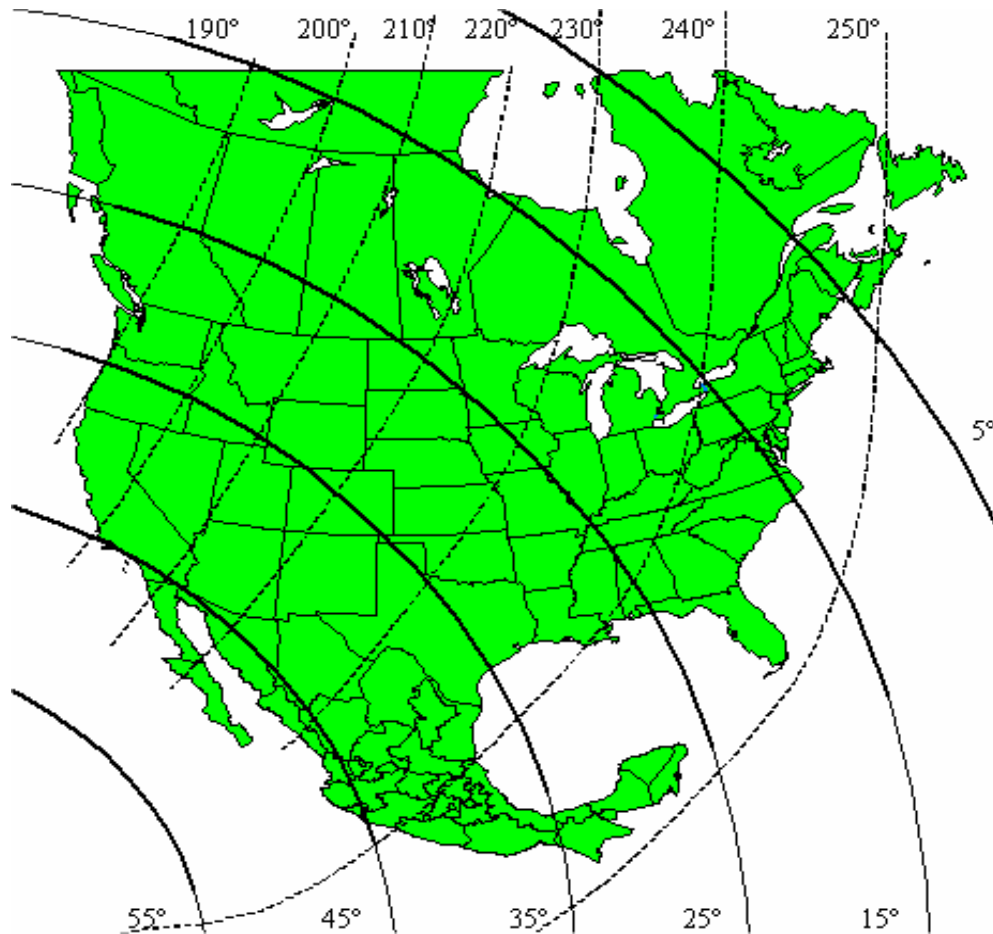
Figure 6-8. Western satellite pointing angles (azimuth: broken lines; elevation: full lines)

6.7.4. TELONICS TGT-1 GOES TRANSMITTER

Coastal Environmental Systems uses the Telonics TGT-1 GOES transmitter, normally, with the TTL standard interface. This unit has the following specifications:

Size:	4.4" × 6.4" × 3.5"
Weight:	2.2 lb.
Frequency:	401.701 - 401.998 MHz (402.0025 - 402.0985 MHz international)
Temperature:	-40°C to +50°C operational, -60°C to +80°C storage
Humidity:	90% non-condensing
Current:	3A maximum, 2.2A typical during transmission (50 Ω load); < 10 mA quiescent
Voltage:	10.5 VDC to 14.0 VDC

To meet the required timing accuracy, the TGT-1 provides timing to a real-time clock that manages the transmit window scheduling. Once deployed, TGT-1's clock is capable of running within GOES specifications for 420 days without adjustment. NOAA has certified that the Telonics regional and international transmitters meet all required standards.

Connection to the ZENO®-3200

The TGT-1 DE-25 port labeled GOES RADIO is connected to the ZENO®-3200 DE-25 port labeled AUX SERIAL DATA, using the cable provided by Coastal Environmental Systems. This cable is *not* a standard serial cable as it includes interface electronics. This interface includes the power supplied to the GOES transmitter.
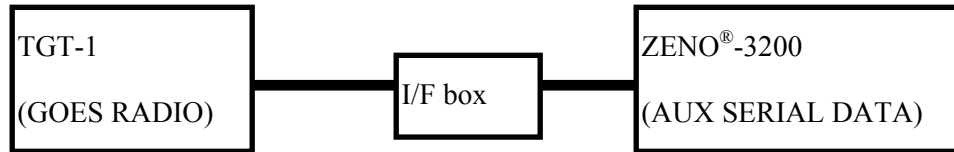

Figure 6-9. Telonics TGT-1 to ZENO®-3200 block diagram.

The ZENO®-3200 provides 12 VDC unregulated power to the TGT-1 over this cable. The interface box also includes a lithium battery to provide backup power to the TGT-1, in case the ZENO®-3200 should lose power for any reason. The reason for the battery backup is because the TGT-1 clock is used to time transmissions, and the TGT-1 clock will reset if its power fails completely. While the ZENO®-3200 clock continues to run if the power fails, it is not certified for GOES transmissions.

6.7.5. Campbell Scientific SAT HDR GOES Transmitter

Coastal Environmental Systems uses the Campbell Scientific SAT HDR GOES transmitter with the RS232 interface. This unit has the following specifications:

Size	8.2" × 5.5" × 1.5" (no connectors), 9.0" × 5.5" × 1.5" (with connectors)
Weight	< 2 lbs.
Frequency	400 - 403 MHz
Temperature	-40°C to +50°C
Humidity	0 - 99% non-condensing
Current	4A typical during transmission (50 Ω load); < 1 mA quiescent, 350 mA during GPS fix.
Voltage	9.6 VDC to 16.0 VDC
Power:	7.9 Watts for 100 & 300 bps, 15.9 Watts for 1200 bps.

To meet the required timing accuracy, the SAT HDR GOES uses a built-in GPS receiver to obtain positioning and timing for its real-time clock that manages the transmit window scheduling.

The Campbell Scientific SAT HDR GOES transmitter port labeled Auxiliary I/O RS232 (DCE) is connected to the ZENO®-3200 DE-25 port labeled Auxiliary Serial Port using the cable provided by Coastal Environmental Systems. (This cable is *not* a standard serial cable.) Power to the Campbell Scientific SAT HDR GOES is not supplied by the ZENO®-3200. Power is connected separately to the transmitter via the connector labeled Power.

6.7.6. ZENO®-3200 Configuration

The ZENO®-3200 supports either the Telonics or Campbell Scientific GOES radio communications on COM2. The first step in configuring a ZENO to transmit using the GOES transmitter is to set COM2 accordingly.

From the User Menu, enter **C{ENTER}** to reach the Communications Menu. For the Telonics TGT-1, set the COM2 port type to GOES, and the COM2 baud rate to 1200 or 9600 (to match the TGT-1 baud rate).

For the Campbell Scientific SAT HDR GOES transmitter, set the COM2 port type to CGOES, and the COM2 baud rate to 9600.

```
┌────────────────────────────────────────────────────────────────┐
│   You can attach both a GOES radio and sensors to COM2 as long as they are │
│                          not on the same pins!                   │
│                                                                  │
│      Set the Communications Menu line items to match the GOES.   │
└────────────────────────────────────────────────────────────────┘
```

```
COMMUNICATIONS MENU
(Cn/m) Change Item n To Value m    (Tn) Terminal Mode On COM Port n
(M)    Modem Menu                  (E)  Save Parameters To EEPROM
(P)    Power Control Menu          (U)  User Menu
(G)    GOES Menu                   (Q)  Quit
(D)    Digital Control Menu        (H)  Help

Item  1:  9600        (COM1 Baud Rate)
Item  2:  1200        (COM2 Baud Rate)
Item  3:  9600        (COM3 Baud Rate)
Item  4:  RS232       (COM1 Port Type)
Item  5:  GOES        (COM2 Port Type)
Item  6:  RS232       (COM3 Port Type)

>
```

Next, type **G{ENTER}** from the Communications Menu to enter the GOES Menu.

```
GOES MENU
(Cn/m) Change Item n to Value m        (E) Save Parameters To EEPROM
(D)    Run GOES Diagnostics            (U) User Menu
(R)    Reset GOES Errors               (Q) Quit
(I)    Initialize GOES                 (H) Help

Item  1:  ce587a74    (Data Collection Platform Address)
Item  2:  52          (Self-Timed Transmit Channel Number)
Item  3:  00:04:00:00 (Self-Timed Transmission Interval)
Item  4:  02:09:00    (Self-Timed Transmission Offset)
Item  5:  1           (Transmission Window Length, in Minutes)
Item  6:  SHORT       (Satellite Link Parameter: Preamble)
Item  7:  128         (Random Transmit Channel Number)
Item  8:  00:15:00    (Random Transmission Interval)
Item  9:  01:05:00    (Random Disable Time)
Item 10:  1200        (GOES Bit Rate)
Item 11:  NONE        (GOES Interleaver)

>
```

Set the GOES Menu line items as follows:

• Specify the Data Collection Platform Address, Line Item #1. This is a hex value.

- If you will be using self-timed transmissions, specify the self-timed transmit channel number, transmission interval, and transmission offset (Line Items #2 through #4).

- Specify the transmission window length in minutes, and the satellite preamble length, Line Item #6, as SHORT or LONG.

- If you are using a Campbell Scientific SAT HDR GOES transmitter, set the GOES bit rate in Item 10 and the Interleaver in Item 11.

- If you will be using random transmissions, set the random transmission channel number, the random transmission interval, and the random transmit disable time. When a random transmission is required, the GOES radio will transmit the random message at the frequency specified in the random transmission interval, until the end of the random transmit disable time. for example, if you set the random transmission interval to 1 minute and the random transmit disable time to 5 minutes, the GOES radio will transmit the random message once per minute to 5 minutes.

- Enter **I{ENTER}** to initialize the GOES radio. This loads the channel number and other information to the GOES radio. It also deletes all data currently in the transmit buffer. The ZENO®-3200 will prompt you to give the system date and time. You *must* give this value accurately, and in GMT[124] (also known as UTC[125] — 8 hours ahead of Pacific Standard Time).

> **When initializing the GOES transmitter you must also set the system clock to GMT or UTC.[126]**

The GOES transmissions are timed on the transmitter's clock. Unlike the ZENO®-3200's system clock, the transmitter's clock does not retain its time through a power failure. Therefore, every time the Telonics TGT-1 GOES transmitter loses and regains power, the GOES clock must be set again by re-initializing the GOES transmitter using GOES Menu option **I**. If there is a backup battery to the Telonics TGT-1 GOES transmitter, resetting of the clock after initial system deployment is not necessary.

For a Campbell Scientific SAT HDR GOES transmitter, you do not need to re-initialize the transmitter if there is power failure since its clock is set according to an internal GPS receiver.

With these communications settings any *regular* ZENO®-3200 Data Output messages routed to COM2 will be sent to the GOES transmitter. At the programmed time, the GOES transmitter will transmit the contents of its data buffer over the self-timed transmit channel when the next self-timed transmission interval occurs. Any *alarm* messages generated by the ZENO will be transmitted over the random transmit channel with the frequency specified in the GOES menu.[127]

> **You may send a maximum of ONLY 355 bytes in a single transmission.**

---

[124] GMT is Greenwich Mean Time.
[125] UTC is Universal Time Coordinate.
[126] The Campbell Scientific SAT HDR GOES transmitter obtains its time from a GPS (Global Positioning System) receiver.
[127] Refer to Section 11.3.3.

6.7.7. Connecting A GOES Radio and Serial Sensors To The Same COM Port

You may wish to attach both a GOES radio and one or more serial sensors to the ZENO. This can be done as long as the serial sensor(s) is not connected to the same line as the GOES radio. In the case of the Telonics TGT-1 transmitter, the RS232, RS485 and Compass ports are available for serial sensor use. In the case of the Campbell Scientific SAT HDR GOES transmitter, the TTL, RS485 and Compass ports are available for serial sensor use.

6.7.8. GOES Transmitter Diagnostics

You can obtain basic diagnostic information on the state of the Telonics TGT-1 or Campbell Scientific SAT HDR GOES transmitter by entering **D** from the GOES Menu. The ZENO®-3200 displays the diagnostic information in a simple-to-read table.

6.7.9. Self-Timed Transmissions

Once you have set up the GOES parameters, the only additional step for self-timed transmissions is to define a data output message to be transmitted over the COM2 port. Refer to Section 10.6 for details on creating an output message. The output message can contain normal ASCII characters, or it can be in binary format as described in Section 6.7.11. All output messages sent to COM2 will be buffered up by the GOES transmitter and transmitted during its self-timed transmit window.

6.7.10. Random Transmissions

To generate random or emergency transmissions, you must perform the following steps:

- Set up a data output message to contain the data to be transmitted when the alarm message occurs.[128] This can be a normal ASCII message, or it can be in the binary format described below.

- In the Output Message Timing Menu, specify that the message is to be routed to COM2, and assign the message a period of zero.[129]

- In the Process Menu, set up a Dial-out Alarm Process to trigger the alarm message under the desired circumstances.[130]

Whenever the sensor or process input moves beyond the defined threshold level, a random transmission is initiated. For example, by setting the sensor or process input to be a water level measurement, and by setting the alarm threshold to a specified level, a random transmission can be initiated whenever the water level reaches the specified value.

6.7.11. GOES Binary Format

The GOES binary format packs data into an efficient format that is suitable for transmission over a GOES satellite (or other limited communications channel).

---

[128] Refer to Section 11.2.
[129] This will indicate that the message is not transmitted as a regular output message. Refer to Section 11.3.
[130] Refer to Section 11.3.

> **To define an output message in GOES Binary Format, each field of that message must be GOES Binary Format (rather than Log Only, Time Stamp, etc.) Field Type.**

Use the Data Output menu to define each field in your message and to choose the GOES Binary Format type.[131] Fields of this type are transmitted but not logged.

The GOES Binary Format converts each data value into an integer, encodes it as a binary value, and then breaks that binary-encoded data value into chunks of 6 bits. Each byte of data will contain one of these 6-bit chunks as its 6 least significant bits. Bit #7 is always set to 1 to ensure that the resulting character is printable. Bit #8 is a parity bit that will only be set to 1 if the there are an even number of bits set in the lower 7 bits of the byte.

The following line items in the Data Output Menu are interpreted in a non-standard way for the GOES Binary Format.

- *Field decimal places*: The data value to be treated is multiplied by the appropriate number of factors of 10 to bring the data value to an integer, while still retaining the requested accuracy. for example, suppose you wish to output a measured temperature to 2 decimal places (e.g., 23.62 degrees). Line item 5 should take the value 2. The value will be converted to 2362 before transmission.
- *Field width*: Suppose that the field width is 3. The data value (2362) will be converted to a 3×6=18-bit value, with the most significant bit being a sign bit. The binary version of this data value becomes:

    000000 100100 111010

The three 6-bit data fields would be calculated and transmitted as follows:

- For output to any device *other* than the GOES radio, the two most significant pair of bits **01** precedes each 6-bit chunk. This will give a printable ASCII string. The above values will be converted as follows:

    Hex values: **<40><64><7A>**

    Characters: **@dz**

- You will see **@dz** on the screen, if the output message is routed to a terminal.
- For output *to* a GOES radio, the most significant bit of each byte will be replaced by a parity bit. When you download the data from NOAA/NESDIS, the format is 7 data bits, 1 parity bit. Therefore, the parity bit will be transparent; and you will therefore still see @dz.

6.8.   ARGOS SATELLITE COMMUNICATION

The ZENO®-3200 data logger can transmit data through the ARGOS satellite system operated by the Centre National d'Etudes Spatiales (CNES) ARGOS System on board two polar-orbiting, sun-synchronous satellites operated by the National Oceanographic and Atmospheric Administration (NOAA).

---

[131] Refer to Section 10.6.

Coastal Environmental Systems uses the Telonics ST-13 ARGOS Platform Transmitter Terminal (PTT) for transmitting data to the ARGOS System. Regular transmissions can be formatted and transmitted, in either clear-text (ASCII) or binary format.

> **Individual messages are limited to a maximum of 32 bytes.**

6.8.1. Applying To Use ARGOS

Before you can use an ARGOS radio, you must first apply to use the ARGOS System to obtain critical ID numbers. The application form is available on the Internet from http://www.argosinc.com. The completed application can be mailed either electronically or standard to the following addresses:

In North America:

Service Argos, Inc.
1801 McCormic Drive, Suite 10
Largo, MD 20774
Telephone: (301) 925-4411
Fax: (301) 925-8995
E-mail: useroffice@argosinc.com

Rest of World:

CLS
8/10 rue Hermès
31526 Ramonville Cedex
France
Telephone: (33) (0) 5-61-39-47-00
Fax: (33) (0) 5-61-75-10-14
E-mail: info@cls.cnes.fr

6.8.2. ARGOS Coverage

Each ARGOS satellite is in a circular, polar-orbiting, sun-synchronous orbit at an altitude of 850 kilometers.

Each ARGOS satellite crosses the equatorial plane at a fixed time each day. Hence, from the user's viewpoint, a given ARGOS platform comes within a satellite's coverage at the same time each day.

Each polar-orbiting satellite covers a circular swath on the ground with a diameter of 5000 kilometers. It takes the satellite 1 hour 40 minutes to go between North and South Poles; hence, the swath is displaced by 25 degrees (2800 kilometers at the equator) each time the satellite passes a pole. Data collection performance is a function of latitude.

6.8.3. Data Recovery

Data collected by the ARGOS System is processed at the two Global Processing Centers (GPC): 1) CNES Toulouse Space Center, France and 2) Service Argos, Inc. in Largo, MD, USA

Regional Processing Centers (RPC) are located worldwide in the United States, Japan and Australia for local data recovery.

6.8.4. Connecting The Telonics ST-13 ARGOS PTT With The ZENO®-3200

Coastal Environmental Systems uses the Telonics ST-13 ARGOS transmitter, normally with the TTL standard interface.

The ST-13 port labeled ARGOS RADIO is connected to the ZENO®-3200 DE-25 port labeled AUX SERIAL DATA, using the specialized interface provided by Coastal Environmental Systems. This interface includes the power supplied to the ARGOS transmitter.

ST-13		ZENO®-3200
(ARGOS RADIO)		(AUX SERIAL DATA)

Figure 6-10. Telonics ST-13 to ZENO®-3200 block diagram.

The ZENO®-3200 provides 12 VDC unregulated power to the ST-13 over this cable. The interface box also includes a lithium battery to provide backup power to the ST-13, in case the ZENO®-3200 should lose power for any reason.

6.8.5. ZENO®-3200 Configuration

The ZENO®-3200 supports ARGOS radio communications on COM2. The first step in configuring a ZENO to transmit using the ARGOS transmitter is to set COM2 accordingly. From the User Menu, enter **C** to reach the **COMMUNICATIONS** menu. Set the COM2 port type to ARGOS, and the COM2 baud rate to 1200 or 9600 (to match the ST-13 baud rate).

> **You can attach both an ARGOS radio and serial sensors to COM2.**
>
> **Set the Communications Menu line items to match the ARGOS.**

```
    COMMUNICATIONS MENU
    (Cn/m) Change Item n To Value m    (Tn) Terminal Mode On COM Port n
    (M)    Modem Menu                  (E)  Save Parameters To EEPROM
    (P)    Power Control Menu          (U)  User Menu
    (G)    GOES Menu                   (Q)  Quit
    (D)    Digital Control Menu        (H)  Help

    Item  1:  9600        (COM1 Baud Rate)
    Item  2:  1200        (COM2 Baud Rate)
    Item  3:  9600        (COM3 Baud Rate)
    Item  4:  RS232       (COM1 Port Type)
    Item  5:  ARGOS       (COM2 Port Type)
    Item  6:  RS232       (COM3 Port Type)

    >
```

Next, enter **A** from the Communications Menu to enter the ARGOS Menu.

```
    ARGOS MENU
    (Cn/m) Change Item n To Value m           (Q) Quit
    (E)    Save Parameters To EEPROM          (H) Help
    (U)    User Menu

    Item  1:  42          (Tranmission Repeat Interval, seconds)
    Item  2:  1           (Transmision Repeat Count)
    Item  3:  10          (Radio Push-To-Talk Delay Time, milliseconds)
    Item  4:  0           (Radio Push-To-Talk Digital Port)
    Item  5:  0           (Use Hour/Min Time Stamp in Message)
    Item  6:  0           (Use Checksum in Final Message Byte)

    >
```

- Specify the Transmission Repeat Interval, line item 1. This is a decimal value between 42 and 297 seconds.

- Specify the Transmission Repeat Count, line item 2. The maximum number of times that the ST-13 can repeat a message is 255.

- Specify the Radio Push-To-Talk Delay Time in milliseconds, line item 3. The range of this value is 10 to 5000 milliseconds.

- Specify the Radio Push-To-Talk Digital Port, line item 4. Set this value to 0 to use the ZENO®-3200's built-in PTT line; otherwise, a value of 18 to 23 can be used to specify a digital output line.

- Specify whether to use Hour/Min Time Stamp in Message, line item 5. By setting this value to 1, ZENOSOFT® will set the first two bytes of the ARGOS message to the current hour and minute. Setting this value to 0 will allow the first two bytes to be used for user-specified data.

- Specify whether to Use Checksum in Final Message Byte, line item 6. By setting this value to 1, ZENOSOFT® will calculate a modulus-256 checksum of the first 31 bytes of the ARGOS message and set the 32nd byte to the checksum. If the user doesn't want a checksum, set the value to 0.

The ARGOS transmissions are timed on the transmitter's clock.

With the above communications settings, any *regular* ZENO®-3200 Data Output messages routed to COM2 will be sent to the ARGOS radio. The ARGOS radio will be buffered up, and transmit over the self-timed transmit channel when the next self-timed transmission interval occurs.

> **ARGOS MESSAGES ARE LIMITED TO 32 BYTES.**

6.8.6. ARGOS Binary Format

The ARGOS binary format packs data into an efficient format, suitable for transmission over an ARGOS satellite. To define a message in ARGOS Binary Format, each field of that message must be a field of type ARGOS Binary Format (rather than Log Only, Time Stamp, etc.) Use the Data Output Menu to define each field in your message, and to choose the ARGOS Binary Format type.[132] Fields of this type are transmitted, but not logged.

The ARGOS Binary Format converts each data value into an integer, encodes it as a 1-, 2-, 3- or 4-byte binary value.

The following line items in the Data Output Menu are interpreted in a non-standard way for the ARGOS Binary Format.

- *Field decimal places*: The data value to be treated is multiplied by the appropriate number of factors of 10 to bring the data value to an integer, while still retaining the requested accuracy. for example, suppose you wish to output a measured temperature to 2 decimal places (e.g., 23.62 degrees). Line item 5 should take the value 2. The value will be converted to 2362 before transmission.
- *Field width*: Suppose that the field width is 3. The data value (2362) will be converted to a 3x8=24-bit value, with the most significant bit being a sign bit. The binary version of this data value becomes:

<div align="center">

00000000 00001001 00111010

</div>

The three 6-bit data fields would be transmitted as follows:

- Unless the data sent to ARGOS is ASCII, it will not be viewable on a standard terminal. In hexadecimal binary, the three values will appear as follows:
<div align="center"><00><09><3A></div>

6.9.   PASSTHROUGH MODES

> **Passthrough mode allows you to talk directly through one COM port on the ZENO®-3200 to a device connected to a different COM port on the ZENO®-3200.**

Examples of using passthrough mode are having direct communication with a serial sensor connected to the ZENO®-3200, or testing communications over a two-way radio.

There are two types of passthrough mode available:

---

[132] Refer to Section 10.6.

- Terminal Passthrough Mode: direct communication between two ZENO®-3200 COM ports.
- SDI-12 Passthrough Mode: direct communication between two ZENO®-3200 COM ports where the remote device is a SDI-12 sensor, which requires special timing and message formatting for communications.

> **When you enter Passthrough Mode, ZENOSOFT® will continue to perform normal data collection EXCEPT from any serial sensor(s) connected to the COM port that you have specified for your Passthrough Mode Session.**

6.9.1. Terminal Passthrough Mode

Terminal Passthrough Mode is accessed via the Communications Menu. There are two options for entering Terminal Passthrough Mode:

Passthrough Mode Option	Command To Enter in Communications Menu
Enter Terminal Passthrough Mode directly to a specific COM port.	Type **Tn{ENTER}**. Valid values for **n** are: - **1** for COM1 - **2** for COM2 - **3** for COM3 - **T** for TTL port on COM2 - **C** for COMPASS port on COM2
Enter Terminal Passthrough Mode to a specific serial sensor. ZENOSOFT® will turn on any specified excitation voltage or switched power to the serial sensor so that communications with the device are possible.	Type **TSn{ENTER}**, where **n** is the Sensor Record Number of the desired serial sensor.

If you use the first option to enter Terminal Passthrough Mode, ZENOSOFT® will ask several questions to setup the necessary communication parameters for communicating on the specified COM port, such as the port type, baud rate, and parity, as illustrated in the next example.

```
COMMUNICATIONS MENU
(Cn/m) Change Item n To Value m          (R)  Repeater Menu
(M)    Modem Menu                        (Tn) Terminal Mode On COM Port n
(P)    Power Control Menu                (E)  Save Parameters To EEPROM
(G)    GOES Menu                         (U)  User Menu
(A)    ARGOS Menu                        (Q)  Quit
(D)    Digital Control Menu              (H)  Help

Item  1:  4800        (COM1 Baud Rate)
Item  2:  9600        (COM2 Baud Rate)
Item  3:  9600        (COM3 Baud Rate)
Item  4:  RS232       (COM1 Port Type)
Item  5:  RS485       (COM2 Port Type)
Item  6:  RS232       (COM3 Port Type)

> T2

Enter Port Type (RS232H, RS232, RS485, GOES, ARGOS OR CGOES):  RS232

Enter Device Baud Rate:  4800

Enter Device Parity (N,E,O):  N

Enter Device Number of Data Bits (7 or 8):  8

Waiting for COM port 2.  Press any key to exit...\

*** Entering Terminal Mode on COM Port 2 ***

Press <ESC> on this terminal to exit.

NOTE: Data collection has been halted.
```

When in Terminal Passthrough Mode, any characters typed will be passed through to the device connected on the other communications port, except for the Passthrough Mode Escape Character.

> **When the Passthrough Mode Escape Character is entered either by you or by the device on the other COM port, ZENOSOFT® will end the Terminal Passthrough Mode session and normal data collection will resume.**

The default Passthrough Mode Escape Character is the ESCAPE (<ESC>) button[133] on your keyboard, but it can be configured to be a different character.[134] This may be necessary if the device being communicated with via Terminal Passthrough Mode uses the Passthrough Mode Escape Character as part of its normal messaging.

> **The ZENO®-3200 will always indicate what the Passthrough Mode Escape Character is when the Terminal Passthrough Mode session begins.**

---

[133] Some specialized versions of ZENOSOFT® use <CTRL-Z> as the default Passthrough Mode Escape Character.
[134] Refer to Section 6.9.3.

6.9.2. SDI-12 Passthrough Mode

The SDI-12 Passthrough Mode lets you interact directly with SDI-12 sensors connected to the ZENO®-3200.

> **Terminal Passthrough Mode cannot be used to communicate with SDI-12 sensors because of unusual timing requirements and special characters used in the SDI-12 protocol. SDI-12 Passthrough Mode manages the timing requirements and special characters so that you can send specific SDI-12 commands to one or more SDI-12 sensors connected to the ZENO®-3200.**

Since SDI-12 Sensors are connected via RS 485, only COM2 and COM3 support them on the ZENO®-3200. Typically, COM3 is the User Interface COM Port and the SDI-12 Sensors are connected to the RS485 interface of COM2.

Entering SDI-12 Passthrough Mode is done via the Test Menu in the User Interface. To enter the Test Menu, type **T{ENTER}** from the User Menu, then type **P{ENTER}** to go into SDI-12 Passthrough mode.

```
USER MENU
(C) Communications Menu              (T) Test Menu
(F) System Functions Menu            (Z) Zeno Program Menu
(S) Sample Period Menu               (Q) Quit
(D) Data Retrieval Menu              (H) Help


> T


TEST MENU
(Rx,y) Display Sensors x-y RAW Data          (Ex) Display Sensor x Error Codes
(Sx,y) Display Sensors x-y SCALED Data        (P)  SDI-12 Pass-Through Mode
(Cx)   Calibrate Sensor Record x              (U)  User Menu
(Vx)   View Process Record x                  (Q)  Quit
(D)    View Data Collection Counters          (H)  Help
(B)    Display BIT Status


> P
Enter the SDI-12 COM port (COM2 or COM3):
```

> **Like Terminal Passthrough Mode, the ZENO®-3200 continues with normal data collection, EXCEPT for any serial sensors connected to COM2 (or any Data Output messages going out on COM2).**

When you enter SDI-12 Passthrough Mode, ZENOSOFT® will ask you which COM port to use. The only choices are COM2 or COM3. No other questions are asked since SDI-12 communication parameters are already defined.

Since SDI-12 sensors cannot accept data at a human's typing rate, as it would be too slow, the ZENO®-3200 buffers data and then sends the commands to the SDI-12 sensor. The ZENO®-3200 then returns the SDI-12 response to the User Interface COM Port, whereupon it is typically displayed to the screen. Any white space and non-printable characters will be represented by their hexadecimal ASCII codes inside angle brackets (refer to Appendix A for a complete list of ASCII codes). When you enter the command to send to the SDI-12 sensor, you may omit the final exclamation mark.

The following example shows how you can use the SDI-12 Passthrough Mode to communicate with a sensor which measures temperature in response to an **aM2!** command. The sensor has an address of zero (0).

```
TEST MENU
(Rx,y) Display Sensors x-y RAW Data          (Ex) Display Sensor x Error Codes
(Sx,y) Display Sensors x-y SCALED Data        (P)  SDI-12 Pass-Through Mode
(Cx)   Calibrate Sensor Record x              (U)  User Menu
(Vx)   View Process Record x                  (Q)  Quit
(D)    View Data Collection Counters          (H)  Help
(B)    Display BIT Status


> P
Enter the SDI-12 COM port (COM2 or COM3):  COM2

Waiting for SDI-12 COM port.  Press any key to exit...

Entering SDI-12 Passthrough mode.  Press <ESC> to exit.
When entering a SDI-12 command you need not append an exclamation mark (!).

Enter a SDI-12 command or an <ESC> to exit
> M2!

SDI-12 Command:  "0M2!"
SDI-12 Response:  "00021<0D><0A>"
Enter SDI-12 command (omit the address, <ESC> to exit):  0D0

SDI-12 Command:  "0D0!"
SDI-12 Response:  "0+25.781<0D><0A>"
Enter SDI-12 command (omit the address, <ESC> to exit):
Note:  Exiting SDI-12 passthrough mode.
```

To end the SDI-12 Passthrough Mode session, type the specified Passthrough Mode Escape Character. The default Passthrough Mode Escape Character is the ESCAPE (<ESC>) button[135] on your keyboard, but it can be configured to be something else.[136]

6.9.3. Configuring the Passthrough Mode Escape Character

The Passthrough Mode Escape Character can be configured by changing the value of Line Item #9 in the System Fucntions Menu, as shown below.

---

[135] Some specialized versions of ZENOSOFT® use <Ctrl-Z> as the default Passthrough Mode Escape Character.
[136] Refer to Section 6.9.3.

```
SYSTEM FUNCTIONS MENU
(Cn/m) Change Item n To Value m                 (I) Contact Information
(S)     System Date And Time                    (E) Save Parameters To EEPROM
(T)     Calibrate Internal Temperature          (U) User Menu
(V)     Program Version                         (Q) Quit
(K)     Constants Menu                          (H) Help
(B)     BIT Names Menu

Item  1:  772         (Primary Unit/Experiment ID)
Item  2:  0           (Secondary Unit/Experiment ID)
Item  3:  2           (Data Dump Format)
Item  4:  2           (Real Time Output Format)
Item  5:  1           (Add Compass To Vane)
Item  6:  0           (Compass Offset)
Item  7:  0           (Barometer Elevation)
Item  8:              (Bad Sensor Value Replace)
Item  9:  <ESC>       (Passthrough Mode Escape Character)

>
```

Nearly any ASCII character[137] can be used as the Passthrough Mode Escape Character. ASCII characters that are not accessible from a standard computer keyboard (by pressing one or a combination of two buttons) cannot be used as a Passthrough Mode Escape Character.   By requesting help on Line Item #9 (by typing the command **H9{ENTER}**), the ZENO®-3200 will display the following list of ASCII characters that can be used as Passthrough Mode Escape Characters:

```
> h9

* Define character to be used to escape from Passthrough Mode. Valid values
  include any ASCII character
        - 0 - 9, A - Z, a - z (case sensitive), any punctuation mark:
            ! " # $ % & ' ( ) * + , - . / : ; < = > ? \ [ ] { } ^ _ | ~
        - the escape character: <ESC>
        - or any non-printable character represented as <CTRL-x>, where 'x'
            is between A and Z
NOTE: Don't use a character that is used within any message.
      <ESC> or <Ctrl-Z> are usually the best choices.

Hit any key to continue . . .
```

Any printable character (a digit, letter or punctuation mark) can be used as the Passthrough Mode Escape Character, as well as most of the non-printable characters.[138] Of all 128 defined ASCII characters, 33 are non-printable control characters. This includes the first 32 characters, as well as the very last character: the DELETE button (sometimes printed as **DEL**). Most non-printable characters are accessible on a standard computer keyboard by pressing the CONTROL button (usually printed as **Ctrl**) in combination with an alphabetic button (A through Z, including the '@' button). The ESCAPE button (usually printed as **ESC**) also generates a non-printable ASCII character.   Hence, since there are 26 letters in the English alphabet, only 29 of the 33 non-printable characters are accessible from a standard keyboard. The ASCII characters whose decimal value range between 28 and 31 are not accessible from a standard computer keyboard.

---

[137] Refer to Appendix A.

[138] A non-printable ASCII character is any character that cannot be seen on a display or printer. These include white spaces, carriage returns, line feeds, and an assortment of control characters. Refer to Appendix A.

> **The four ASCII characters whose decimal value range between 28 and 31, as well as the NULL (ASCII decimal value 0, Ctrl-@) and DELETE (ASCII value of 127) characters, are excluded from being used as the Passthrough Mode Escape Character.**

> **Coastal Environmental Systems recommends that the two best choices for the Passthrough Mode Escape Character are the ASCII characters ESCAPE or Ctrl-Z (ASCII decimal values of 26 and 27)[139] since these are the _least likely_ to be used by serial sensor communications.**

> **Before you decide to use a printable or other non-printable ASCII character as the Passthrough Mode Escape Character, make sure that the device being communicated with in Passthrough Mode does _NOT_ use the character by reading the device's instruction manual.**

6.10. REPEATER CAPABILITY

Any ZENO®-3200 can be set up as a repeater between a host and up to eight remote ZENO®-3200s. The purpose of a repeater is to repeat CCSAIL messages from a host to remote ZENO®-3200s that communicate over a radio link but do not have direct line-of-sight (LOS) to one another.

The full set of CCSAIL commands available to the ZENO®-3200 is NOT available through a repeater. CCSAIL commands requiring an x-modem data transfer, or an unknown amount of data to be returned (the CCSAIL "DB" command), or direct access to the ZENO®-3200 User Interface (CCSAIL "OPEN" command), are NOT available through the repeater. All other CCSAIL commands are available.[140]

To set up a ZENO®-3200 to be a repeater, go to the Repeater Menu that is accessible from the Communications Menu.

The following is a listing of the Repeater Menu from a ZENO®-3200 that is NOT set up as a repeater.

---

[139] Refer to Appendix A.
[140] Refer to Appendix F.

```
    REPEATER MENU
    (Cn/m) Change Item n To Value m          (U) User Menu
    (R)    Reset All Repeater Values         (Q) Quit
    (E)    Save Parameters To EEPROM         (H) Help


    Item  1:  Repeater Tranmit Delay            0 msec
    Item  2:  Network Source Address           -1
    Item  3:  Alternative Source Address       -1
    Item  4:  Remote ZENO Address #1           -1
    Item  5:  Remote ZENO Address #2           -1
    Item  6:  Remote ZENO Address #3           -1
    Item  7:  Remote ZENO Address #4           -1
    Item  8:  Remote ZENO Address #5           -1
    Item  9:  Remote ZENO Address #6           -1
    Item 10:  Remote ZENO Address #7           -1
    Item 11:  Remote ZENO Address #8           -1
```

The Network Source Address (Item 2) is the CCSAIL address of the host. When this value is set to a valid CCSAIL address[141], the ZENO®-3200 repeater will ONLY respond to CCSAIL messages that meet the following requirements:

- The Destination Address[142] must be the same as the Primary Unit ID[143] or 9999.
- The Source Address[144] must the same as the Network Source Address or 9999.

If a CCSAIL message is received with a matching Primary Unit ID or 9999 as the destination address but the source address does not match the Network Source Address or 9999, the ZENO®-3200 will NOT respond to the message.

If the user requires the ZENO®-3200 to respond to another CCSAIL address other than those originating from Network Source Address or 9999, the Alternate Source Address (Item 3) is available. Once set, the ZENO®-3200 will also respond to any CCSAIL message with a Destination Address that matches the Primary Unit ID, or 9999, AND a source address that matches the Network Source Address, an Alternate Source Address, or 9999.

> **The ZENO®-3200's Primary Unit ID, Network Source Address, Alternative Source Address, and each remote address must all be unique—no address can be used more than once.**

To begin setting up the repeater, the Network Source Address (Item 2) and at least one Remote ZENO®-3200 Address (Items 4 through 11) must be set to something other than –1. Further, in each remote ZENO®-3200, the Network Source Address should be set to the Primary Unit ID of the repeater ZENO®-3200. This will prevent the remote from responding to a host's CCSAIL command directly, in the event that an occasional LOS is achieved between the host and the remote.

When a ZENO®-3200 has been set up as a repeater, the ZENO®-3200 will perform the following procedure:

---

[141] A valid CCSAIL address is any decimal number between 0 and 9998.
[142] Refer to Section 4.6.
[143] Refer to Section 5.5
[144] Refer to Section 4.6.

1. The ZENO®-3200 receives a CCSAIL message.

2. The ZENO®-3200 checks whether the Source Address of the received message is the same as the Network Source Address and if the Destination Address is one of the specified remote ZENO®-3200 addresses. If the check fails, it proceeds to step #5; otherwise, it proceeds to step #3.

3. The ZENO®-3200 checks the received CCSAIL message to see if it contains a repeatable command. If so, it proceeds to step #4; otherwise, it does nothing further.

4. The ZENO®-3200 changes the Source Address of the received message to its Primary Unit ID. The ZENO®-3200 then calculates a new CCSAIL message checksum and transmits the modified CCSAIL message on the same COM port that the original message was received. The procedure ends.

5. The ZENO®-3200 checks whether the Source Address of the received message is one of the specified remote ZENO®-3200 addresses and if the Destination Address is the same as its Primary Unit ID. If the check fails, the procedure ends; otherwise, it proceeds to step #6.

6. The ZENO®-3200 checks whether the received CCSAIL message contains data. If so, it proceeds to step #7; otherwise, it does nothing further.

7. The ZENO®-3200 changes the Destination Address of the received message to the Network Source Address. The ZENO®-3200 then calculates a new CCSAIL message checksum and transmits the modified CCSAIL message on the same COM port that the original message was received. The procedure ends.

If the host needs to send a command intended for the repeater itself, it simply sets the destination address of its message to the Primary Unit ID of the repeater.

> **A ZENO®-3200 that is set up to be a repeater can continue its primary function of data collection with any suite of supported sensors.**

As an example, a host with a CCSAIL address of 1 wants to communicate with 4 remote ZENO®-3200s whose addresses are 1010, 1020, 1030 and 1040. There is no direct LOS between the host and the remotes, but another ZENO®-3200 with address 500 has LOS with the host and all the remotes. The ZENO®-3200 with address 500 will be set up as a repeater by setting the Network Source Address to 1 and setting the first four remote addresses as 1010, 1020, 1030 and 1040. A secondary host must also talk to the remotes and to the repeater. If its address is 10, then the Alternate Source Address in the repeater ZENO®-3200 is also set to 10.

```
REPEATER MENU
(Cn/m) Change Item n To Value m          (U) User Menu
(R)    Reset All Repeater Values         (Q) Quit
(E)    Save Parameters To EEPROM         (H) Help


Item  1:  Repeater Tranmit Delay              0 msec
Item  2:  Network Source Address              1
Item  3:  Alternative Source Address         10
Item  4:  Remote ZENO Address #1           1010
Item  5:  Remote ZENO Address #2           1020
Item  6:  Remote ZENO Address #3           1030
Item  7:  Remote ZENO Address #4           1040
Item  8:  Remote ZENO Address #5             -1
Item  9:  Remote ZENO Address #6             -1
Item 10:  Remote ZENO Address #7             -1
Item 11:  Remote ZENO Address #8             -1
```

To prevent the possibility that a remote ZENO®-3200 could respond directly to a host's command, each Network Source Address in each remote ZENO®-3200 will be set to 500—the address of the repeater ZENO®-3200.

The host sends the CCSAIL message "#10200001DN34<ETX>" to the repeater whose Primary Unit ID is 500. The repeater receives the message over COM1 and recognizes that the message is from the designated Network Source Address and is intended for a remote ZENO®-3200. The repeater changes the message to "#10200500DN38<ETX>" and transmits the message back out of COM1. The repeater then receives the following response through COM1 from the remote ZENO®-3200: "#05001020<CR><LF>212,64<ETX>," and recognizes that the message is intended for the host. The repeater changes the received message to "#00011020<CR><LF>212,60<ETX>" and transmits it over COM1.

If the radio that the ZENO®-3200 is using requires a delay, the Repeater Transmit Delay value (Line Item #1 in the Repeater Menu) can be used to

- Delay the transmission of the repeated command to the remote ZENO®-3200
- And delay the response to the host from the remote communication with sensors directly.

6.11.   SPEECH INTERFACE CAPABILITY

Coastal Environmental Systems' ZENO®-3200 data logger, equipped with a speech interface board and low power (IDC) modem, can provide spoken messages over a telephone connection. The spoken message is easily configured, using normal English text and data so that the caller is provided with current conditions without the need for any special equipment other than a standard touch-tone telephone.

When calling a Speech Interface-equipped ZENO®-3200, you can

- Obtain a custom, spoken report of current output data
- Receive data or access the user interface via the data modem
- Remotely disable or enable the speech capability

This section describes how to set up the ZENO®-3200 and the speech and modem interface for robust communications. This interface can also be used with a cellular modem; however, because of the noisy and intermittent nature of cellular communications, some performance degradation of speech quality will result, as well as limiting data rates on the data modem.[145] If you have purchased the ZENO®-3200 and the speech interface as a part of a complete system, then everything is probably already configured for your particular application. At most, you are likely only to create messages, or modify existing messages.

More details of the modem setup are given in Section 6.4 covering modem communications. This section concentrates on speech.

6.11.1. Overview

The ZENO®-3200 Speech Interface allows for a single spoken message to be delivered via a standard telephone connection. You can only program one message.

> **Ordinary text such as "the air temperature is…" will be converted to speech using American English pronunciation rules.[146]**

A caller will be prompted to press a touch-tone key. If a tone is detected within about 5 seconds of the prompt, the caller will hear a spoken message. If no tone is detected within this time, the ZENO®-3200 will begin handshaking to set up a modem (data) connection. So, a single phone line and a single serial port on the ZENO®-3200 can be used for both voice and data communications (e.g., to download logged data, or to reconfigure the ZENO®-3200).

The spoken message will normally contain a combination of fixed strings (such as "the air temperature is…") and data fields (such as "seventy-two").

The following sections describe how to set up such a message.

6.11.2. Creating A Spoken Output Message

Creating a spoken output message within the ZENO®-3200 is very similar to creating any other output message. Coastal Environmental Systems recommends that you read Section 10.6 before attempting to configure a spoken message. This section only describes those aspects of the configuration that are specific to the speech interface.

To designate which communications port is to be used for the spoken message, enter the Output Message Timing Menu. The Output Message Timing Menu is accessible from the Zeno Program Menu by typing the command `O{ENTER}`.[147]

---

[145] Contact Coastal Environmental Systems if you wish to use a cellular modem with the speech interface.

[146] On occasion, it is necessary to change the spelling to accomplish a more understandable pronunciation, but this is rare.

[147] Refer to Section 10.7.

```
OUTPUT MESSAGE TIMING MENU
(Cn/m) Change Item n To Value m          (H) Help
(Z)    Zeno Program Menu

Item  1:  COM3        (Data Output Message #1 COM Port)
Item  2:  COM2        (Data Output Message #2 COM Port)
Item  3:  COM3        (Data Output Message #3 COM Port)
Item  4:  COM3        (Data Output Message #4 COM Port)
Item  5:  0.0         (Data Output Message #1 Period)
Item  6:  0.0         (Data Output Message #2 Period)
Item  7:  0.0         (Data Output Message #3 Period)
Item  8:  0.0         (Data Output Message #4 Period)
Item  9:  0           (Record Counter Starting Value)
Item 10:  0           (Record Counter Reset Value)

>
```

The output message that is actually spoken by the ZENO®-3200 is the output message assigned to the COM port connected to the modem/speech interface. for example, if the modem/speech interface port is COM2 and Data Output Message #2 is to be spoken, then type the command **C2/COM2{ENTER}** in the Output Message Timing Menu. The Data Output Message Period[148] should be set to 0 so that the message is not transmitted automatically by the ZENO®-3200.

To create a spoken output message, add Data Output Records from the Data Output Menu and designate them to apply to the same Data Output Message number that you specified in the Output Message Timing Menu for the speech interface. The Data Output Menu is accessible from the Zeno Program Menu by typing the command **D{ENTER}**.[149]

To specify the text to be spoken in addition to the actual data, configure one or more Data Output Records to be Literal String Fields.[150] It is likely that many Data Output Records will be configured as Literal String Fields because each one is limited to holding up to ten characters in Line Item #3, the Field Name. Continuing with the previous example, set the Literal String Field to be transmitted as part of Data Output Message #2 so that it will be part of the spoken message:

---

[148] The Data Output Message Period defines how often that particular output message is to be automatically transmitted by the ZENO®-3200. Refer to Section 10.7.
[149] Refer to Section 10.6.
[150] A Literal String Field is created in a Data Output Record by setting Line Item #1 to a field code of 6. Refer to Section 10.6.5.

```
    DATA OUTPUT MENU
    (Cn/m) Change Item n To Value m            (Jn) Jump To Record n
    (A)    Insert After This Record           (N)  Go To Next Record
    (B)    Insert Before This Record          (P)  Go To Previous Record
    (X)    Cut Record to Clipboard            (XA) Delete ALL Records
    (C)    Copy Record To Clipboard           (Z)  Zeno Program Menu
    (V)    Paste Record From Clipboard        (H)  Help
    (Sn/m) Search Item n for Value m

    Data Items for Record 1 of 10:
    Item  1: Field Type Code                6 : Literal String Field
    Item  2: Output Message(s)              2
    Item  3: Field Name                     wind<20>speed

    >
```

Coastal Environmental Systems recommends using space delimiting between each Data Output Record for the spoken output message. This is explained in Section 4.4.

Space characters and other non-printable characters are represented by their hex ASCII character values enclosed within the **<>** brackets.[151] In order to create long words and sentences, you will have to string many data output records together.

The following small configuration will demonstrate how to create a useful spoken message. When the caller responds to a spoken prompt to "press a number," a message indicating the current temperature is given, i.e. "the current temperature is twenty-five point four degrees Celsius."

---

[151] **<20>** and other non-printable characters count as one character each. Refer to Section 10.6.5.

```
DATA OUTPUT MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record             (N)  Go To Next Record
(B)    Insert Before This Record            (P)  Go To Previous
Record
(X)    Cut Record to Clipboard             (XA) Delete ALL Records
(C)    Copy Record To Clipboard            (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard         (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 1 of 6:
Item  1: Field Type Code              6 : Literal String Field
Item  2: Output Message(s)            2
Item  3: Field Name                   the<20>curren

Data Items for Record 2 of 6:
Item  1: Field Type Code              6 : Literal String Field
Item  2: Output Message(s)            2
Item  3: Field Name                   t<20>temperat

Data Items for Record 3 of 6:
Item  1: Field Type Code              6 : Literal String Field
Item  2: Output Message(s)            2
Item  3: Field Name                   ure<20>is<20>

Data Items for Record 4 of 6:
Item  1: Field Type Code              7 : Transmit Only Field
Item  2: Output Message(s)            2
Item  3: Field Name
Item  4: Input Record and Element     S3  : AirTemp
Item  5: Field Decimal Places         1
Item  6: Field Width                  5

Data Items for Record 5 of 6:
Item  1: Field Type Code              6 : Literal String Field
Item  2: Output Message(s)            2
Item  3: Field Name                   degrees<20>

Data Items for Record 6 of 6:
Item  1: Field Type Code              6 : Literal String Field
Item  2: Output Message(s)            2
Item  3: Field Name                   celsius.
```

6.11.3. Defining The Speech/Modem Ports and Control Lines

There are a number of control lines, which must be specified for the modem/speech interface board. These settings and the COM port connected to the modem/speech interface are accessed in the Modem Menu and the Speech Menu, a submenu of the Modem Menu. From the User Menu, type **C{ENTER}** to access the Communications Menu, followed by **M{ENTER}** for the Modem Menu. You should see the Modem Menu on your screen, similar to the following:

```
   MODEM MENU
   (Cn/m) Change Item n To Value m          (Q) Quit
   (E)    Save Parameters To EEPROM         (S) Speech Menu
   (U)    User Menu                         (H) Help

   Item  1:  1                              (System Modem Type)
   Item  2:  COM3                           (Modem COM Port)
   Item  3:  5                              (Modem Retry Period)
   Item  4:  30                             (Modem Hangup Delay)
   Item  5:  NONE                           (Modem Telephone Number 1)
   Item  6:  NONE                           (Modem Telephone Number 2)
   Item  7:  NONE                           (Modem Telephone Number 3)
   Item  8:  NONE                           (Modem Telephone Number 4)
   Item  9:                                 (Modem Initialization
   String)
   Item 10:  5                              (Modem Switched Voltage)
   Item 11:  18                             (Modem Ring Detect Channel)
```

The modem configuration should be identical to that for a standard IDC modem.[152]

> **A power-controlled IDC modem is required for use with the speech interface board.**

A Modem Switched Voltage (Line Item #10 in the Modem Menu) and a Modem Ring Detect Channel (Line Item #11 in the Modem Menu) must be specified when using the speech interface.[153]

Once you have configured the telephone (or cellular) modem communications link, set up the speech interface channels in the Speech Menu. Type the command **S{ENTER}** from the Modem Menu to access the Speech Menu.

```
   SPEECH MENU
   (Cn/m) Change Item n To Value m          (Q) Quit
   (E)    Save Parameters To EEPROM         (H) Help
   (U)    User Menu

   Item  1:  YES          (Speech Interface Installed)
   Item  2:  21           (Speech Activity Channel)
   Item  3:  20           (Speech Tone Detect Channel)
   Item  4:  4            (Speech Switched Voltage)
```

Line Item #1 designates whether or not a speech interface is connected to the ZENO®-3200. Valid values are YES and NO. The speech interface can be disabled at any time by setting Line Item #1 to NO.[154]

---

[152] Refer to Section 6.4.

[153] The ZENO®-3200 must be allowed to control when the modem is powered and when the modem answers an incoming call. This is because the telephone modem and the speech interface board cannot be powered up simultaneously since only one can have control over the telephone line at one time. Hence, only the power-controlled IDC modem can be used with the speech interface board. Refer to Section 6.4 for information on how to configure the Modem Switched Voltage and Modem Ring Detect Channel.

[154] This disables the spoken prompt to press a key at the beginning of a call to the ZENO®-3200 but does not disable the telephone modem from attempting to answer an incoming call.

> **If the speech interface is disabled and modem settings are unchanged, the modem should work normally, as if the speech interface were not installed.**

Line Item #2, the Speech Activity Channel, is an output from the speech interface board to the ZENO®-3200. It allows the ZENO®-3200 to detect when speech is being generated and when it has finished. Valid values for Line Item #2 range from 18 through 23.

Line Item #3, the Tone Detect Channel, is used to detect whether the caller is pressing a touch-tone key on the telephone. Valid values range from 12 through 23.[155]

> **The Modem Ring Detect Channel[156], the Speech Activity Channel and the Tone Detect Channel CANNOT specify the same channels.**

Line Item #4, the Speech Switched Voltage, specifies which switched voltage is used to power the speech interface board. The normal speech interface board is powered with 12 VDC. Contact Coastal Environmental Systems if you require the speech interface board to be powered by 5 VDC. Valid values for this line item are as follows:

- 0 (no switched voltage)
- 1 (5 VDC Switched A)[157]
- 2 (5 VDC Switched B)[158]
- 3 (12 VDC Switched A)
- 4 (12 VDC Switched B)
- 5 (12 VDC Switched C)
- 18 - 23 (a digital output)[159]

6.11.4. Wiring Diagram

The speech/modem interface product contains three boards: the IDC modem, the speech engine board, and the speech interface board. All connections to the ZENO®-3200 are through connectors on the speech interface board, with a wiring harness provided by Coastal Environmental Systems. The following diagram illustrates the wiring to the complete speech/modem interface product.

---

[155] ZENOSOFT® versions prior to V2.00 only support digital input channels 18-23 for the Tone Detect Channel.
[156] The Modem Ring Detect Channel is Line Item #11 in the Modem Menu.
[157] Requires a modified speech interface board. Contact Coastal Environmental Systems for this modification.
[158] Requires a modified speech interface board. Contact Coastal Environmental Systems for this modification.
[159] As with the Modem Switched Voltage (refer to Section 6.4), the Speech Switched Voltage could also be configured to control one of the digital control channels (digital I/O channels 18 through 23). However, an external switching device would be required to meet the voltage and current requirements of the speech interface.
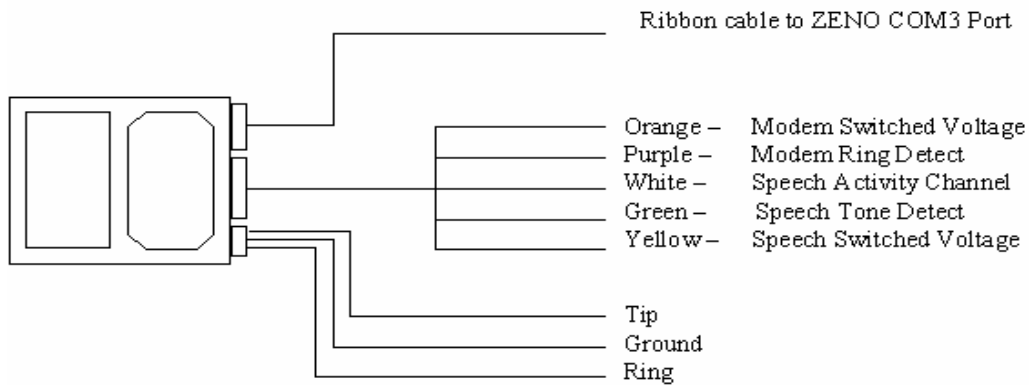
Figure 6-11. Speech interface wiring diagram.

6.12. OPTIONAL ACCESS CONTROL CUSTOMIZATION TO THE USER INTERFACE

The Communications Menu contains two extra Line Items that are optionally accessible to the user. These extra Line Items are displayed below:

```
COMMUNICATIONS MENU
(Cn/m) Change Item n To Value m          (R)  Repeater Menu
(M)    Modem Menu                        (Tn) Terminal Mode On COM Port n
(P)    Power Control Menu                (E)  Save Parameters To EEPROM
(G)    GOES Menu                         (U)  User Menu
(A)    ARGOS Menu                        (Q)  Quit
(D)    Digital Control Menu              (H)  Help

Item  1:  2400       (COM1 Baud Rate)
Item  2:  2400       (COM2 Baud Rate)
Item  3:  9600       (COM3 Baud Rate)
Item  4:  RS232      (COM1 Port Type)
Item  5:  RS232      (COM2 Port Type)
Item  6:  RS232      (COM3 Port Type)
Item  7:  COM1,COM2  (COM Ports to Exclude from User Interface)
Item  8:  NO         (Enable Exclusive CCSAIL Access)

>
```

Line Item #7 provides a means to exclude specific communications ports from having access to the User Interface.

> **The default ZENO®-3200 configuration excludes COM1 and COM2 from the User Interface.**

If you need to have full bi-directional access to the User Interface via COM1 or COM2, access to Line Item #7 is required to change the exclusion settings.

> **Contact Coastal Environmental Systems if you require access to Line Items #7 or #8 in the Communications Menu.**

The options for excluding communications ports from the User Interface in Line Item #7 of the Communications Menu are as follows:

- NONE
- COM1
- COM2
- COM3
- COM1,COM2
- COM2,COM3
- COM1,COM3

Line Item #8 provides a means to exclude access to the User Interface via the standard **U{ENTER}** command, meaning that it will only respond to CCSAIL commands. The possible values for Line Item #8 are either NO or YES.

An example of using Line Item #8 would be when there are multiple ZENO®-3200s being communicated with on a multi-drop link, such as two-way radios or RS485. In this case, it is very important that each ZENO®-3200 only respond when it is specifically addressed. If the **U{ENTER}** command was sent on a multi-drop line to several ZENO®-3200s, each ZENO®-3200 would respond simultaneously, which is not desirable.

7.   MONITORING & CALIBRATING SENSOR DATA

Coastal Environmental Systems

ZENO®-3200 User Manual

The ZENO®-3200 allows you to do very important things without interfering with data collection:

- Monitor raw and scaled data collected by any Sensor Record.
- Modify the parameters that scale (or calibrate) the raw sensor data into scaled data of any analog or digital Sensor Record.

Both of these functions are available in the Test Menu. From the User Menu, type **T{ENTER}** to enter the Test Menu. Your screen should look something like this:

```
TEST MENU
(Rx,y) Display Sensors x-y RAW Data        (Ex) Display Sensor x Error Codes
(Sx,y) Display Sensors x-y SCALED Data     (P)  SDI-12 Pass-Through Mode
(Cx)   Calibrate Sensor Record x           (U)  User Menu
(Vx)   View Process Record x               (Q)  Quit
(D)    View Data Collection Counters       (H)  Help
(B)    Display BIT Status

>
```

7.1.   MONITORING RAW OR SCALED SENSOR DATA

The two options in the Test Menu allowing monitoring of raw or scaled sensor data are listed below.

Use of either option does not interfere with ZENO®-3200 data collection.

When half-duplex communication is used with either option, five screens worth of data will be shown, then the option will stop.

Rx,y   Display **RAW** sensor data for Sensor Record Numbers **x** through **y**. for example, enter **R1,3** to display the first 3 Sensor Records defined in the Sensor Menu (refer to Section 10.3). Your terminal emulation program will display the raw data from each sensor updated once a second. The values are displayed before any scaling, such as volts for analog sensors. You can also enter **R** to inspect all raw sensor values.

> **For sensors that output more than one data value, only the first value will be shown in response to Rx,y command.**

Sx,y   Display SCALED sensor data for sensor numbers **x** through **y**. Your terminal emulation program will display scaled data from each sensor updated once a second.

> **All measurements made by multi-output sensors will be shown with the Sx,y command.**

7.2.   SCALING (CALIBRATING) RAW SENSOR DATA

Scaling (or calibrating) of the raw sensor data is defined by the three line items 13, 14 and 15 in a Sensor Record.[160] These three line items define three coefficients (A, B, and C respectively) for the following quadratic equation:

$$y = Ax^2 + Bx + C$$

"y" represents the scaled (or calibrated) value and "x" represents the raw sensor value.

Option **Cx** (Calibrate Sensor Record x) in the Test Menu allows you to modify the settings of A, B and C for Sensor Record Number **x**.

As an example, you have 10 Sensor Records defined in your sensor suite, and Sensor Record #3 is a 12-bit ADC Sensor reading wind direction. If you need to recalibrate the conversion of volts to wind direction of Sensor Record #3, you would type **C3{ENTER}** in the Test Menu. You will then be shown the user-defined name for the Sensor Record and be prompted with three questions to set three new values for coefficients A, B and C.

> **If you hit {ENTER} without entering a new coefficient value, the old value will remain unchanged.**

Your screen will look something like this:

---

[160] Refer to Section 10.3.13.

```
TEST MENU
(Rx,y) Display Sensors x-y RAW Data          (Ex) Display Sensor x Error Codes
(Sx,y) Display Sensors x-y SCALED Data        (P)  SDI-12 Pass-Through Mode
(Cx)   Calibrate Sensor Record x              (U)  User Menu
(Vx)   View Process Record x                  (Q)  Quit
(D)     View Data Collection Counters         (H)  Help
(B)     Display BIT Status

> C3
Sensor Name: VANE

Conversion Coefficient A: 0
Enter new Conversion Coefficient A: 0

Conversion Coefficient B: 142
Enter new Conversion Coefficient B: 142

Conversion Coefficient C: 0
Enter new Conversion Coefficient C: 0
```

7.3.   VIEWING PROCESS RECORD DATA

Option **Vx** in the Test Menu allows you to view the current values being outputted by Process Record Number **x**. It operates essentially the same as typing help option **HPx**.[161]

The information that you will see is as follows:

- the type of process (e.g., averaging)
- the definition of each output from the process (e.g., the mean and standard deviation)
- the latest value of each output

> **Values outputted by the Test Menu are updated only while the sensor is actually sampling. Hence, whenever a change is made that causes the ZENO®-3200 data collection to restart, any values outputted by the Test Menu are not updated until the beginning of next Sample Interval.**

7.4.   VIEWING SENSOR ERROR & STATUS CODES

Option **Ex** in the Test Menu allows you to view the current error & status codes for Sensor Record Number **x**.

> **It is unlikely that you will use this option.[162]**

Three values are displayed:

---

[161] Refer to Section 2.4.2.
[162] This is primarily for personnel at Coastal Environmental Systems (CES).

1. Number of times Sensor Record has been called to collect data.

2. Number of times Sensor Record has collected data.

3. Status and error codes displayed as individual bits in a two-byte hexadecimal word. The lower byte contains the error bits and the upper byte contains the status bits.

These are summarized in the following table:

Bit	Description
1	Sensor Record NOT signaled during Sample Interval.
2	Serial sensor communications failure.
3	Sensor Record data collection failure.
4	Sensor Record data collection is intermittently failing.
5	Not currently used.
6	
7	
8	
9	Excitation voltage in use for Sensor Record.
10	Sensor Record on/off status.
11	Sensor Record data collection status.
12	Sensor Record's sample timing loop has expired.
13	Was Sensor Record signaled?
14	Sensor Record is marked.
15	Not currently used.
16	

7.5.   VIEWING SENSOR & PROCESS RECORD DATA COLLECTION COUNTERS

ZENOSOFT® maintains a data collection counter for each Sensor Record, and Process Record, and for each Data Input for each Process Record. The data collection counters are used to match the number of times that a Sensor or Process Record has collected (or processed) data with how many times a reference to that Sensor or Process Record has been used.

> **Discrepancies between the data collection counter of a Sensor or Process Record, with the data collection counter of reference to that Sensor or Process Record, indicate timing problems with your configuration.**

> **The more complicated a configuration, the greater the possibility that it may exhibit timing problems.**

> **Timing problems are corrected by simplifying the configuration (reducing the number of processes where possible) and/or slowing the data collection rates.**

```
┌──────────────────────────────────────────────────────────────────────┐
│        You will need to thoroughly know the links between each Sensor and      │
│              Process Record in order to use this option successfully.          │
└──────────────────────────────────────────────────────────────────────┘
```

Option **D** in the Test Menu allows you to view the current, ongoing Sensor and Process Record data collection counters, including the data collection counter for each Data Input for each Process Record. The data is updated approximately once a second.

You should use the text file capture mechanism in your terminal emulation program so that you can analyze all the information that is generated by this option.

The information that ZENOSOFT® generates will appear as follows:

```
TEST MENU
(Rx,y) Display Sensors x-y RAW Data           (Ex) Display Sensor x Error Codes
(Sx,y) Display Sensors x-y SCALED Data        (P)  SDI-12 Pass-Through Mode
(Cx)   Calibrate Sensor Record x              (U)  User Menu
(Vx)   View Process Record x                  (Q)  Quit
(D)    View Data Collection Counters          (H)  Help
(B)    Display BIT Status

> D

Sensor Data Collection Counters:
(  1) (  2) (  3) (  4) (  5) (  6) (  7) (  8) (  9)
   21     3    11    11    10     1     0     0    11

Process Data Collection Counters:
(  1) (  2) (  3) (  4) (  5) (  6) (  7) (  8) (  9) ( 10) ( 11) ( 12)
   11    10    11    10    10    10     1     0     0     0     0     0
   11    10    11    10    10    10     1     0     0     0     0     0
                           10     0
                                 10
                                  0
( 13) ( 14) ( 15) ( 16) ( 17) ( 18) ( 19) ( 20) ( 21)
    0     0     0     0    11    11     0    11     5
    0     0     0     0     3    11     0     3    20
                          11    11     0    11
                          21     0          21
                           0
                           0
```

The above example illustrates data collection counters for a configuration containing 9 Sensor Records and 21 Process Records. Sensor and Process Record numbers are shown in parentheses. The first number below the Record Number is the data collection counter for that Sensor or Process Record. Any numbers shown below the Process Record data collection counter are the data collection counters for the data inputs (if any) for each Process Record.

7.6.   DISPLAYING GLOBAL BUILT-IN-TEST (BIT) STATUS

The Global Built-In-Test (BIT) is a 32-bit value that can be configured to store alarm conditions or other "on/off" or "yes/no" related information. The least significant 8 bits are used internally by ZENOSOFT®, but the other 24 bits are available to store any user-specific "on/off" data.[163]

Since there are up to 32 bits available, ZENOSOFT® provides the means for the user to define a unique name for each bit. This is done in the BIT Names Menu, which is accessible from the System Functions Menu:

```
BIT NAMES MENU
(Cn/m) Change Bit n to Value m              (Q) Quit
(E)    Save Parameters To EEPROM            (H) Help
(U)    User Menu

BIT Names 1 through 32
Bit  1: ZENO-3200-Reset               Bit 17:
Bit  2: Real-Time-Clock-Suspect       Bit 18:
Bit  3: Logging-Memory-Initialized    Bit 19:
Bit  4: Serial-Sensor-COM-Failure     Bit 20:
Bit  5: EEPROM-Suspect                Bit 21:
Bit  6: 18-Bit-ADC-Suspect            Bit 22:
Bit  7: 12-Bit-ADC-Suspect            Bit 23:
Bit  8: Temperature-Clock-Adjustment  Bit 24:
Bit  9:                               Bit 25:
Bit 10:                               Bit 26:
Bit 11:                               Bit 27:
Bit 12:                               Bit 28:
Bit 13:                               Bit 29:
Bit 14:                               Bit 30:
Bit 15:                               Bit 31:
Bit 16:                               Bit 32:

>
```

The first 8 names are predefined since they are the 8 bits used internally by ZENOSOFT®. If you want to change any name (including the first 8), simply use option **Cn/m{ENTER}** to change Bit Name **n** to string **m**.

> **Changing a name for a specific bit in the BIT does *not* affect ZENO®-3200 data collection.**

Option **B** in the Test Menu allows you to view the status of the BIT from the *previous* Sample Interval.

> **Since the contents of the BIT is dynamic during data collection, only the value of the BIT from the previous Sample Interval is available to be viewed using this option.**

When you type this option, you will be presented ONLY with the ACTIVE or SET bits in the BIT from the previous Sample Interval.

---

[163] More information is available in Appendix D in the Alarm Processes Category.

8.   ZENO®-3200 ACCESS PRIVILEGES

Coastal Environmental Systems

ZENO®-3200 User Manual

Since the ZENO®-3200 is a configurable device, and things can be done that would interfere with the purpose that the user intends, Coastal Environmental Systems provides each ZENO®-3200 with built-in access privilege and security.

8.1.   ACCESSING THE ZENO PROGRAM MENU

An Administrator Password is required to access the Zeno Program Menu from the User Menu. To enter the Zeno Program Menu, you should:

- connect and power up the ZENO®-3200 as described in Section 2.2
- type **U{ENTER}** to enter the User Menu
- type **Z{ENTER}** to enter the Zeno Program Menu

You will be prompted for the Administrator Password. The default Administrator Password (which you can change) is **ZENO.**   After you enter the correct Administrator Password, the ZENO®-3200 will stop performing all data collection, processing, data logging and output message transmission. If any serial sensors are in use, ZENOSOFT® will wait to complete any current communications between them and the ZENO®-3200. Once all data collections have stopped, you will be presented with the Zeno Program Menu.[164]

> **Sensor sampling, logging and data output cease when you enter the Zeno Program Menu.**
>
> **From the Zeno Program Menu, type Q (to quit the User Interface) or U (to enter the User Menu) to resume normal operation.**
>
> **The default Administrator Password is ZENO.**

The Zeno Program Menu will offer you the following options.

---

[164] If you have to return to the User Menu for some reason, then re-enter the Zeno Program Menu, you won't have to re-enter the Administrator Password unless you exited the User Interface altogether.

```
ZENO PROGRAM MENU
(S) Sensor Menu                       (M) Memory Management Menu
(P) Process Menu                      (W) Password Menu
(D) Data Output Menu                  (R) Reset System
(T) Sensor Timing Loop Menu           (E) Save Parameters To EEPROM
(O) Output Message Timing Menu        (U) User Menu
(L) System Load Menu                  (Q) Quit
(G) General Serial Script Menu        (H) Help

  >
```

When you have finished with the Zeno Program Menu, you can exit by typing either **Q{ENTER}** (to **QUIT** all menus), or **U{ENTER}** (to return to the **USER** Menu). In contrast to the User Menu (and its submenus), ZENOSOFT® will not time out from the User Interface while you are in the Zeno Program Menu or any of its submenus. This could lead to a flawed configuration. However, if the carrier detect line to the User Interface COM Port is disrupted ZENOSOFT® will exit from the User Interface. The reason for this is simple--if your communications link is susceptible to noise or disruption, you would not want to be locked out from the User Interface.

> **ZENOSOFT® will not time out from the Zeno Program Menu (or its submenus) unless the User Interface COM Port carrier detect line is disrupted.**

The ZENO®-3200 will resume all data collection functions at the beginning of the next Sample Interval once you leave the Zeno Program Menu using the new configuration. If you want the changes you made to be permanent, you must save the configuration to EEPROM. If you only want to try out the new configuration, with the option to revert to the old one, do not save the configuration to EEPROM.

8.2. SETTING ACCESS PRIVILEGES

ZENO®-3200 systems are generally delivered with one level of password access, the Administrative Password. You may wish to use a more secure password or to block unauthorized access to the User Menu and the Zeno Program Menu.

The ZENO®-3200 allows for two levels of password: (1) the User Password allows access to the User Menu, and (2) the Administrator Password allows access to the Zeno Program Menu. To change these passwords, enter **W{ENTER}** at the Zeno Program Menu. You will be presented with the Password Menu.

```
PASSWORD MENU
(A) Change Administrator Password       (Z) Zeno Program Menu
(U) Change User Password                (H) Help
(V) View All Passwords
```

To change either the Administrator Password or the User Password, you must enter the appropriate command (**A** or **ʊ**). You will be prompted to enter the current password, and then to enter and confirm the new password.

> **Contact Coastal Environmental Systems if you have**
> **forgotten your password.**

9.   UPLOADING AND DOWNLOADING AN ENTIRE CONFIGURATION

Coastal Environmental Systems

ZENO®-3200 User Manual

A great feature of the ZENO®-3200 is the ability to download a configuration into a file on your computer. This feature allows you to configure multiple ZENO®-3200s with the same configuration, or to back-up your configuration, or to send the configuration to Coastal Environmental Systems if you need assistance.

> **Coastal Environmental Systems recommends that you periodically save your configuration onto a computer while you make changes so that you can go back to an earlier configuration if a mistake occurs.**

To upload or download a complete configuration, you need to use the System Load Menu, which is a submenu of the Zeno Program Menu. From the Zeno Program Menu, type **L{ENTER}** to enter the System Load Menu. You should see the following:

```
SYSTEM LOAD MENU
(R) Receive Configuration From Host          (Z) Zeno Program Menu
(T) Transmit Configuration From Zeno         (H) Help
(V) View Configuration & Menus (ASCII)

Precede The R Or T Command With An 'X' for X-Modem Transfer
(e.g. Enter 'XR' To Receive A Configuration File Via X-Modem)

>
```

9.1.   DOWNLOADING A CONFIGURATION TO YOUR COMPUTER

> **When download a configuration from the ZENO®-3200, you are downloading the configuration that is currently stored in the ZENO®-3200's RAM.**

As with downloading Data Records, you can either download the configuration using a simple ASCII-text dump, or you can use the X-modem file transfer protocol.[165]

> **Coastal Environmental Systems recommends that you use the X-modem file transfer protocol to download configuration files when your communications link is prone to noise.**

- *Text Transfer*: Enter **T{ENTER}** in the System Load Menu and the ZENO®-3200 will TRANSMIT the configuration to your computer as a text file. The ZENO®-3200 will first prompt you to turn on your terminal emulation program's text transfer file capture.

```
> t
Turn On Host Computer File Capture Now.
Enter Any Key To Continue.
```

Once you have done this, press any key to start the text transfer. You will see the configuration file as it is transmitted. At the end of the transmission, you will be prompted to stop the text file capture in your terminal emulation program. Once you have done this, press any key to return to the System Load Menu.

```
* Zeno 3200 System Setup File
* Program Version and Date: ZENO-3200 V1.80 compiled: Aug 01 1996 15:53:35
* Copyright (C) Coastal Environmental Systems, 1995, 1996.
* Setup File Date and Time: 96/08/12 19:49:11
PARAM1 3 0 2 2 80 110 1 0 9600 9600 PARAM2 9600 0 0 0 0 1 1 0 0 0
PARAM3 16777 1 60 18 0 4 5 6 2 2 PARAM4 2 2 0 0 1 3276800
PARAM5 0 0 0 0 100 0 0 0 0
PARAM6 0 518400 86400 835747200 50336144 151 196608 0 1 0
PARAM7 151 0 1280 18 10000
PARAM8 "NONE" "NONE" "NONE" "NONE" "NONE" "NONE" "" "ZENO"
SENSOR 1 "Temperat" 3 0 0 0 0 0 0 1 0 1 0 1 0 0 0
SENSOR 1 "Battery" 2 0 0 0 0 0 0 1 0 1 0 1 0 0 0
PROCESS 5 8 S1.1 0 1.8 32
PROCESS 1 1 S2.1
DATA 6 1 "<0D><0A>" 1.1 0 0 1
DATA 3 1 "" 1.1 0 0 1
DATA 9 1 "Temp" 1.1 1 0 8DATA 9 1 "Volts" 2.1 1 0 8
* !!SYSTEM TRANSFER COMPLETE.
* Turn Off File Capture Now.
* Enter Any Key To Continue.
EOF
```

---

[165] The X-modem file transfer protocol was developed by Ward Christensen in 1977 and is a public domain. It is a simple send-and-wait ARQ (automatic repeat request) protocol using a fixed-length data field and uses either a simple single-byte checksum or CRC checksum for error detecting. For a complete description of the X-modem file transfer protocol, refer to pages 100-112 of the book **C Programmer's Guide to Serial Communications, 2nd Edition**: Joe Campbell, 1994, Sams Publishing.

- *X-modem Transfer*: Enter **XT{ENTER}** in the System Load Menu. The ZENO®-3200 will prompt you to turn on your terminal emulation program's X-modem transfer file capture.[166] Once you start the X-modem file capture, the ZENO®-3200 will automatically start the transfer. When you see that your terminal emulation program has stopped receiving data from the ZENO®-3200, press {ENTER} to return to the System Load Menu.

9.2.   UPLOADING A CONFIGURATION TO YOUR ZENO®-3200

> **If you upload a complete configuration to your ZENO®-3200, you must accept the loss of all currently logged Data Records as well as the configuration currently stored in RAM.**

> **If you don't want to lose the currently logged Data Records but still need to upload a new configuration, download the desired Data Records before you upload the new configuration.**

> **Coastal Environmental Systems generally recommends that you do NOT load a new configuration over a wireless communications link since wireless communication is prone to noise.[167]**

As with downloading a configuration, you can upload a new configuration into the ZENO®-3200 using either simple ASCII text transfer, or via the X-modem file transfer protocol.

Typing **R{ENTER}** in the System Functions Menu will start the process to do an ASCII text upload of the new configuration.

Typing **XR{ENTER}** will perform an X-modem protocol file transfer.[168] In either case, ZENOSOFT® will query you as to whether you want to continue because uploading a new configuration will delete all currently logged Data Records.

Type **y{ENTER}** to **accept deletion** of all Data Records, and ZENOSOFT® will then instruct you to begin the text file transfer from your terminal emulation program.

---

[166] Many terminal emulation programs refer to an X-modem file transfer as a *binary file* transfer. If you don't see X-modem file transfer specified, try the binary file transfer. If your terminal emulation program does not support X-modem file transfer, you might want to find a different terminal emulation program that does. (Contact Coastal Environmental Systems for assistance.) Note: X-modem file transfer *is not the same as* Z-modem file transfer or Kermit file transfer.

[167] Refer to Section 6.

[168] Many terminal emulation programs refer to an X-modem file transfer as a binary file transfer. If you don't see X-modem file transfer specified, try the binary file transfer. If your terminal emulation program does not support X-modem file transfer, you might want to find a different terminal emulation program that does. Contact Coastal Environmental Systems for assistance. Note: X-modem file transfer is not the same as Z-modem file tranfer of Kermit file transfer.

Type **n{ENTER}** to **not** accept deletion of all Data Records, and ZENOSOFT® will abort the configuration file upload procedure.

```
SYSTEM LOAD MENU
(R) Receive Configuration From Host            (Z) Zeno Program Menu
(T) Transmit Configuration From Zeno           (H) Help
(V) View Configuration & Menus (ASCII)

Precede The R Or T Command With An 'X' for X-Modem Transfer
(e.g. Enter 'XR' To Receive A Configuration File Via X-Modem)

> R

WARNING: The requested change will prevent the System from
         accurately reading the Data Records currently stored
         in Logging Memory. To proceed with this change all
         Log Data Records must first be deleted!

WARNING: All records in data logging memory will be deleted!
  Continue? (Y/N)
```

If you typed **Y{ENTER}** to proceed, the Zeno®-3200 will begin waiting to receive the configuration file from your computer. If you typed **R{ENTER}** before that, follow the procedure in your terminal emulation program to send the configuration file stored in your computer as a text file transfer. Otherwise, if you typed **XR{ENTER}** before that, follow the procedure in your terminal emulation program to send the configuration file stored in your computer as an X-modem file transfer. The terminal emulation program should indicate when the text or X-modem file transfer is complete.

Upon completion of uploading the new configuration file, type **{ENTER}** to restore the System Load Menu.

> **If the file upload is successful, the new configuration file will be uploaded into RAM only. If you want it saved, you must return to the Zeno Program Menu and type** E{ENTER} **to save the configuration to EEPROM.**

> **If the new configuration file fails to upload for any reason, ZENOSOFT®
> will restore the configuration that is currently stored in EEPROM.**

9.3.   VIEWING A CONFIGURATION WITH ALL MENUS

You can instruct the ZENO®-3200 to display the entire configuration with the menus from the User Interface by using option **V** in the System Load Menu.

> **Option V in the System Load Menu allows you to download your configuration in the same user-readable format as all the User Interface menus.**

It would be the same as going to each and every menu in the User Interface by hand while you capture all of the text in your terminal emulation program.

When you type **V{ENTER}** in the System Load Menu, the ZENO®-3200 will query you to start an ASCII file capture. After you start the file capture and type any key in your terminal emulation program the ZENO®-3200 will transmit the entire configuration--including menus--into the file that you specified.

Using any text editor program, you can then print the view of your configuration as a hardcopy for your records.

> **The file that you download using option V in the System Load Menu CANNOT be uploaded as a readable configuration file by the ZENO®-3200.**

9.4.   CONFIGURATION FILE COMPATIBILITY BETWEEN DIFFERENT ZENOSOFT® VERSIONS

ZENOSOFT® is designed so that it can upload configuration files that were generated by earlier versions of ZENOSOFT®. for example, a configuration file that was generated using ZENOSOFT® V1.811 can be uploaded by any subsequent version of ZENOSOFT® such as V1.965.

However, an older version of ZENOSOFT® cannot upload configuration files generated by newer versions of ZENOSOFT®. for example, a configuration file that was generated using ZENOSOFT® V1.965 cannot be uploaded into ZENOSOFT® V1.811.

The same rules listed above also apply to custom versions of ZENOSOFT®, but with several additions:

- A custom version of ZENOSOFT® can upload a configuration file generated by any earlier version of the same custom version or any earlier standard version of ZENOSOFT®.
- A custom version of ZENOSOFT® may or may not be able to upload a configuration file that was generated by a different custom version of ZENOSOFT®.[169] Each custom version of ZENOSOFT® is identified by its custom version identifier, which is part of the custom version number as described below.
- A configuration file generated by a custom version of ZENOSOFT® may or may not be uploadable by any standard version of ZENOSOFT® that is newer than the custom version.[170]

---

[169] Each custom version of ZenoSoft™ may include unique elements that are not compatible with any other version of ZenoSoft™ rendering their configuration files unusable to a different ZenoSoft™ version.
[170] Custom versions of ZenoSoft™ may include unique elements that are not present in standard versions of ZenoSoft™ and, consequently, won't be understood by the standard version.

Custom versions of ZENOSOFT® are distinguished from standard versions by their version numbers.

The version number for a standard version of ZENOSOFT® takes the form "Vx.xx", where "x.xx" is the standard version number.

The version number for a custom version of ZENOSOFT® takes the form "Vx.xx-yyyy-z.zz", where "x.xx" is the baseline standard version number, "yyyy" is the custom version identifier and "z.zz" is the custom version sub-number.

10.   ZENO®-3200 CONFIGURATION SPECIFICS

Coastal Environmental Systems

ZENO®-3200 User Manual

This section contains detailed information regarding the creation and/or modification of a ZENO®-3200 configuration. It focuses primarily on the details and options available in the Zeno Program Menu and its submenus.

The Zeno Program Menu provides for the following:

- Match the ZENO®-3200 hardware and firmware to your sensor suite.
- Specify calculations, such as averaging, to apply to the sensor outputs.
- Specify the format and content of data to be logged, and to be transmitted.
- Using multiple data output messages.
- Setting up an alarm message to be transmitted if one or more conditions are met.
- Using Constants in Processes.

> **If you have not yet done so, it is highly recommend that you work through Part 2 of the tutorial in Section 3 before proceeding with this section.**

10.1.   ZENO®-3200 CONFIGURATION TIPS

When you create or modify a configuration, you can take several precautionary steps to ensure recovery if any mistakes are made along the way:

1. **Ask yourself the list of questions described in Section 3.2.1.** These questions will assist you in writing an effective configuration.
2. **Provide each Sensor Record, Process Record and Data Output Record with a user-defined name.** This will help you remember what each record is responsible for.
3. **Before you change an existing configuration, make sure you have a copy of the configuration stored on your computer.** If you don't have the current configuration stored on your computer, download the configuration before you make any changes in case you need to go back to it. Refer to Section 9.1.
4. **Periodically save your configuration to EEPROM or download the configuration to your computer while you change it.** When you change a configuration, you are changing the configuration that is stored in RAM. If there is a power surge, any changes that have not been saved to EEPROM or downloaded to a computer will not be recoverable. If you periodically save your

configuration changes either to EEPROM or as a file in your computer, you will be able to recover any changes. Refer to Section 9.1 to learn how to download a configuration to your computer.

5. **Make backups of any configuration files stored on your computer.** It is very easy to accidentally erase files on a computer, and sometimes computers crash, making it impossible to recover files. If you backup the configuration files in a safe place, you will always be able to recover them.

6. **Clearly identify the configuration file stored on your computer that is currently running in your ZENO®-3200.** You might not have to look at a configuration file for a very long time. Giving the file a very descriptive name makes it that much easier to recognize.

10.2. COMMON SENSOR, PROCESS AND DATA OUTPUT MENU COMMANDS

The Sensor Menu, Process Menu and Data Output Menu essentially use the same menu options. These are summarized in the following table. (Note: each command is invoked only after the **{ENTER}** key has been pressed.)

Command	Description	Details
A	Insert a new record after the current record.	Each command will affect the order of the specific records. Insertion or deletion of one or more sensor or process records will cause ZENOSOFT® to update references to affected sensor or process records.
B	Insert a new record before the current record.	
X	Delete the current record.	
XA	Delete all records within the current menu.	
Cn/m	Change the value of item number **n** to value **m**.	Contents of value **m** depends upon the menu and line item number.
Jn	Jump to record number **n**	No changes are made to any record for these commands.
N	Move to the next record.	
P	Move to the previous record.	
Hx	Obtain help about item **x**.	Item **x** could be a submenu option or a line item number. Refer to Section 2.4.2 for more details.
Z	Return to the Zeno Program Menu.	

From the Zeno Program Menu group, returning to the User Menu, quitting the User Interface altogether, or saving the current configuration to EEPROM can only be done from the Zeno Program Menu.

10.3. DEFINING THE SENSORS

The Sensor Menu lets you configure ZENOSOFT® to match your sensor hardware inputs and outputs. Type **S{ENTER}** from the Zeno Program Menu to enter the **SENSOR** Menu. You will be presented with a menu containing the menu options discussed in Section 10.2, followed by a list of line items that fully define a Sensor Record. Since a configuration usually contains more than one sensor, each Sensor Record is numbered. This number (or index) is referred to as the Sensor Record Number. The first Sensor Record is always Sensor Record #1.

```
SENSOR MENU
(Cn/m) Change Item n To Value m          (Jn) Jump To Record n
(A)    Insert After This Record          (N)  Go To Next Record
(B)    Insert Before This Record         (P)  Go To Previous Record
(X)    Cut Record to Clipboard           (XA) Delete ALL Records
(C)    Copy Record To Clipboard          (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard       (H)  Help
(Sn/m) Search Item n for Value m

Sensor Items for Record 1 of 1:
Item  1: Sensor Type Code                 0 (No Sensor)

>
```

The line items for each Sensor Record usually represent the same type of information. This simplifies the task of configuring each sensor type, but since different sensor types have different requirements, not all line items appear for the different sensor types.

> **Each line item in a Sensor Record can be regarded as a question that needs to be answered by you.**

The questions that you need to answer are generalized below:

- What type of sensor do I have (analog, digital or serial)?

  Analog Sensors

  - Do I need 12-bit accuracy or 18-bit accuracy?
  - What is the input and output voltage range of the sensor?

  Digital Sensors

  - Do I need to measure a simple on-off state, count pulses or measure frequency?
  - If I am measuring frequency, what is the frequency range?

  Serial Sensors

  - If the sensor is a serial sensor, is there a serial sensor type that directly supports it, or do I need to write a General Serial Script[171] to retrieve its data?
  - What type of serial interface is required (RS232, RS485, TTL)?
  - What baud rate, parity, etc., does the sensor communicate with?
- Where and how does the sensor need to be connected to the ZENO®-3200?
- Do I want the sensor to be on at all times, or do I need to the ZENO®-3200 to control power to the sensor in order to conserve power?
- How frequently do I need to read data from the sensor?
- How many times during the Sample Duration do I need to read data from the sensor?
- Do I need any data conversion to be done within the Sensor Record?

---

[171] Refer to Section 12.2.

> **Appendix D contains a number of sensor configuration examples for commonly used sensors.**

If you want to set up a Sensor Record to read the Internal Battery Voltage, your Sensor Record may look something like this:

```
SENSOR MENU
(Cn/m) Change Item n To Value m          (N) Go To Next Record
(A)     Insert After This Record         (P) Go To Previous Record
(B)     Insert Before This Record        (X) Delete all Records
(D)     Delete This Record               (Z) Zeno Program Menu
(Jn)    Jump To Record n                 (H) Help

Sensor Items for Record 2 of 2:
Item  1: Sensor Type code =               1 (12-bit Analog to Digital)
Item  2: Sensor Name =                    Battery
Item  3: Sensor Input Channel =           BATTERY VOLTAGE
Item  6: Switched Power code =            0 (NO SWITCHED POWER)
Item  7: Sensor Excitation Voltage code = 0 (NO EXCITATION VOLTAGE)
Item  8: Switched Excitation Return =     0
Item  9: Switched Power Warmup Time =     0
Item 10: Sensor Sample Count =            1
Item 11: Maximum Sensor Readings =        0
Item 12: Sensor Timing Loop =             1 (0.5 seconds)
Item 13: Conversion Coefficient A =       0
Item 14: Conversion Coefficient B =       1
Item 15: Conversion Coefficient C =       0
Item 17: No. of Additional 15-msec Delays 0

>
```

10.3.1. Analog Sensors

The ZENO®-3200 can measure an analog sensor by converting the analog voltage created by the sensor into a digital representation using an Analog-to-Digital Converter, or ADC. Two ADCs are installed on a ZENO®-3200: 12-bit ADC and 18-bit ADC.[172] The 12-bit ADC is strictly unipolar (single-ended), but the 18-bit ADC supports both unipolar and bipolar (differential) measurements.

To know which ADC is best suited to meet the requirements of measuring a particular analog sensor, the differences between 12-ADC and 18-bit ADC are described in the following table:

Type of ADC	Baseline Voltage Range		Per-Bit Accuracy
12-bit ADC	Single-ended only:	0 to 4.096 VDC	0.1 mV DC
18-bit ADC	Single-ended:	0 to 512 mV	1.95 μV DC
	Differential:	±512 mV DC	3.91 μV DC

Each 12-bit ADC conversion requires a minimum of 100 microseconds, but each 18-bit ADC conversion requires a minimum of 100 milliseconds. Therefore, in one second, only 10 18-bit ADC conversions can be made.

---

[172] These are illustrated in Section 2.5 in the ZENO®-3200 Block Diagram.

Due to their fine, as opposed to coarse, resolution 18-bit ADC measurements are highly susceptible to noise. A single 18-bit ADC measurement is generally only accurate to 15 bits. To obtain 18-bit accuracy, at least 3 consecutive measurements must be made by setting Line Item #10, the Sensor Sample Count, to 3.

Three consecutive 18-bit ADC measurements will require a minimum of 300 milliseconds.

Because the baseline voltage range of the 18-bit ADC is so small, extra electronics are available on the ZENO®-3200 to attenuate or provide a gain to the inputted analog voltage. Together the gain and attenuation greatly extend the available voltage range of each 18-bit ADC sensor type, either single-ended or differential.

To configure an analog sensor, you will need to configure 3 line items in the Sensor Record for a 12-bit ADC sensor type or 5 line items for an 18-bit ADC sensor type:

- Line Item #1:   Sensor Type
- Line Item #3:   Channel
- Line Item #4:   Analog Channel Gain (18-bit ADC Only)
- Line Item #5:   Analog Channel Attenuation (18-bit ADC Only)
- Line Item #17:   No. of Additional 15-msec Delays

To configure Line Items #1 and #3, use the following table:

Sensor Type		Available Channels (Line Item #3)	
Code (Line Item #1)	Name	Internally Connected	Externally Connected
1	12-bit ADC	Internal Temperature Sensor, Battery Voltage, GND	8 or 9
2	18-bit Single-Ended ADC	GND	1- to 7-, 1+ to 7+
3	18-bit Differential ADC	GND	1 to 7

If your ZENO®-3200 is equipped with one or more *optional* Analog Expansion Boards (up to four), then the total number of available channels is greatly increased!

Each Analog Expansion Board supports up to 16 single-ended analog channels or up to 8 differential analog channels.

> **Contact Coastal Environmental Systems if you need an Analog Expansion Board.**

Use the following table if you are using any Analog Expansion Boards:

Sensor Type		Available Optional Analog Expansion Board Channels (Line Item #3)	
Code (Line Item #1)	Name	Analog Expansion Board	Channels
1	12-BIT ADC	A	A1- to A8- and A1+ to A8+
		B	B1- to B8- and B1+ to B8+
		C	C1- to C8- and C1+ to C8+
		D	D1- to D8- and D1+ to D8+
2	18-bit Single-Ended ADC	A	A1- to A8- and A1+ to A8+
		B	B1- to B8- and B1+ to B8+
		C	C1- to C8- and C1+ to C8+
		D	D1- to D8- and D1+ to D8+
3	18-bit Differential ADC	A	A1 to A8
		B	B1 to B8
		C	C1 to C8
		D	D1 to D8

> **When any Analog Expansion Boards are used, channels +5 and -5 on the main ZENO®-3200 are NOT available to be used for data collection.**

To configure Line Items #4 and #5 for an 18-bit ADC sensor, use the table shown below.

> **Matching the input scale to the sensor improves the resolution, linearity and dynamic range of the signal, while reducing noise effects.**

> **When applying the analog channel gain and attenuation, ensure that the sensor signal level will not lie outside the A/D converter's ±512 mV input range. Larger signals will not damage the ZENO®-3200, but will give erroneous readings; signals outside ±750 mV may also affect other channels.**

> **Do not amplify analog signals beyond the range ±512 mV!**

18-bit ADC Input voltage range selection				
Nominal full scale sensor output voltages	Full scale sensor output voltages	Gain (Item 4)	Attenuation (Item 5)	Worst-case accuracy degradation
±5 mV	±5.12 mV	100	1	±.03%+3ppm/ºC
±10 mV	±10.24 mV	100	2	±.05%+5ppm/ºC
±20 mV	±20.48 mV	100	4	±.05%+5ppm/ºC
±50 mV	±51.2 mV	10	1	±.03%+3ppm/ºC
±100 mV	±102.4 mV	10	2	±.05%+5ppm/ºC
±200 mV	±204.8 mV	10	4	±.05%+5ppm/ºC
±500 mV	±512 mV	1	1	0.0
±1 V	±1.024 V	1	2	±.02%+2ppm/ºC
±2 V	±2.048 V	1	4	±.02%+2ppm/ºC
±5 V	±5.12 V	1	10	±.02%+2ppm/ºC

For differential 18-bit ADC other than passive bridge sensors, do not exceed the common mode input signal voltage of ±8 V. Or, simply, the voltage between ground and either input must not exceed ±8 V.

Exceeding this level will give erroneous readings.

When an analog sensor is powered up, it is common for the voltages to vary until a steady state is achieved. The amount of time for the voltages to reach steady state depends upon the electronic components within the circuit. Taking a measurement before the voltages have reached steady state can make the measurements inaccurate. Therefore, it may be necessary to configure the ZENO®-3200 to wait for several milliseconds for the analog circuit to reach steady state after it is powered. Line Item #17 provides the delay mechanism and should be configured according to the type of power being used for the analog sensor as shown in the following table.

Type of Power	Line Item #17 Setting
Continuous	0. No added delay is necessary.
Switched Power with Warmup	0. No added delay is required. Warmup time can provide any amount of delay.
Excitation Voltage & Switched Return	0 to 7 (15-millisecond delay increments). Excitation voltage and switched return provides no delay on its own. If the measurement is taken too quickly, the voltages will not be fully settled. Some additional delay time may be required to delay the measurement to ensure an accurate measurement is taken. The delay can be set up to 95 milliseconds. Typical values are 2 or 3 (30 or 45 millisecond delay).

10.3.2. Digital Sensors

The ZENO®-3200 has several ways that it can measure a digital signal:

- Simple on/off status
- Period of streaming digital pulses
- Frequency of streaming digital pulses
- Count streaming digital pulses
- Read a digital encoder

> **For any digital sensor, the valid voltage range is 0.0 to 5.0 VDC. Any voltage below 2.0 VDC is regarded as an OFF state and any voltage above 2.5 VDC is regarded as an ON state.**

Setting the sensor type and the channel, to read the digital sensor through, are set via Line Items #1 and #3 in the Sensor Menu for the particular Sensor Record. These are summarized in the following table:

Sensor Type		Available Channels (Line Item #3)
Code (Line Item #1)	Name	
4	Digital Period Measurement, f > 10 kHz	10 through 23
5	Digital Frequency Measurement, f > 10 kHz	
6	Digital Period Measurement, f < 10 kHz	
7	Digital Frequency Measurement, f < 10 kHz	
8	Digital State Measurement	
9	Digital Edge Counter	
10	Tipping Bucket	24
14	Differential Encoder	10 through 23; requires 2 adjacent channels.

The specifics of each digital sensor type is summarized in the following table:

Sensor Type		
Code	Name	Specifics
4	Digital Period Measurement, f > 10 kHz	The minimum time for a measurement is 100 μs. The shortest measurable interval is 0.25 μs, or 4 MHz.
5	Digital Frequency Measurement, f > 10 kHz	
6	Digital Period Measurement, f < 10 kHz	The maximum time required per measurement is 1 second. The lowest measurable frequency is 1 Hz.
7	Digital Frequency Measurement, f < 10 kHz	
8	Digital State Measurement	Measures whether the input is ON or OFF only.
9	Digital Edge Counter	16-bit accumulator--up to 65,536 rising edges can be measured. Tipping Bucket pulses are measured via processor interrupts meaning that it can wake up the microprocessor from sleep mode and continue to count pulses outside of the Sample Duration Time.
10	Tipping Bucket	
14	Differential Encoder	Treats two-wire quadrature shaft encoder using the 16-bit pulse accumulator. Wraps around if more than 32,767 pulses are read in a single direction. Resets to its initial value if the ZENO®-3200 loses power. Uses two adjacent digital input channels. Input the initial value as Line Item #14 (*B*), change per pulse as Line Item #15 (*C*).

10.3.3. Serial Sensor Background

A variety of serial sensors is directly supported by the ZENO®-3200.

> **The ZENO®-3200 can communicate with most serial sensors by using the Universal Serial Interface (USI).[173]**

Serial sensors can be classified into two general categories:

- **Polled**: the serial sensor transmits data only after receiving a specific instruction to do so.
- **Asynchronous**: the serial sensor transmits data on its own, usually on an internally generated timer.

The ZENO®-3200 supports both polled and asynchronous serial sensors. for most asynchronous serial sensors, a specified amount of time is internally allotted for the ZENO®-3200 to wait to receive the asynchronous message.[174]

Serial sensors can also be classified according to their message formats. Unfortunately, NO single universal standard that defines serial sensor message formats exists. Each serial sensor manufacturer is free to choose its own message format. Some manufacturers will use a generally used standard such as NMEA or SDI-12, but many choose to use their own proprietary format. Message formats supported by the ZENO®-3200 include these types:

---

[173] Refer to Section 12.2 for more information about USI.
[174] The only exception is the Asynchronous CCSAIL Sensor.

- **NMEA 0183**: this interface protocol was created by the National Marine Electronics Association. Originally established to allow marine navigational equipment to share information, NMEA 0183 is a simple but comprehensive ASCII protocol that defines both the communications interface and data format.[175] NMEA 0183 messages can be polled or asynchronous.

- **SDI-12**: the acronym stands for Serial Data Interface at 1200 baud. It was created by a group of serial sensor company representatives and programmers to create a standard communications protocol between intelligent sensors and data records.[176] All SDI-12 messages are polled.

- **CCSAIL Communications Protocol**: was created by Coastal Environmental Systems.[177] CCSAIL messages can be polled or asynchronous.

- **Proprietary**: any message format that does not conform to any known standard format and includes both polled and asynchronous messages.

Information specific to each sensor type is listed in the next table:

Sensor Type		Polled or Asynch.	Message Format	Time Per Measurement
Code (Line Item #1)	Name			
11	Serial Compass	P	NMEA	600 ms
15	GPS Receiver	A		Up to 5 s
12	CCSAIL Sensor	P	CCSAIL	Up to 4 s
19	Asynchronous CCSAIL Sensor	A		N/A
16	General Serial Script Sensor (USI)	Both	Any	Depends upon Script Definition
13	SDI-12 Sensor	P	SDI-12	2 s Minimum, Depends upon Sensor.
18	Concurrent SDI-12 Sensor			
17	Continuous SDI-12 Sensor			Up to 2 s

10.3.4. Specifics for Each Supported Serial Sensor Type

Serial Compass Specifics

The Serial Compass sensor type was designed around the Navico Serial Compass. Its measurement range is 0 to 360 degrees from true North with 0.1 degree resolution. It uses NMEA messages transmitted at 4800 baud on TTL. It is usually connected to the ZENO®-3200 via the COMPASS interface located on the ZENO®-3200 CPU board.

A typical NMEA serial compass message looks something like this:

---

[175] Each NMEA 0183 message starts with a "$", a two letter "talker ID", a three letter "sentence ID", followed by a number of data fields separated by commas, an asterisk "*", an optional checksum, and a carriage return/line feed combination. The checksum is calculated by exclusive-oring all of the characters between the "$" and "*" characters. Total message length is restricted to 82 characters. Information about NMEA is available at their website: http://www.nmea.org/**.**

[176] More information, including a complete description of SDI-12, is available from the SDI-12 Support Group's website at http://www.sdi-12.org/.

[177] Refer to Section 4.6.

```
$HCHDM,342.7,M*2B
```

The value set in the Compass Offset of the System Functions Menu[178] will be added to the value reported by the Sensor Record specified as a Serial Compass sensor type.

GPS Receiver Specifics

The GPS Receiver supported by the ZENO®-3200 outputs several NMEA messages, from which 14 different values are retrieved. The following table describes the outputs and their origin.

Sensor Output	Output Description	Units	Recommended Storage Type	From NMEA Message
1	Latitude (DDMM.mmmm)	D = deg., M = min., m = dec.min.	float	GLL, GGA, RMC
2	Longitude (DDDMM.mmmm)	D = deg., M = min., m = dec.min.	float	GLL, GGA, RMC
3	Universal Time Constant (UTC, hhmmss.ss)	h = hour, m = min., s = sec.	float	GLL, GGA, RMC
4	GPS Quality Indicator	0 = no fix, 1 = fix, 2 = diff. fix	byte	GGA
5	Number of Satellites in Use	(none)	byte	GGA
6	Horizontal Dilution of Precision (HDOP)	Percent	float	GGA
7	Antenna Altitude	Meters	float	GGA
8	Geoidal Separation	Meters	float	GGA
9	Age of Differential GPS Data	Seconds	float	GGA
10	Differential Reference Station ID	(none)	short int	GGA
11	Speed Over Ground (SOG)	Knots	float	RMC,VTG
12	Course Over Ground (COG)	Degrees	float	RMC,VTG
13	Date (DDMMYY)	D = day, M = month, Y = year	int	RMC
14	Variation	Degrees	float	RMC

CCSAIL Sensor Specifics

This sensor type gives ZENOSOFT® the ability to poll a remote CCSAIL sensor (usually a remote ZENO®-3200) for data. The number of floating-point data values collected is specified by Line Item #10. An extra hexadecimal value is received at the end of the message. The address of the remote CCSAIL sensor is specified by Line Item #17.

The CCSAIL Communications Protocol[179] was created for automated data collection. To support this sensor type, ZENOSOFT® sends a CCSAIL **DL1** command to a remote sensor that communicates using the CCSAIL Communications Protocol to obtain its data. for example, you need to collect five floating-point data values and one hexadecimal data value from a remote ZENO®-3200 configured with a Primary Unit ID of 1505. The CCSAIL message that would be sent from the remote ZENO®-3200 in response to a CCSAIL **DL1** command might look something like this:

---

[178] Refer to Section 5.7.
[179] Refer to Section 4.6.

#00011505<CR><LF>5.65,-24.98,78.2,0,1.2,1A0,51<ETX>

> **If you are collecting data from multiple CCSAIL sensors via RS485 or two-way radio, you will need to make sure that each remote CCSAIL sensor has a unique address.**

CCSAIL "DL1" Poll Commands →   ← Data Messages
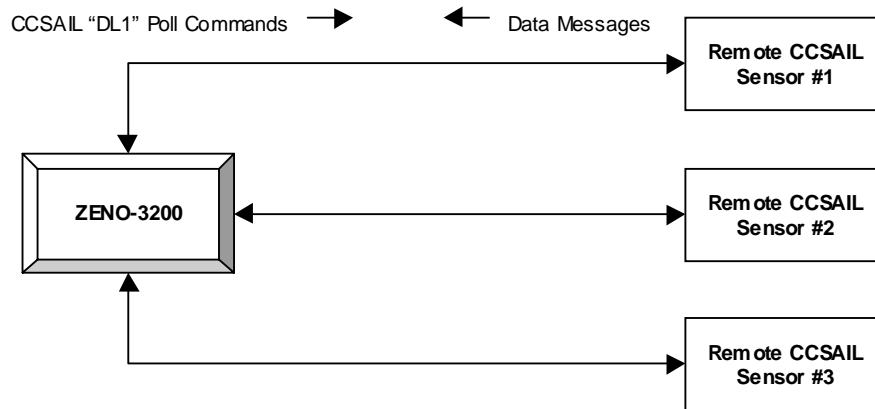
Asynchronous CCSAIL Sensor Specifics

In cases where it would be best for the ZENO®-3200 not to poll a remote CCSAIL sensor, ZENOSOFT® can have an Asynchronous CCSAIL Sensor configured. This means that ZENOSOFT® will not actively poll a remote CCSAIL sensor. Instead, when the remote CCSAIL sensor is ready to supply data, it simply sends out its data message automatically. The ZENO®-3200, with an Asynchronous CCSAIL Sensor configured in ZENOSOFT®, receives and extracts the data from the remote CCSAIL sensor just like it would as if it had polled the sensor for the data.

Like the regular CCSAIL Sensor, the number of data values that ZENOSOFT® will collect through the CCSAIL Sensor is set using Line Item 10 (Sensor Sample Count) in the Sensor Menu. The CCSAIL address of the remote CCSAIL sensor (probably another ZENO®-3200) is set using Line Item 17.

> **Unlike the regular CCSAIL Sensor, no Sensor Input Channel is specified for the Asynchronous CCSAIL Sensor so that ZENOSOFT® can receive data from the remote CCSAIL sensor over any COM port.**

To receive data from a remote CCSAIL sensor asynchronously, the remote CCSAIL sensor's CCSAIL address MUST be the same as the configured address in the Sensor Menu. Further, the destination address in the asynchronous message MUST match the ZENO®-3200 Primary Unit ID, configured in the System Functions Menu.[180]
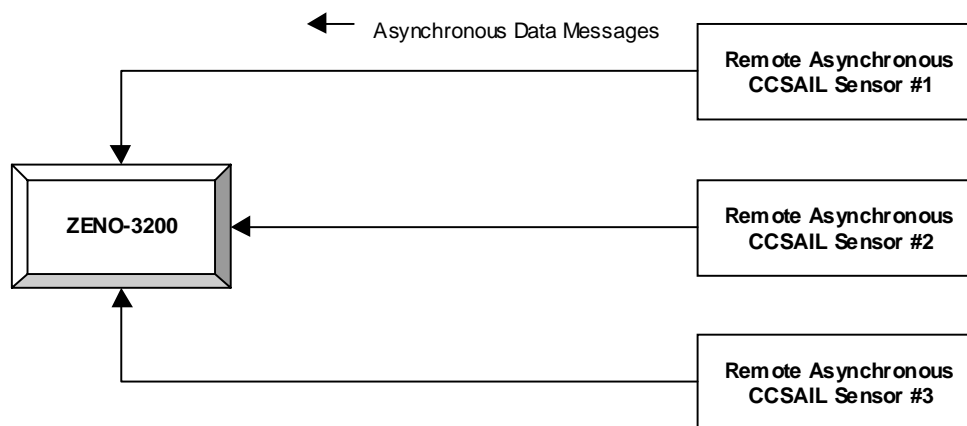
> **Since asynchronous CCSAIL messages are comprised of data only and since there may be more than one asynchronous CCSAIL sensor on a multi-drop communications link, ZENOSOFT® does not transmit a response to the messages.**

SDI-12 Sensor Specifics

SDI-12 Sensors are always RS485 and communicate at 1200 baud. Up to 16 addressable SDI-12 Sensors can be configured on a single ZENO®-3200. The number of floating-point data values collected is specified by Line Item #10. The address of the SDI-12 Sensor is specified by Line Item #17.

The procedure for collecting data from an SDI-12 Sensor is follows:

- The ZENO®-3200 transmits an **aM!** command to the SDI-12 Sensor with address **a**. This command instructs the SDI-12 Sensor to start its measurement. The SDI-12 Sensor responds with

---

[180] Refer to Section 5.5.

atttn<CR><LF> where **ttt** is the time in seconds required to make the measurement and **n** is the number of values that will be collected.

- The ZENO®-3200 waits for the time specified by the SDI-12 Sensor.

- Once the waiting is complete, the ZENO®-3200 sends one or more **aDx!** commands to recover the measured data where x begins with 0 and increments by one for each successive command required to recover all of the measured data. A data message sent by SDI-12 Sensor with address 0 in response might look like **0+1.1-4.5+6+7.7<CR><LF>**. Each **+** or **-** sign delimits the data fields.

Continuous SDI-12 Sensor Specifics

A Continuous SDI-12 Sensor operates very similarly to a regular SDI-12 Sensor. The difference is that the continuous SDI-12 Sensor is continually taking measurements. No **aM!** command is required. Instead, a series of **aRx!** commands are sent to recover the data similar to the **aDx!** commands sent for regular SDI-12 Sensors.

Concurrent SDI-12 Sensor Specifics

The Concurrent SDI-12 Sensor type operates quite differently from any other serial sensor type because, as the name implies, it allows data collection from up to four Concurrent SDI-12 Sensors simultaneously. The setting of Line Items #10 and #17 in the Sensor Menu are different from the standard and Continuous SDI-12 Sensor types:

- Line Item #10: since up to four Concurrent SDI-12 Sensors can be specified, the Sensor Sample Count must contain the sum total of the number of data fields reported by up to all four sensors. For example, data will be collected from three Concurrent SDI-12 Sensors that report 5, 8 and 7 data fields respectively. The total number of data fields from all three sensors is $5 + 8 + 7$ or 20 data fields. Line Item #10 must be set to 20 by typing the command **C10/20{ENTER}**.

- Line Item #17: similarly, up to four, single-digit SDI-12 addresses can be specified. No delimiting is used. For example, data will be collected from three Concurrent SDI-12 Sensors whose addresses are 1, 4 and 7. Line Item #17 must be set to **147** by typing the command **C17/147{ENTER}**. The ZENO®-3200 will interpret each character as individual Concurrent SDI-12 Sensor addresses.

When the ZENO®-3200 is ready to collect data from the multiple Concurrent SDI-12 Sensors, the following steps will occur:

- The ZENO®-3200 will issue an **aC!** (start concurrent measurement) command for each configured Concurrent SDI-12 Sensor, where **a** is the concurrent SDI-12 sensor address. Each sensor should respond with the message **atttnn<CR><LF>** where **ttt** is the time in seconds required to make the measurement and **nn** is the number of values that will be collected.

- The ZENO®-3200 will collect the data from each configured sensor in ascending order based upon each sensor's required time to complete a measurement; i.e., the sensor that requires the least amount of time to complete a measurement will have its data collected first, and so on. To collect the data, the ZENO®-3200 will send one or more **aDx!** commands where **x** begins with 0 and increments by one for each successive command required to recover all of the measured data for that sensor. A data message sent in response by a Concurrent SDI-12 Sensor with address 0 might look like **0+1.1-4.5+6+7.7<CR><LF>**. Each **+** or **-** sign delimits the data fields. This process will be repeated for each Concurrent SDI-12 Sensor as its data becomes available.

General Serial Script Sensor Specifics (USI)

A full explanation of the USI is presented in Section 12.2. This sensor type is used when no other specific serial sensor type can collect data from a serial sensor.

10.3.5. Configuring A Serial Sensor

Four Line Items in the Sensor Menu are required to be configured for any serial sensor. Use of the other 9 Line Items depends upon the sensor type and collection requirements.

- Line Item #1:   Sensor Type   Mandatory
- Line Item #3:   Channel   Mandatory
- Line Item #10   Sample Count   Any CCSAIL or SDI-12 Sensor
- Line Item #16:   Retry Count   Optional
- Line Item #17:   Depends on the Sensor Type   Depends on the Sensor Type
- Line Item #18:   Sensor Port Type.   Mandatory
- Line Item #19:   Sensor Baud Rate.   Mandatory
- Line Item #20:   Sensor Bits Per Character   General Serial Script Sensor Only
- Line Item #21:   Sensor Parity   General Serial Script Sensor Only
- Line Item #22:   Sensor Start Bits   General Serial Script Sensor Only
- Line Item #23:   Sensor Stop Bits   General Serial Script Sensor Only
- Line Item #24:   Sensor GSI Script Number   General Serial Script Sensor Only
- Line Item #25:   Sensor Data Collection Control   General Serial Script Sensor Only

Channel Selection and Communications Settings

> **You must identify the communications interface required by your serial sensor to select the correct channel because each channel supports a finite number of port types.**
>
> **If you don't set up the communications interface correctly, the ZENO®-3200 won't be able to collect data from the serial sensor.**

Each channel supports the following baud rates:

        300, 600, 1200, 2400, 4800, 9600, 19200

The port types available for each channel are listed in the following table:

Available Port Types	
Channel (COM Port)	Available Port Types
COM1	RS232, RS232H, RADIO, TW-RADIO
COM2	RS232*, RS232H, RS485*
COM3	
TTL INTERFACE*	TTL Only (listed as RS232)
COMPASS INTERFACE*	

*The TTL INTERFACE and COMPASS INTERFACE are multiplexed connections of COM2, along with the RS232 and RS485 connections.

> **COM2 is multiplexed to support up to four fully separated communication links.**

The following table summarizes the *typical* communication link associated with each sensor type:

Sensor Type		Typical Port Type (Line Item #18)	Typical Baud Rate (Line Item #19)
Code (Line Item #1)	Name		
11	Serial Compass	RS232 or TTL (TTL if used on COMPASS INTERFACE port)	4800
12	CCSAIL Sensor	RS232, RS485 or Two-way Radio	9600 or 1200 (if on two-way radio)
19	Asynchronous CCSAIL Sensor		
15	GPS Receiver	RS232 or RS485	4800
16	General Serial Script Sensor (USI)	Any	Any
13	SDI-12 Sensor	RS485	1200
17	Continuous SDI-12 Sensor		
18	Concurrent SDI-12 Sensor		

> **COM1 and COM3 are _NOT_ multiplexed: if you attempt to connect more than one serial sensor (or other communications link) to COM1 or COM3 using different port types, you will get garbled and unusable communication.**

In addition to the Port Type & Baud Rate for a General Serial Script Sensor (USI), you also need to specify four more serial port parameters:

- Line Item #20:   Sensor Bits Per Character   Valid values are 5, 6, 7 or 8.
- Line Item #21:   Sensor Parity   Valid values are N (none), E (even) or O (odd).
- Line Item #22:   Sensor Start Bits   Valid values are 1 or 2.
- Line Item #23:   Sensor Stop Bits   Valid values are 1 or 2.

The available serial sensor types are summarized in the following table, along with their available channels.

Sensor Type		Available Channels (Line Item #3)
Code (Line Item #1)	Name	
11	Serial Compass	COM1, COM2, COM3, TTL or COMPASS (depending upon sensor requirements)
12	CCSAIL Sensor	
15	GPS Receiver	
16	General Serial Script Sensor (USI)	
19	Asynchronous CCSAIL Sensor	COM1, COM2 or COM3 (but not specified using Line Item #3)
13	SDI-12 Sensor	COM2 or COM3
17	Continuous SDI-12 Sensor	
18	Concurrent SDI-12 Sensor	

For wiring information to each COM port, refer to Section 13.4.

Specifying Number of Serial Sensor Data Fields

Most serial sensors output more than one data field in their data messages. for some serial sensors, the number of data fields is known, but some require the user to specify how many data fields are to be received from the sensor. This is summarized in the following table:

Sensor Type		Number of Data Fields	
Code (Line Item #1)	Name	Number	Where Specified
11	Serial Compass	1	N/A
12	CCSAIL Sensor	Variable	Line Item #10
19	Asynchronous CCSAIL Sensor		
15	GPS Receiver	15	N/A
16	General Serial Script Sensor (USI)	Variable	USI
13	SDI-12 Sensor	Variable	Line Item #10
17	Continuous SDI-12 Sensor		
18	Concurrent SDI-12 Sensor		

CCSAIL and SDI-12 sensors require that you specify the number of received data fields using Line Item #10, the Sample Count. General Serial Script Sensors are different in that the USI script defines the number and type of data fields that are to be received from the sensor.[181]

Specifying Sensor Address

---

[181] Refer to Section 12.2.

All SDI-12 and CCSAIL sensors are designed to be used where there is more than one sensor present on a single communications link. for this reason, Line Item #17 is used by both SDI-12 and CCSAIL sensors to designate the address of the serial sensor. Sensors using the NMEA 0183 protocol are not addressable, but may be using optional checksum verification. for this reason, Line Item #17 for the GPS Receiver is used to specify whether to use checksum verification on received GPS messages.

| Sensor Type | | Line Item #17 | |
Code (Line Item #1)	Name	Usage	Valid Values
11	Serial Compass	N/A	N/A
12	CCSAIL Sensor	Sensor's CCSAIL Address	0 to 9998
19	Asynchronous CCSAIL Sensor		
15	GPS Receiver	Use Checksum Verification?	0 = no, 1 = yes
16	General Serial Script Sensor (USI)	Sensor Address	Depends upon sensor
13	SDI-12 Sensor	Sensor's SDI-12 Address	0 to 9 and A to F
17	Continuous SDI-12 Sensor		
18	Concurrent SDI-12 Sensor		

Communication Retries

Once you have specified all of the communications port parameters, it is important to decide if you need to use any "retries" for communication. Retries are necessary when:

- Communication between the ZENO®-3200 and the serial sensor is suspect.

- The serial sensor is busy and cannot immediately answer a poll to transmit data.

> **ZENOSOFT® will make as many extra attempts to receive data from a serial sensor as are defined by the Retry Count in Line Item #16. Once a data message is successfully received from the serial sensor, no more retries are made.**

> **If the ZENO®-3200 fails to communicate with a serial sensor, bit #4 in the Global BIT[182] is set as is bit #2 in the Sensor Record's Error and Status Code[183].**

User Interface Exclusion

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[182] Refer to Appendix D.
[183] Refer to Section 7.4.

> **Coastal Environmental Systems recommends that any communications port that is being used to collect data from a serial sensor should be excluded from the User Interface.[184]**

If the ZENO®-3200 attempts to look for access to the User Interface on a communications port that is configured to collect data from a serial sensor, the ZENO®-3200 may interfere with data collection to that serial sensor.

10.3.6. User-Specified Sensor Name

Use of the Sensor Name field, Line Item #2 in each Sensor Record, is strictly optional. You can specify up to an eight-character name for your particular sensor. The Sensor Name will appear adjacent to a reference to the Sensor Record when it is used as an input to a Process Record or Data Output Record.

> **Coastal Environmental Systems recommends that you use this optional field to specify a unique name for each Sensor Record in your sensor suite because it makes it a lot easier to understand what your configuration is doing.**

10.3.7. Setting How Often To Read A Sensor--The Sensor Timing Loop

Three line items in each Sensor Record control how often readings are taken from a sensor, the number of consecutive measurements taken during a single reading, and how many total readings can be taken during Sample Duration. These are summarized below:

- Line Item #10:   Sensor Sample Count
- Line Item #11:   Maximum Number of Readings
- Line Item #12:   Sensor Timing Loop

> **At the beginning of the Sample Duration, the ZENO®-3200 collects data once from all configured Sensor Records. Subsequent measurements are timed according to the Sensor Timing Loop specified by each Sensor Record within the same Sample Duration.**

This can be illustrated with a simple timing diagram. In the following diagram, the Sample Interval is set to 20 seconds, the Sample Duration is set to 19 seconds and the Sensor Timing Loop period is set to 2.5 seconds. A total of 8 sensor readings can be made every 2.5 seconds through a Sample Duration of 19 seconds.

---

[184] Refer to Section 6.12.

```
   Sample Interval    |--------------------------------------|   20s
   Sample Duration    |-------------------------------------| |   19s
   Sensor Timing Loop  ^    ^    ^    ^    ^    ^    ^    ^  |    2.5s

                    Sensor Reading at each ^
```
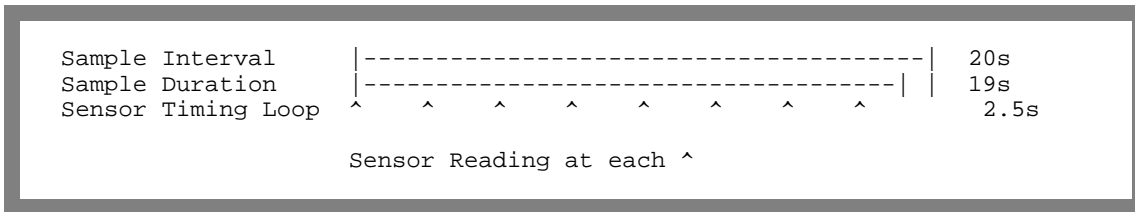
The Sensor Timing Loop (Line Item #12) defines how often the ZENO®-3200 will take a reading from the sensor through a Sample Duration. There are four Sample Timing Loops and they are numbered 1 through 4. The period of each Sensor Timing Loop is defined in seconds.

> **The smallest resolution that can be set for a Sensor Timing Loop period is 0.5 of a second.**
>
> **The period for Sensor Timing Loop #1 is always set to 0.5 seconds, but the settings for Sensor Timing Loops #2, #3 and #4 can be changed via the Sensor Timing Loop Menu.**

The Sensor Timing Loop Menu is accessible from the Zeno Program Menu. If you are in the Sensor Menu, return to the Zeno Program Menu by typing the command **Z{ENTER}**. Once in the Zeno Program Menu, type the command **T{ENTER}** to enter the Sensor Timing Menu and the screen should look something like this:

```
ZENO PROGRAM MENU
(S) Sensor Menu                          (M) Memory Management Menu
(P) Process Menu                         (W) Password Menu
(D) Data Output Menu                     (R) Reset System
(T) Sensor Timing Loop Menu              (E) Save Parameters To EEPROM
(O) Output Message Timing Menu           (U) User Menu
(L) System Load Menu                     (Q) Quit
(G) General Serial Script Menu           (H) Help

> T

SENSOR TIMING LOOP MENU
(Cn/m) Change Item n To Value m          (H) Help
(Z)    Zeno Program Menu

Item  1:  0.5        (Timing Loop #1 Period)
Item  2:  1.0        (Timing Loop #2 Period)
Item  3:  1.5        (Timing Loop #3 Period)
Item  4:  10.0       (Timing Loop #4 Period)

>
```

In the above example, the ZENO®-3200 will collect data from any sensor using Sensor Timing Loop #1 every 0.5 seconds and from any sensor using Sensor Timing Loop #2 every second. The ZENO®-3200 will collect data from any sensor using Sensor Timing Loop #3 every 1.5 seconds and from any sensor using Sensor Timing Loop #4 at every 10.0 seconds.

The values set for Sensor Timing Loops #2, #3 and #4 can be set to any value at or above 0.5 seconds and be divisible by 0.5 seconds.

> **Coastal Environmental Systems recommends that the period length of each Sensor Timing Loop should increase with Sensor Timing Loop index number. This is not necessary, but it makes it easier to remember which Sensor Timing Loop has the longer period length.**

10.3.8. Setting The Maximum Number of Readings

You can specify a limit to the number of readings taken from a sensor over the course of the Sample Duration. This is done using Line Item #11.

In Section 10.3.7, an example timing diagram was made showing a Sample Interval of 20 seconds, a Sample Duration of 19 seconds and a Sensor Timing Loop period of 2.5 seconds. In that example, there was no limit placed upon the total number of readings to be taken, so with such a configuration, the ZENO®-3200 would collect data from that sensor 8 times during each Sample Duration. Lets say that you only want to collect data 3 times through each Sample Duration of 19 seconds, but at a Sensor Timing Loop period of 2.5 seconds. By setting the Maximum Number of Readings (Line Item #11) to 3, that is exactly what will happen:

```
Sample Interval      |-------------------------------------|    20s
Sample Duration      |------------------------------------| |   19s
Sensor Timing Loop   ^     ^      ^                            2.5s
Maximum Readings                 stop                            3

                     Sensor Reading at each ^
```

> **Setting the Maximum Number of Readings (Line Item #11) to 0 means there is no limit.**

The valid range of values that can be set for Line Item #11 is 0 to 32,767.

10.3.9. Setting Number of Measurements To Take--Sensor Sample Count

> **For any analog or digital sensor, the Sensor Sample Count, Line Item #10, specifies how many individual measurements will be taken during a single sensor reading.**
>
> **This is _not_ the same usage as for Serial Sensors.[185]**

If you want to take multiple, consecutive measurements to increase accuracy of reading an analog or digital sensor, you can specify the total number of measurements in Line Item #10, the Sensor Sample

---

[185] Refer to Section 10.3.5.

Count. When the Sensor Sample Count is set to one, only one measurement for the analog or digital sensor is taken at each Sensor Timing Loop period.

> **When the Sensor Sample Count is greater than one, the ZENO®-3200 will take more than one measurement of the analog or digital sensor and report the average of all measurements taken.**

In Section 10.3.7, an example timing-diagram was made showing a Sample Interval of 20 seconds, a Sample Duration of 19 seconds and a Sensor Timing Loop period of 2.5 seconds. As an example, you want to increase the accuracy of an 18-bit ADC sensor. To do this, take three consecutive measurements at each Sensor Timing Loop period and average them, which will increase accuracy. Setting the Sensor Sample Count (Line Item #10) to 3 can be illustrated with the following timing diagram:

```
Sample Interval      |-------------------------------------|   20s
Sample Duration      |------------------------------------| |   19s
Sensor Timing Loop   ^     ^     ^     ^     ^     ^     ^     ^     2.5s
Sensor Sample Count ¤¤¤   ¤¤¤   ¤¤¤   ¤¤¤   ¤¤¤   ¤¤¤   ¤¤¤   ¤¤¤      3

                     Sensor Reading at each ^
                     Individual Measurement at each ¤
```
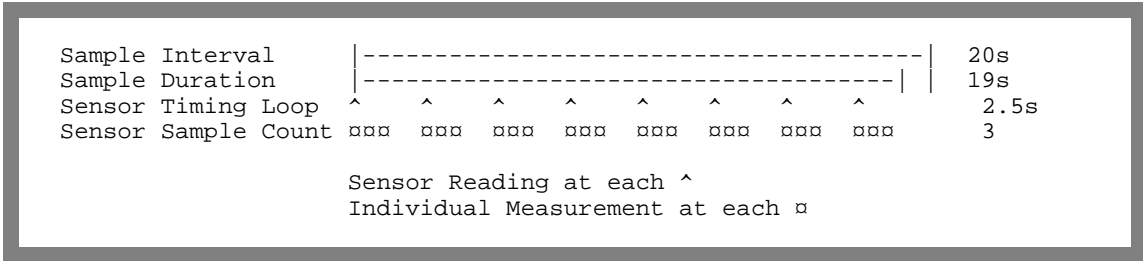
> **Care must be taken when setting the Sensor Sample Count in conjunction with the Sensor Timing Loop period because taking multiple consecutive measurements increases the time required for each reading of that sensor.**

> **The more time it takes to read an individual sensor, less time is available for other similar sensor types to get their readings.**

> **Configuration timing issues are explained in detail in Section 12.1.**

The default (and minimum) value for the Sensor Sample Count is 1. The maximum value is 255.

10.3.10.   Using Switched Voltage To Control Sensor Power

The ZENO®-3200 provides two 5 V DC and three 12 V DC switched, regulated output voltages for powering sensors.

> **The ZENO®-3200 conserves power by turning on a switched voltage *only* *when* a sensor is read.**
>
> **In the event that more than one sensor can be powered by a single switched voltage, the ZENO®-3200 turns on the switched voltage as long as at least one sensor requires power.**

Line Item #6 is used to assign one of the five switched voltages in the Sensor Menu. The following table below indicates the maximum current available from each source.

Line Item #6 Value	Power source	Maximum current
0	No Switched Voltage	0
1	5 V Switched A	200 mA mean, 600 mA peak*
2	5 V Switched B	200 mA mean, 600 mA peak*
3	12 V Switched A	700 mA
4	12 V Switched B	150 mA
5	12 V Switched C	150 mA

*The two 5V switched power outputs can together provide a total of 200 mA mean power, 600 mA peak power, partitioned as required

> **Connect the sensor's positive power terminal to the same switched voltage on the ZENO®-3200 Front Panel[186] as specified in the ZENOSOFT® configuration.**
>
> **Connect the sensor's negative power terminal (may also be called common or return) to one of the grounds marked as GND on the ZENO®-3200 Front Panel.[187]**
>
> **Refer to Section 13.2 for a full discussion on grounding.**

10.3.11. Specifying Warm-up Time for a Sensor Using Switched Voltage

Your sensor may require time to warm up prior to being read in order to provide accurate measurements. The ZENO®-3200 allows you to specify a Sensor Warm-up Time using Line Item #9 in the Sensor Menu if your sensor is being powered by a switched voltage specified in Line Item #6.[188]

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[186] Refer to Section 2.1.
[187] Refer to Section 2.1.
[188] Refer to Section 10.3.10.

> **The ZENO®-3200 will turn on a switched voltage before the start of a Sample Interval when the sensor requires time to warm up.**
>
> **If the Sensor Warm-up Time is set to a value longer than the Sample Interval, the ZENO®-3200 will always keep the designated Switched Voltage on.**
>
> **If more than one sensor is on the same Switched Voltage and all require warm-up time, the Switched Voltage will be turned on based upon the sensor with the longest warm-up time.**
>
> **No warm-up time will occur if no Switched Voltage is specified for the sensor.**

The valid range of values for the Sensor Warm-up Time (Line Item #9) is 0 to 255 seconds.

10.3.12.   Using Excitation Voltage and Returns To Control Sensor Power

> **The Excitation Voltage can be used to cancel errors due to reference voltage drift in ratio-metric measurements, such as bridge sensors, because the Excitation Voltage is referenced to the same voltage reference as the A/D converter.**

The Excitation Voltage outputs are marked **EXC +** on the ZENO®-3200 Front Panel.[189]

The Excitation Voltage can be set to one of four values in Line Item #7 in the Sensor Menu. The values are described in the following table.

Line Item #7 Value	Excitation Voltage Setting	Comments
0	No excitation voltage (0 V DC)	N/A
1	1.25 V DC	Use if sensor self-heating is a problem
2	2.50 V DC	Use for highest accuracy
3	5.00 V DC	Use if noise pickup is severe

The sensor's positive power terminal is connected to one of the outputs marked **EXC +** on the ZENO®-3200 Front Panel.[190]

The sensor's negative power terminal is connected to one of the grounds marked AGND or one of the five terminals labeled as SWITCHED EXCITATION RETURNS on the ZENO®-3200 Front Panel.[191] The Switched Excitation Return Channels are labeled **A**, **B**, **C**, **D** or **E**. If one of the Excitation Voltage Return Channels is used, then you need to specify which Switched Excitation Return Channel is being used in Line Item #8 of the Sensor Menu.

---

[189] Refer to Section 2.1.
[190] Refer to Section 2.1.
[191] Refer to Section 2.1.

> **The ZENO®-3200 sets the Excitation Voltage to the value specified in Line Item #7 _and_ turns on the Excitation Voltage Return Channel specified in Line Item #8 _only when_ a measurement from the sensor is being taken.**
>
> **Sensor Warm-up Time DOES NOT APPLY to the Excitation Voltage. DO NOT USE the Excitation Voltage IF your sensor requires a warm-up time.**

The amount of available power that the Excitation Voltage provides is more limited than what the Switched Voltage provides:

> **The Excitation Voltage can supply up to 100 mA.**
>
> **You can put more than one sensor on a given Excitation Voltage Return Channel, if the Excitation Voltage used by one sensor is not so large that it will damage the others.**
>
> **If you need to connect more than one sensor to a single Excitation Return Channel, Coastal Environmental Systems recommends that the sensors operate at the same voltage.**

When the Excitation Voltage and the Excitation Voltage Return Channels are not in use, the connections are floating. Thus, current will flow through your sensor only while the ZENO®-3200 is sampling the sensor. This process avoids sensor self-heating problems and reduces the system's power consumption.

With analog sensors, an important consideration with use of the Excitation Voltage and Return for powering the sensor is the time required for the voltages to reach steady state: a measurement taken too quickly after the Excitation Return is closed may result in inaccurate voltage readings. It may therefore be necessary to set Line Item #17 in the analog sensor to a non-zero value to increase the delay time between the time the Excitation Return is closed and the measurement is taken. Please refer to Section 10.3.1 for more information about setting Line Item #17.

10.3.13.   Setting Scaling (Calibration) Coefficients

> **Scaling (calibration) coefficients are used primarily with analog and digital sensors, and can be used to calibrate a sensor or to convert a voltage into standard engineering units.**

Line Items #13, #14 and #15 are used in each sensor record for the three scaling (calibration) coefficients. They define the coefficients used in the following quadratic equation:

$$x = A\,v^2 + Bv + C\ .$$

_v_ is the unprocessed sensor output (in volts) represented by the A/D converter output, and _x_ is the value in the desired engineering units.

> **If your sensor output is linear[192], then coefficient A is always zero.**

In the case of linear sensor, to calculate B and C, you need to know the following values:

- The output voltage range of the sensor, v_{min} to v_{max}.
- The corresponding range in engineering units, x_{min} to x_{max}.

The slope B is given by the equation:

$$B = \frac{x_{max} - x_{min}}{v_{max} - v_{min}}$$

The offset C is given by the equation:

$$C = \frac{x_{min} v_{max} - x_{max} v_{min}}{v_{max} - v_{min}}.$$

As an example, a sensor voltage range is 0 to 2.5 VDC and it represents the linear range of 0 to 355 degrees in engineering units. To determine the coefficients B and C, you will obtain the following:

$$v_{min} = 0 \quad v_{max} = 2.5$$
$$x_{min} = 0 \quad x_{max} = 355$$
$$B = \frac{355 - 0}{2.5 - 0} = 142$$
$$C = \frac{(0 \times 2.5) - (355 \times 0)}{2.5 - 0} = 0$$

The above example gives B=142 and C=0, and the A/D converter input range is -0.512 VDC to +0.512 VDC.

> **If your sensor output is nonlinear, coefficient A will not be zero.**
>
> **Nonlinear sensor outputs are not necessarily parabolic[193], but the quadratic equation may approximate the desired, scaled readings within a limited range.**
>
> **If your nonlinear sensor output cannot be accurately scaled using the quadratic equation, then use one or more Processes (refer to Section 10.4) to create the scaled value.**

---

[192] Linear means that for any sensor voltage change, the equivalent value in engineering units changes proportionally the same amount.

[193] Parabolic means that as the sensor voltage changes, the change in scaled units changes proportionally to the square of the sensor voltage.

In the case of parabolic (or near-parabolic) sensor outputs, three sensor voltage readings along with their corresponding scaled values must be known in order to calculate the three coefficients A, B and C:

- The three sensor voltage readings are defined by v_1, v_2 and v_3.

- The three corresponding scaled values are defined by x_1, x_2 and x_3 respectively.

First, calculate the divisor named DIV:

$$DIV = v_1^2(v_2 - v_3) + v_2^2(v_3 - v_1) + v_3^2(v_1 - v_2)$$

Coefficients A and B are calculated by the next two equations:

$$A = \frac{x_1(v_2 - v_3) - x_2(v_1 - v_3) + x_3(v_1 - v_2)}{DIV}$$

$$B = -\frac{x_1(v_3^2 - v_2^2) + x_2(v_1^2 - v_3^2) + x_3(v_2^2 - v_1^2)}{DIV}$$

Coefficient C is calculated using the next equation once coefficients A and B are calculated:

$$C = v_1 - Ax_1^2 - Bx_1$$

From the previous example, if the value in engineering units is actually 150 degrees at 1.25 VDC instead of 177.5 degrees at 1.25 VDC, a parabolic approximation will provide better accuracy for converting the sensor voltage to engineering units:

$$v_1 = 0 \quad v_2 = 1.25 \quad v_3 = 2.5$$
$$x_1 = 0 \quad x_2 = 150 \quad x_3 = 355$$
$$DIV = 0^2(1.25 - 2.5) + 1.25^2(2.5 - 0) + 2.5^2(0 - 1.25) = -3.90625$$
$$A = \frac{0(1.25 - 2.5) - 150(0 - 2.5) + 355(0 - 1.25)}{-3.90625} = 17.6$$
$$B = \frac{0(2.5^2 - 1.25^2) + 150(0^2 - 2.5^2) + 355(1.25^2 - 0^2)}{-3.90625} = 98$$
$$C = 0 - 17.6 \times 0^2 - 98 \times 0^2 = 0$$

For this example, if you set coefficients A, B, and C to the values 17.6, 98, and 0 respectively, you will obtain the correct values in engineering units from the parabolic sensor.

> **You can reset the calibration coefficients within the Test Menu without going into the Zeno Program Menu and stopping data sampling.[194]**

10.4. DEFINING THE DATA PROCESSES

The ZENO®-3200 provides a large library of processes that allow you to process the collected sensor data in innumerable ways. Defining a Process Record is done via the Process Menu which is accessible from

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[194] Refer to Section 7.2 for details.

the Zeno Program Menu by typing the command **P{ENTER}**. A Process Record may look something like this:

```
PROCESS MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard              (XA) Delete ALL Records
(C)    Copy Record To Clipboard             (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard          (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 1 of 14:
Item  1: Process Category                    2  : Environmental
Item  2: Process Number                      2  : Running Wind Vector Avg. Process
Item  3: User-defined Process Name        wavg3
Item  4: Input for Wind Speed              S2  : wspd
Item  5: Input for Wind Direction          S3  : wdir
Item  6: Input for Compass                 S1.1 : ritchie
Item  7: Wind Gust Window (1 to 5 secs.)   4
Item  8: Running Average Time (minutes)    10
Item  9: Percent Valid Data                31

>
```

> **The first three Line Items of a Process Record <u>are common to all processes</u>,
> but any Line Items beyond the first three are unique for each process
> because each process performs unique arithmetic operations and require
> different data.**

10.4.1. Process Category and Process Number

Line Items #1 and #2 of any Process Record define the Process Category and Process Number of a particular process.

> **The ZENO®-3200 contains over 60 processes in its library! for this reason,
> processes are classified and grouped according to a Process Category.**

There are six Process Categories in the standard ZENO®-3200[195] and they are listed in the following table. The first column contains the identifier code for each category that is used in Line Item #1 of any Process Record.

---

[195] Some specialized versions of ZenoSoft™ contain a seventh category or extra processes in other categories.

Category Number (Line Item #1)	Process Category Name	Description
1	General Processes Category	Processes that perform simple averaging, running averages, rate of change, etc. on any type of data.
2	Environmental Processes Category	Processes that calculate all types of environmental data such as dewpoint, average wind speed, vector average wind direction, rainfall, etc.
3	Alarm Processes Category	Processes that perform conditional analysis such as out of range calculations, error checking, setting of flags, turning on or off digital outputs on specific conditions, etc.
4	Special Sensor Processes Category	Processes that calculate data on unique sensors such as thermistors, thermocouples, dual-barometric pressure sensors, etc.
5	Arithmetic Processes Category	Processes that perform simple addition, subtraction, multiplication, division, polar to Cartesian conversion, Boolean operations, etc.
6	Control and Output Processes Category	Processes that control special output boards such as a digital-to-analog converter.

Processes within each category are numbered. This Process Number corresponds to the value that is used to identify each process type (along with the Process Category). The Process Number is specified in Line Item #2 of each Process Record.

The following table lists all of the processes along with the Process Category that each process is classified.

For a detailed description of each process, refer to Appendix D.

Process Category Code (Line Item #1)	Process Number (Line Item #2)
1 - General Processes Category	1 - Immediate Data 2 - Average The Data Over The Sample Time 3 - Running Average 4 - Block Average 5 - Accumulate Data Over The Sample Time 6 - Rate of Change 7 - Differential 8 - Free-Running Average 9 - Collection 10 - Trend Data 11 - Multiple-Input Minimum/Maximum 12 - Previous Sample Data 13 - Multiple Data Validation 14 - Single Data Validation
2 - Environmental Processes Category	1 - Wind Vector Average 2 - Running Wind Vector Average 3 - Block Average Direction 4 - (Vehicle Mounted) True Wind Vector Average 5 - Barometric Pressure 6 - Rainfall 7 - Dewpoint 8 - Evapotranspiration 9 - Free Running Wind Vector Average 10 - Altimeter Setting 11 - FAA SAWS Wind Gust 12 - NWS Running Average Wind Speed 13 - NWS Running Vector Average Wind Direction 14 - FAA Running Wind Average
3 - Alarm Processes Category	1 - Built-In-Test (Bit) 2 - Data Range 3 - Alarm 4 - Data Time-Out 5 - Alarm Reset 6 - Two-Range Alarm 7 - Two-Range Alarm Constants 8 - Missing Sensor Data 9 - Multiple Alarm 10 - Alarm Message 11 - Incremental Change Alarm 12 - Error Checking Alarm 13 - Timed Event 14 - One-Shot Daily Timed Event 15 - Static Data Alarm
4 - Special Sensor Processes Category	1 - NTC Thermistor 2 - Paroscientific Barometer 3 - Thermocouple 4 - Raw GPS To Real Number 5 - UV Biometer 6 - PIR Temperature Correction 7 - Four-Pole Switch 8 - Dual Barometric Pressure Sensor Validation
5 - Arithmetic Processes Category	1 - U-V Vectors To Magnitude-Direction

	2 - Add Constant Value
	3 - Add Two Data Values
	4 - Subtract Two Data Values
	5 - Multiply By A Constant
	6 - Multiply Two Data Values
	7 - Divide Two Data Values
	8 - Quadratic
	9 - Invert Data Value
	10 - Raise Data Value To A Constant Power
	11 - Add Multiple Data Values
	12 - Polynomial
	13 - Conditional Select
	14 - Boolean Combine Data & Constant
	15 - Boolean Combine Data
	16 - Data Rounding
6 - Output and Control Processes Category	1 - Digital-To-Analog Output

10.4.2. User-Defined Process Name

Use of the User Defined Process Name field, Line Item #3 in each Process Record, is strictly optional. It is equivalent to specifying a user-defined Sensor Name for each Sensor Record (refer to Section 10.3.6). You can specify up to an eight-character name for process. The User-defined Process Name will appear adjacent to a reference to the Process Record when it is used as an input to another Process Record or Data Output Record.

> **Coastal Environmental Systems recommends that you use this optional field to specify a unique name for each Process Record because that makes it much easier to understand what your configuration is doing.**

10.4.3. Selecting the Appropriate Processes

Answering the following questions will assist you in deciding what processes are required in your configuration:

- What data needs to be logged?
- What data needs to be transmitted?
- Which data that needs to be logged and/or transmitted comes directly from Sensor Records?
- Which data that needs to be logged and/or transmitted is not directly available from individual Sensor Records? This data needs to be processed.
  - How does each datum need to be processed?
  - In which category of processes can each datum be classified?
  - Which process output most closely matches each required datum?
  - Which data require multiple processes to be calculated?

> **The most important resource in knowing which processes you will need to
> use in your configuration is Appendix D of this manual, which contains
> detailed information about each process available in the ZENO®-3200.**

10.4.4. Unique Data Inputs and User Inputs for Each Process

A process can have Data Inputs, User Inputs, both or neither.

> **Any Process Record line item that requires a reference to a Sensor Record
> or a preceding Process Record is called a Data Input to the process.**
>
> **Any Process Record line item that requires a numerical value is called a
> User Input to the process.**

In the example Process Record, shown at the beginning of Section 10.4, Line Items #4 through #6 are
Data Inputs and Line Items #7 through #9 are User Inputs.

For any Data Input to a Process Record (or any Input Record for a Data Output Record[196]), the following
format is used to reference a data value collected by a particular Sensor or Process Record:

	Originating From	
Type of Data	**A Sensor Record**	**A Process Record**
Floating point	`Sn.m` or `Sn`	`Pn.m`
Long-integer	`Sn.Lm`	`Pn.Lm`
String	`Sn.Sm`	(N/A)
Error & Status Codes[197]	`Sn.E1`, `Sn.E2` or `Sn.E3`	`Pn.E1`

For any format, **n** is the record index number and **m** is the data value index number. In the case that you
are referencing data collected by a Sensor Record that only gets a single data value, you can use the
shorthand format **Sn** because the only possible value for **m** would be 1. This is usually only applicable to
an analog or a digital sensor.

> **The user-defined name that is set for a Sensor or a Process Record[198] is
> displayed when you refer to that record.[199]**

There are several types of User Inputs to Process Records:

- Floating-point
- Hexadecimal integer
- Time (which may include date)

The type of User Input and the range of valid values that can be specified for a particular User Input are
specified for each process type in Appendix D.

---

[196] Refer to Section 10.6.6.
[197] Error & status codes are treated as long integers by the ZENO®-3200. Information about these codes is available
in Sections 7.4 and 10.4.5.
[198] Refer to Sections 10.3.6 and 10.4.2.
[199] This is illustrated in the example Process Record shown at beginning of Section 10.4.

10.4.5. Process Error Checking and Reporting

Sometimes, the ZENO®-3200 cannot collect data from sensors for one or more reasons:

- Disruption in serial communication with a serial sensor
- Insufficient time to collect data from all configured sensors[200]
- Poor electrical connections to a sensor

When the ZENO®-3200 cannot collect data from a particular sensor, the output of that sensor will be set to a specific value that indicates invalid data:

- -1,000,000 for floating-point data
- 0xffffffff for long integer data
- a null string[201] for string data

> **-1,000,000 or 0xffffffff is referred to as a Bad Sensor Value or "BSV."**

ZENOSOFT® was enhanced to prevent processes from erroneously processing invalid data.

> **Any process that inputs data from a Sensor or a previous Process Record that is a BSV will NOT use the BSV in its calculations. Instead, the process will ignore the BSV and output BSVs of its own, or leave its data unchanged depending upon the nature of the process.**

As a general rule, any process that accumulates data over time to calculate its outputs will simply ignore BSVs and leave its own data unchanged, but any immediate data outputs will be set to BSVs.

To report that an error has occurred in a process, every process has an extra error output designated as output E1. E1 is a long integer output. The following types of errors are reported in error output E1:

Bit	Meaning
1	Process not evaluated during sample interval.
2	Input data is out of range.
3	Input data is a Bad Sensor Value (BSV, -1,000,000 or 0xFFFFFFFF).
4	Input data is intermittently bad or out of range during sample interval.
5	Input data is questionable (from a process reporting an error).
6	User input data out of range.
7	Internal error (meaning depends upon process).
8	Not defined.

When a process receives a BSV, it will set bit 3. If the process receives the BSV more than once during a sample interval, it will also set bit 4. If an input to a process has a limited range of acceptable values, and

---

[200] This is usually the result of an incorrect configuration.
[201] A null string is a string containing no characters. It has a length of zero.

the received value is out of range, bit 2 will be set in the error output of the process. If due to a timing problem a process is never evaluated during a sample interval, bit 1 will be set.

To simplify analysis of multiple problems within a configuration, an Error Checking Alarm Process can be created (Category 3, Number 12). It will report the total number of processes reporting errors and the first four process record numbers as well as their error codes.

10.5.   DEFINING CONSTANTS

Twenty user-definable floating-point constants are available to the user in the Constants Menu.[202]

> **Constants defined in the Constants Menu can be used as inputs to Process Records or outputted in the Data Output Records.**

> **You might want to use a constant as a replacement to real data collected by a sensor when a particular sensor is not available.**

The Constants Menu is accessible from the System Functions Menu by typing the command **K{ENTER}**. The Constants Menu will look something like this:

```
CONSTANTS MENU
(Cn/m) Change Constant n to Value m            (E) Save Parameters To EEPROM
(P)    Previous Page of Constants              (U) User Menu
(N)    Next Page of Constants                  (Q) Quit
(X)    Erase All Constants                      (H) Help


Constants 1 through 20
Constant  1: 100             Constant 11: 0
Constant  2: 200             Constant 12: 0
Constant  3: 300             Constant 13: 0
Constant  4: 3.14159         Constant 14: 0
Constant  5: -9.23e-10       Constant 15: 0
Constant  6: 0               Constant 16: 0
Constant  7: 0               Constant 17: 0
Constant  8: 0               Constant 18: 0
Constant  9: 0               Constant 19: 0
Constant 10: 0               Constant 20: 0

  >
```

---

[202] Some versions of ZenoSoft™ support as many as 60 constants. Since only 20 constants can be adequately shown on a single page, options P and N were added to the Constants Menu to allow you to see constants numbered greater than 20.

> **The range for any constant is a floating-point number between**
> **±3.40282334663×10³⁸.**

To refer to a constant as a Data Input or Data Output Record Data Field, use the form **Cn**, where **n** is the constant number between 1 and 20.

If the number you want to enter requires scientific notation, **n×10ᵈ**, enter the value using the format **ned**. for example, to enter the number $1.25×10^{20}$ for constant #1, you would type the command **C1/1.25e20{ENTER}**. As another example, to enter the number $9.653×10^{-15}$, you would type the command **C1/9.653e–15{ENTER}**. This is the same format, which will appear in the Constants Menu.

> **The values of constants can be changed while the ZENO®-3200 collects data**
> **without any disruption to data collection.**

10.6.   DEFINING DATA TO BE TRANSMITTED AND/OR LOGGED

Data that is to be logged and/or transmitted by the ZENO®-3200 is defined using the Data Output Menu.

The Data Output Menu allows you to define:

- The contents of up to four different output messages, transmitted on the same or different communications ports.
- Data fields that can be conditionally added to a message, which are commonly used within Alarm Messages.[203]
- What data fields are to be logged in ZENO®-3200 RAM[204] for later retrieval.

10.6.1. Data Record Structure

> **The ZENO®-3200 logs data as binary data, meaning that each data field**
> **takes up as little memory as possible to optimize memory usage.**

> **A Data Record is the complete set of Data Output Records that define all the**
> **data to be logged in ZENO®-3200 RAM at the end of each Sample Duration**
> **for later retrieval[205].**

---

[203] Refer to Section 11.
[204] Refer to Section 2.3.1.
[205] Refer to Section 4.

> **A Data Output Record is an individual data field to be transmitted in an output message or logged in a Data Record and is defined in the Data Output Menu.**

Data Output Records can be subdivided into three different field type categories:

- Field types that transmit information or data only
- Field types that log data into ZENO®-3200 memory only
- Field types that both log and transmit data

> **If no Data Output Records specify a field type that logs data, then no data will be logged by the ZENO®-3200.**

> **Any time one or more data is logged, the ZENO®-3200 _always_ logs the Time Stamp as the first four bytes of the Data Record.**

> **The order of the Data Output Records that log data defines the order of the data fields within the Data Record.**

As an example, you have a configuration that contains 15 Data Output Records, of which Data Output Records #5, #8 and #12 are the only ones that log data. The Data Record will consist of four data fields: the Time Stamp, followed by the data referred to by Data Output Records #5, #8 and #12 respectively. If you were to go the Data Retrieval Menu[206] to retrieve the logged data, you will retrieve Data Records consisting of those four data fields.

> _The data content and length of each Data Record is the SAME!_
>
> _You cannot configure different Data Records of different lengths!_

> **If more than one Output Message contains fields that log data, each logged Data Record will contain ALL of the logged data from ALL of the output messages in the order of the Data Output Records!**

---

[206] Refer to Section 4.

10.6.2. Output Message Structure

Like the Data Record structures, the order and field types defined in each Data Output Record determine the contents of each Output Message.

> **Except for the GOES Binary and ARGOS Binary field types, the ZENO®-3200 transmits Output Messages using the standard ASCII character set.[207]**

Unlike the Data Record structure that is limited to one length and content definition for a configuration, up to four unique output messages can be configured in the ZENO®-3200 within a single configuration.

> **What is transmitted automatically in an output message can be totally different from what is logged in each Data Record in the ZENO®-3200 memory.**

> **If no Data Output Records specify a field type that transmits data, then no data will be automatically transmitted by the ZENO®-3200.**

> **The order of the Data Output Records that transmit data defines the order of the data fields transmitted automatically in an output message.**

> **When configuring more than one output message, Coastal Environmental Systems recommends that you group the Data Output Records common to each output message together as much as possible. Data Output Records that define data fields for more than one output message are the exception.**

---

[207] ASCII, the acronym for American Standard Code for Information Interchange, is an encoding standard used by computers for 128 characters, numbers, and symbols commonly used in written communication. The first 32 characters are control characters. The second group of 32 characters contains punctuation marks, special characters and numeric digits. The third group of 32 characters contains mostly uppercase alphabetic characters and the fourth group of 32 characters contains mostly lowercase alphabetic characters.

10.6.3. The Different Types of Data Output Records

Line Item #1 of the Data Output Menu defines the Field Type Code of each Data Output Record. To go to the Data Output Menu, type the command **D{ENTER}** from the Zeno Program Menu. A fully configured Data Output Record could look something like this on your terminal emulation program screen:

```
DATA OUTPUT MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 28 of 72:
Item  1: Field Type Code          9 : Transmit and Log Data Field
Item  2: Output Message(s)        1
Item  3: Field Name               heading
Item  4: Input Record             P1.10 : wavg3
Item  5: Field Decimal Places     1
Item  6: Field Width              6
Item  7: Data Storage Class Code  7 : 2-byte compressed float

>
```

The current library of 20 different Field Type Codes (numbered 0 through 19) is summarized in the following table:

Table of Data Output Record Field Type Codes		
Field Type Code (Line item #1 Value)	**Field Type Code Name**	**Field Type Category**
0	Null field	Transmit Only
1	Checksum	
2	NMEA Checksum	
3	Timestamp	
4	Primary Unit ID Number	
5	Secondary Unit ID Number	
6	Literal String	
7	Data Transmit Only	
8	Data Log Only	Log Only
9	Data Transmit and Log	Transmit and Log
10	Conditional Start	Transmit Only
11	Conditional Stop	
12	Data in GOES Binary Format	
13	Data in ARGOS Binary Format	
14	Start Checksum	
15	Selectable Data Transmit and Log	Transmit and Log
16	Message Number	Transmit Only
17	Resetable Record Number	
18	Backspace	
19	FAA Wind Data Transmit Only	

More complete descriptions of each Data Output Field Type Codes are shown in the next table:

Detailed Information about Data Output Field Type Codes		
Field Type Code (Line Item #1)	Field Type Code Name	Description
0	Null field	Place holder that will cause the ZENO®-3200 to print an extra delimiter character as specified in the System Functions Menu (refer to Section 4.4).
1	Checksum	Sum of all the ASCII characters from the start of the message (not including the leading # sign if a CCSAIL Format is specified, refer to Sections 4.4 and 4.6) or from the Start Checksum Field Type (Code #14). Number of least significant digits displayed set by Line Item #5. No delimiter character follows this field.
2	NMEA Checksum	Hexadecimal value that is the exclusive-or of all the characters between Literal String Field Type Codes containing $ and *, as specified by NMEA 0183 (refer to Section 10.3.3).[208]
3	Timestamp	The ZENO®-3200 prints the current date and time in the form **YY/MM/DD hh/mm/ss**, where **YY** is the year, **MM** is the month, DD is the day, **hh** is the hour, **mm** is the minutes and **ss** is the seconds.
4	Primary Unit ID Number	The ZENO®-3200 prints the 4-digit Primary Unit ID as specified in the System Functions Menu (refer to Section 5.5).
5	Secondary Unit ID Number	The ZENO®-3200 prints the 4-digit Secondary Unit ID as specified in the System Functions Menu (refer to Section 5.6).
6	Literal String	The ZENO®-3200 prints the characters specified in Line Item #3. An example of using this Field Type is to insert a **{CR}{LF}** at the beginning or ending of each output message. This is done by setting the contents of Line Item #3 to **<D><A>**, the ASCII hexadecimal values for a carriage return & line feed respectively.
7	Data Transmit Only	Data referenced in Line Item #4 is transmitted, but not logged into ZENO®-3200 memory.
8	Data Log Only	Data referenced in Line Item #4 is logged into ZENO®-3200 memory, but not automatically transmitted. (Data that is logged only is printed when requested in the Data Retrieval Menu. Refer to Section 4.)
9	Data Transmit and Log	Data referenced in Line Item #4 is both logged into ZENO®-3200 memory and automatically transmitted.
10	Conditional Start	Indicates that any following Data Output Records will be transmitted when the specified Data Input is non-zero until a Data Output Record specifying a Conditional Stop is encountered. Any Data Output Records logging data WILL continue to be logged regardless of the condition.
11	Conditional Stop	Indicates the end of a conditionally printed Data Output Records indicated by a previous Data Output Record specifying a Conditional Start Field Code.
12	GOES Binary Format	ASCII-encoded binary data. Refer to Section 6.7.11.
13	ARGOS Binary Format	ASCII-encoded binary data. Refer to Section 6.8.6.
14	Start Checksum	Indicates that all characters following this point in the message are to be included in a checksum calculation using either Field Type

---

[208] NMEA 0183 is a communications protocol established by the National Marine Electronics Association. Information about NMEA is available at http://www.nmea.org.

		Codes #1 or #2. No characters preceding this point in the message will be included in a checksum calculation following this field.
15	Selectable Data Transmit and Log	When more than one output message is transmitted, the data that is both logged and transmitted is selected based upon the output message number. Line Items #4, #8, #9 and #10 specify which data is selected based upon output message #1, #2, #3 and #4 respectively.
16	Message Number	Prints the output message number (1 through 4). This will always be 1 when only one output message is specified.
17	Resetable Record Number	A record counter can be outputted to provide a means of counting the outputted records. To set the values for the record counter, set two menu items in the Output Timing Menu: the Record Counter Starting Value and the Record Counter Reset Value.[209]
18	Backspace	The previous character is removed from the output message before transmission.
19	FAA Wind Data Transmit Only	This is a special data output requiring 3 data input fields for wind speed, wind direction and wind gust. If the wind speed is below 2.5 knots, the output is "CALM." If the wind speed is greater than or equal to 2.5 knots, the output is as "dddss" where "ddd" is the three-digit wind direction and "ss" is the 2-digit wind speed. If the wind speed is greater than 99, the output becomes "dddsss." If there is a wind gust present, then the output becomes "dddssGgg" where "ddd" and "ss" are the same as before and "gg" is the wind gust. If the wind gust exceeds 99, then the output becomes "dddssGggg."

10.6.4. Setting Which Output Message Uses Which Data Output Record

A single Data Output Record can apply to a single output message or to multiple output messages. Line Item #2, in the Data Output Menu, defines which output message (or messages) where each Data Output Record is being used. A single output message number, or a comma-delimited list of message numbers containing up to 4 output message numbers, can be specified in Line Item #2.

If, for instance, you want a particular Data Output Record to apply to output message #2, you would type the command **C2/2{ENTER}** in the Data Output Menu while viewing the desired Data Output Record. If you want a Data Output Record to apply to output message #2 and #4, you would type the command **C2/2,4{ENTER}** in the Data Output Menu while viewing the desired Data Output Record.

```
Specifying which output message that a Data Output Record applies DOES
NOT specify whether the data will be logged.
```

---

[209] This record counter is NOT an actual count of the number of records stored in logging memory, but a count of the number of records currently being outputted.

> **Instead, you need to specify which Data Output Field Type to use to determine whether you want the data logged.**

> **Data is only logged at the end of a Sample Duration, not necessarily when an output message is sent.**

> **If Field Type Code #8 (Log Data Only) is used, specifying an output message number does not apply.**

10.6.5. The Data Output Record Field Name--A Columnar Heading Or A Literal String

Line Item #3 in the Data Output Menu specifies the user-defined Field Name for a Data Output Record.

> **The user-defined Field Name for any Data Output Record that logs data is used as a columnar heading when data are retrieved in the Data Retrieval Menu[210].**

> **The other primary use of the user-defined Field Name is to specify text that will be transmitted verbatim when the Field Code for the Data Output Record is a Literal String (Field Code #6) in the specified output message(s).**

Some common uses for the Field Name when the Data Output Record specifies a Literal String are listed below:

- The name of the site where your ZENO®-3200 is installed
- A carriage-return/line-feed (`{CR}{LF}`) at the start or end of each message to start a new line
- The delimiting fields `$` and `*` in two Data Output Records for use with a NMEA 0183 checksum
- Sensor names or data identifiers to aid in reading a message

---

[210] Refer to Sections 3.2.5 and 4.

> **The length of the Field Name is limited to ten characters.**
>
> **If you require text that exceeds ten characters, create more than one Data Output Record specified as a Literal String and put up to ten characters in each Field Name of each Data Output Record.**

> **If you need to specify a nonprintable or nonviewable character, such as a carriage return, you can specify nonprintable ASCII codes using the format `<xx>`, where `xx` is the hexadecimal value of the desired ASCII code.**

> **Since commands in the ZENO®-3200 User Interface are always space-delimited, you cannot directly type a space to be a part of a Field Name. Instead, you must type its hexadecimal ASCII code value as `<20>` in the desired location within the Field Name.**
>
> **Further, quotation marks cannot be accepted by the ZENO®-3200 User Interface. If you want to use quotation marks in an output message, use the hexadecimal ASCII code `<22>` for each quotation mark.**

> **A complete table of ASCII codes is shown in Appendix A.**

The most frequently used ASCII codes are shown in the next table:

Frequently Used ASCII Codes			
Hexadecimal Value	Character	Hexadecimal Value	Character
7	Bell	11	XON
9	Tab	13	XOFF
A	Line Feed	20	Space
D	Carriage Return	27	Escape

As an example, you want to include the string **SITE 1** at the beginning of your output message and you also want it to appear immediately after a carriage-return and line-feed. After creating a new Data Output Record (or using an existing one), you would type the command in the Data Output Menu:

C1/6 C3/<D><A>SITE<20>1{ENTER}

Your Data Output Record would look something like this:

```
 > C1/6 C3/<D><A>SITE<20>1

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m         (Jn) Jump To Record n
(A)    Insert After This Record         (N)  Go To Next Record
(B)    Insert Before This Record        (P)  Go To Previous Record
(X)    Cut Record to Clipboard          (XA) Delete ALL Records
(C)    Copy Record To Clipboard         (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard      (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 1 of 73:
Item  1: Field Type Code                6 : Literal String Field
Item  2: Output Message(s)              1
Item  3: Field Name                     <D><A>SITE<20>1

 >
```

10.6.6. Setting Up A Data Output Record To Transmit And/Or Log Data

Four Line Items must be set in a Data Output Record when you plan to transmit data in an output message and/or log data in ZENO®-3200 memory:

- Line Item #1: Field Type Code
- Line Item #4: Input Record
- Line Item #5: Field Decimal Places
- Line Item #6: Field Width
- Line Item #7: Data Storage Class Code (used ONLY when logging data)

Setting The Field Type Code, Line Item #1

The following questions will assist you in deciding what type of Field Type Code is needed:

1. Will you have more than one output message?
   - If you need different data in different output messages but in the same field, you need to use Field Type Code #15.
   - Otherwise, proceed with question #2.

> **If you use Field Type Code #15, data specified in Line Items #4, #8, #9 and #10 must be of the same type--all floating-point, long integer or string data values.**

2. Do you need the ZENO®-3200 to transmit the data value automatically?
   - If yes, proceed with question #3.
   - If no, go question #7.
3. Is the data going to a GOES transmitter?
   - If you need GOES binary data, use Field Type Code #12.
   - If you also need the data logged and/or transmitted in another output message, create a separate Data Output Record and proceed to question #5.
4. Is the data going to an ARGOS transmitter?

- If you need ARGOS binary data, use Field Type Code #13.
- If you also need the data logged and/or transmitted in another output message, create a separate Data Output Record and proceed to question #5.

5. If you only need to transmit the data, use Field Type Code #7.
6. If you need to BOTH transmit and log the data, use Field Type Code #9.
7. If you ONLY need to log the data, then you need to use Field Type Code #8.

Setting the Input Data, Line Item #4

Once you decide which type of Field Type Code is appropriate for your data value, you need to set the values for Line Item #4, the Input Record, to tell the ZENO®-3200 which data to transmit and/or log.

> **The format for Line Item #4, the Input Record, is the same as for a Process Record Data Input[211].**

> **Remember, you can always type the command for help `HPn`, where `n` is the Process Record Number, to view the all the outputs for Process Record #`n`.**

> **String outputs can ONLY be transmitted and logged using Data Output types 7, 8 and 9 (Transmit Only, Log Only, and Transmit and Log). An error will be generated if a user attempts to use a string output as a Conditional Start, a GOES Binary Format, or an ARGOS Binary Format field.**

The ZENO®-3200 does not put quotation marks around string data. Since strings can contain commas or spaces, confusion can result with the type of delimiter being used within output messages. If you want the string data to be contained inside quotation marks, specify two separate Data Output Records as Literal Strings, one immediately before and one immediately after the string Data Output Record.

Setting the Decimal Places, Line Item #5

After setting the Field Type Code and the Input Data (Line Items #1 and #4), you are ready to set the Field Decimal Places and Field Width (Line Items #5 and #6 respectively).

The following table will assist you in setting the value for Line Item #5, which depends upon the type of data that is going to be transmitted and/or logged:

---

[211] Refer to Section 10.4.4.

Type of Data Specified In Line Item #4	Recommended Value to Set In Line Item #5
Floating-point	Any value between 0 and 6 according to the precision you require.
Long Integer	0. (Long integer values are whole numbers.)
String	0. (This is not applicable to a string.)

Setting the Field Width, Line Item #6

> **Setting the Field Width (Line Item #6) depends upon the expected range of your data and the number of decimal places specified in Line Item #5.**

If the data specified in Line Item #4 is **floating-point** or **long integer**, use the following steps to set the value of the Field Width (Line Item #6):

1. Using whole numbers only, determine (or estimate) the maximum and minimum values of the data specified in Line Item #4. These values can be represented as D_{MAX} and D_{MIN} respectively.

2. Count the number digits, *including any minus sign*, in D_{MAX} and D_{MIN} and represent the number of counted digits as N_{MAX} and N_{MIN} respectively.

3. Take the larger value of the two values N_{MAX} and N_{MIN} and represent it as value M.

4. If the value set in Line Item #5 (Decimal Places) is greater than zero, add this value, plus one (for the decimal point), to the value represented by M.

5. Set Line Item #6 to value represented by M plus one (for a leading space).

String outputs are transmitted and logged in a fixed width format specified by the Field Width defined in Line Item #6 of the Data Output menu. If the data specified in Line Item #4 is **a string**, use the following steps to set the value of the Field Width (Line Item #6):

1. Look at all of the possible strings that can come from the string data specified in Line Item #4. Represent the number of possible strings as N.

2. Determine the length of each possible string by counting the number of characters in each of the possible N strings. Represent the counted string lengths as $S_1, S_2 . . . S_N$.

3. Determine the largest value out of the list $S_1, S_2 . . . S_N$ and represent it as S_{MAX}.

4. Set the value of Line Item #6 to the value represented by S_{MAX} plus one.

> **Strings too long will be truncated.**
>
> **Strings too short will be padded with spaces.**

Setting the Data Storage Class Code, Line Item #7

> **Since the total amount of logging memory contained in the ZENO®-3200 is finite, there is a trade-off between the amount of memory used to log each data value and the accuracy and range with which values are logged.**

> **Line Item #7 (the Data Storage Class Code) in each Data Output Record tells the ZENO®-3200 how many bytes of memory to use to store the data specified in Line Item #4.**

The following table displays what values are available for the Data Storage Class Code, the number of bytes used and the range of values that can be contained in the available memory space.

Line Item #7 Value	Data storage class	Numerical Range	
		Minimum	Maximum
1	1-byte signed integer	-128	127
2	1-byte unsigned integer	0	255
3	2-byte signed integer	-32768	32767
4	2-byte unsigned integer	0	65535
5	4-byte signed integer	-2147483648	2147483647
6	4-byte unsigned integer	0	4294967295
7	2-byte compressed float (precise up to 0.1)	-3276.8	3276.7
8	4-byte floating point (precise up to 1×10^{-7})	-3.40×10^{37}	$+3.40 \times 10^{37}$
9	n-byte string ("n" determined by Line Item #6)	N/A (used for string values ONLY)	

> **Data Storage Class Codes #1 through #8 apply to floating-point or long integer data ONLY.**
>
> **Data Storage Class Code #9 applies to string data ONLY.**

If you are logging **string** data, ALWAYS use Data Storage Class Code #9. The number of bytes set aside in logging memory to store the string data is defined by the Field Width value set in Line Item #6.

The following steps will assist you in determining which Data Storage Class Code should be used to log **floating-point** or **long integer** data:

1. If Line Item #5 (Decimal Places) is set to zero, do not use Data Storage Class Codes #7 or #8.
   - Using whole numbers only, determine (or estimate) the maximum and minimum values of the data specified in Line Item #4. These values can be represented as D_{MAX} and D_{MIN} respectively.
   - Compare D_{MAX} and D_{MIN} to the maximum and minimum values respectively of Data Storage Class Codes #1 through #6 listed in the above table.
   - If D_{MIN} is zero or greater, limit your selection to Data Storage Class Codes #2, #4 or #6.
   - If D_{MIN} is less than zero, limit your selection to Data Storage Class Codes #1, #3 or #5.
2. If Line Item #5 (Decimal Places) is non-zero, consider using only Data Storage Class Codes #7 or #8.
   - If Line Item #5 (Decimal Places) is greater than one, use Data Storage Class Code #8.
   - If Line Item #5 (Decimal Places) is set to one, determine (or estimate) the maximum and minimum values of the data specified in Line Item #4. These values can be represented as D_{MAX} and D_{MIN} respectively. If D_{MAX} and D_{MIN} are between the limits of Data Storage Class Code #7, use Data Storage Class Code #7; otherwise, use Data Storage Class Code #8.

10.6.7. Creating An Automatic Output Message for CCSAIL Format

You need to perform several steps if you need the ZENO®-3200 to automatically transmit one or more output messages in CCSAIL format.[212]

> **For a CCSAIL-formatted output message, Coastal Environmental Systems recommends that you (1) set the first Data Output Record to be a Literal String containing a Carriage-Return/Linefeed, and (2) set the second Data Output Record to be a Timestamp.**

Since the ZENO®-3200 is the source of an automatically transmitted output message, the Primary Unit ID (Line Item #1 of the System Functions Menu) will be used as the Source Address in the CCSAIL message. The Secondary Unit ID (Line Item #2 of the System Functions Menu) is used by the ZENO®-3200 to contain the Destination Address.

> **You do NOT need to create Data Output Records containing the Attention Character, Destination Address, Source Address or End of Transmission Character. The ZENO®-3200 will automatically generate these fields when Real Time Output Format in the System Functions Menu is set to 3 for CCSAIL format.[213] This will also cause the individual data fields to be comma-delimited.**

> **If you want the Source Address (Primary Unit ID) or the Destination Address (Secondary Unit ID) to be transmitted as separate data fields, create one or two Data Output Records and set the Field Type Code accordingly.**

> **NOTE: Coastal Environmental Systems PC program Intercept™ requires the Primary Unit ID immediately after the timestamp data field.**

Use the following steps to create an automatically transmitted output message in CCSAIL format:

1. Create all of the Data Output Records necessary to transmit the various data values in your output message.
2. Go to the first Data Output Record, create another Data Output Record BEFORE the first record (using Data Output Menu option **B**).
   - Set Line Item #1 (the Field Type Code) to 6 for a Literal String.
   - Set Line Item #3 (the Field Name) to the ASCII values for a Carriage-Return/Line-Feed, **<D><A>**.

---

[212] Refer to Section 4.6 for details about the CCSAIL Protocol.
[213] Line Item #4 of the System Functions Menu. Refer to Sections 4.4.2 and 4.6.4.

3. After the first Data Output Record, create another Data Output Record using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) in the new Data Output Record to 3 for a Timestamp.

4. If you are using Intercept™, create another Data Output Record after the timestamp Data Output Record using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) in the new Data Output Record to 4 for the Primary Unit ID.

5. Jump to the last Data Output Record and create one more Data Output Record after it using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) to 1 for a Checksum.
   - Set Line Item #6 (the Field Width) to 2 for a 2-digit checksum.

6. Go to the System Functions Menu, a submenu of the User Menu.[214]

7. Set the Primary Unit ID (Line Item #1 of the System Functions Menu) to the CCSAIL address of your ZENO®-3200.[215]

8. Set the Secondary Unit ID (Line Item #2 of the System Functions Menu) to the destination address for the CCSAIL message.[216]

9. Set the Real Time Output Format, Line Item #4 of the System Functions Menu, to 3 for CCSAIL format.[217]

10.6.8. Creating An Automatic Output Message in NMEA 0183 Format

Several steps need to be performed to configure the ZENO®-3200 to automatically transmit an output message in NMEA 0183 format. (Refer to Section 0 for information about NMEA 0183.)

1. Create all of the Data Output Records necessary to transmit the various data values in your output message.

2. Jump to the first Data Output Record and create another Data Output Record before it using Data Output Menu option **B**.
   - Set Line Item #1 (the Field Type Code) in the new Data Output Record to 6 for another Literal String.
   - Set Line Item #3 (the Field Name) will contain six characters as follows: a **$**, a two-character "talker ID" and a three-character "sentence ID".

3. Jump to the last Data Output Record and create one more Data Output Record after it using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) to 18 for a Backspace to remove the delimiter character from the last Data Output Record that transmits data.

4. Create another Data Output Record after the backspace using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) in the new Data Output Record to 6 for a Literal String.
   - Set Line Item #3 (the Field Name) to an asterisk.

5. Create another Data Output Record after the asterisk literal string using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) to 18 for a Backspace to remove the delimiter character that follows the asterisk.

---

[214] Refer to Section 5.
[215] Refer to Section 5.5.
[216] Refer to Section 5.6.
[217] Refer to Section 4.4.2.

6. Create another Data Output Record after the backspace using Data Output Menu option **A**.
   - Set Line Item #1 (the Field Type Code) to 2 for an NMEA Checksum.
7. Create another Data Output Record after the NMEA checksum using Data Output Menu option **A**. Set Line Item #1 (the Field Type Code) to 6 for a Literal String.
   - Set Line Item #3 (the Field Name) to the ASCII values for a Carriage-Return/Line-Feed, **<D><A>**.
8. Go to the System Functions Menu, a submenu of the User Menu.[218]
9. Set the Real Time Output Format (Line Item #4 of the System Functions Menu) to 1 for comma-delimited data.[219]

10.6.9. Conditional Message Fragments

> **The ZENO®-3200 provides the means to vary the contents of each output message according to the actual data values using the Conditional Start & Conditional Stop Field Type Codes in the Data Output Menu.**

> **Conditional Start and Conditional Stop Data Output Records must be used in pairs.**

> **More than one pair of Conditional Start and Conditional Stop Data Output Records can be used in a single output message, but they CANNOT be nested or overlap.**

Examples of using the Conditional Start and Conditional Stop include:

- Transmitting extra data fields or text during an alarm condition.[220]
- Transmitting different text for different data.[221]

> **The ZENO®-3200 transmits all Data Output Records contained between Conditional Start and Condition Stop Data Output Records ONLY when the**

---

[218] Refer to Section 5.
[219] Refer to Section 4.4.2.
[220] Refer to Section 11.
[221] This would be used extensively with the Optional Speech Interface, refer to Section 6.11.

> **data referred to in Line Item #4 (the Input Record) of the Conditional Start Data Output Record is not zero.**

> ***NO*** **data is transmitted by the Conditional Start Data Output Record itself!**

> **The ZENO®-3200 *ALWAYS LOGS* data from any Data Output Records that log data and are contained between Conditional Start and Conditional Stop Data Output Records, regardless of the Conditional Start status!**

When you configure a Data Output Record to be a Conditional Start, you will see something like the following example on your terminal emulation program screen, along with the matching Conditional Stop Data Output Record.

```
DATA OUTPUT MENU
(Cn/m) Change Item n To Value m            (Jn) Jump To Record n
(A)    Insert After This Record            (N)  Go To Next Record
(B)    Insert Before This Record           (P)  Go To Previous Record
(X)    Cut Record to Clipboard             (XA) Delete ALL Records
(C)    Copy Record To Clipboard            (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard         (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 8 of 72:
Item  1: Field Type Code              10 : Conditional Start Field
Item  2: Output Message(s)            2
Item  3: Field Name                   BITdisplay
Item  4: Input Record                 P14.L1 : BIT

> S1/11

DATA OUTPUT MENU
(Cn/m) Change Item n To Value m            (Jn) Jump To Record n
(A)    Insert After This Record            (N)  Go To Next Record
(B)    Insert Before This Record           (P)  Go To Previous Record
(X)    Cut Record to Clipboard             (XA) Delete ALL Records
(C)    Copy Record To Clipboard            (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard         (H)  Help
(Sn/m) Search Item n for Value m

Data Items for Record 11 of 72:
Item  1: Field Type Code              11 : Conditional Stop Field
Item  2: Output Message(s)            2

>
```

In the above example, Data Output Records #9 and #10 will be transmitted when the value referenced in Line Item #4 of Data Output Record #8 is not zero.

10.6.10.   Selecting Data To Log & Transmit Via Output Message Number

When you configure the ZENO®-3200 to output more than one output message, you can configure single data fields within each output message to contain different data based upon the output message number. This is done using the Selectable Log and Transmit Field Type Code in a Data Output Record.

> **The ZENO®-3200 WILL ONLY LOG extra output messages when the Dial-out Alarm Process or Multiple Alarm Process is included in the configuration and set up to log a specific output message!**

> **You cannot configure different output messages to log different numbers of data values. Each output message that logs unique data will log the same number of data values.**

When you configure a Data Output Record using the Selectable Log and Transmit Field Type Code, the Data Output Record will look something like this:

```
DATA OUTPUT MENU
(Cn/m) Change Item n To Value m               (Jn) Jump To Record n
(A)    Insert After This Record               (N)  Go To Next Record
(B)    Insert Before This Record              (P)  Go To Previous Record
(X)    Cut Record to Clipboard                (XA) Delete ALL Records
(C)    Copy Record To Clipboard               (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard            (H)  Help
(Sn/m) Search Item n for Value m


Data Items for Record 2 of 22:
Item  1: Field Type Code              15 : Selectable Transmit and Log Field
Item  2: Output Message(s)            1,2,3
Item  3: Field Name                   MsgId
Item  4: Msg 1 Input Record           P8.1 : SelectID
Item  5: Field Decimal Places         0
Item  6: Field Width                  0
Item  7: Data Storage Class Code      3 : 2-byte signed integer
Item  8: Msg 2 Input Record           C2
Item  9: Msg 3 Input Record           C3
Item 10: Msg 4 Input Record           C4

>
```

In this example, when Message #1 is generated, ZENOSOFT® will select output #1 from Process Record #8 to both transmit and log. When Message #2 is generated, ZENOSOFT® will select the value of constant C2 to both transmit and log. When Message #3 is generated, ZENOSOFT® will select the value of constant C3 to both transmit and log. Since Message #4 is not specified in the Output Messages (Item 2), constant C4 would NOT be selected if Message #4 were generated; instead, ZENOSOFT® would use the same value as selected for Message #1 (the default message number).

> **When the Selectable Transmit and Log data field is used, ZENOSOFT® will store the message number which generated that output message immediately after the Timestamp with each Data Record.[222]**

> **Care must be taken when using the Selectable Transmit and Log data field because when downloading data, ALL Data Records are dumped— regardless of which message number logged the Data Record.**

> **Coastal Environmental Systems recommends that you use some means to identify which message number logged each Data Record. You can create a separate Data Output Record, using the Message Number Field Type Code[223], or by using another Selectable Transmit and Log data field to store a user-specified identification number.**

> **Further, when multiple output messages are being logged, information provided by option C in the Data Retrieval Menu[224] may not be accurate, because ZENOSOFT® cannot predict when extra output messages are going to be logged.**
>
> **However, these extra messages in NO way interfere with data collection or retrieval!**

10.7.   SETTING OUTPUT MESSAGE SCHEDULES AND DESTINATIONS

> **Since the ZENO®-3200 can transmit up to four different output messages, the ZENO®-3200 provides the means to configure which COM port each output message is transmitted on, as well as the time of transmission for each output message.**

The Output Message Timing Menu lets you control when, and from which communications port, each of the up to four output messages will be sent. To access the Output Message Timing Menu, type **O{ENTER}** from the Zeno Program Menu. Your screen should look something like this:

---

[222] The Timestamp is always the first value stored in each Data Record and requires 4 bytes. The message number is stored using a single byte.
[223] Refer to Section 10.6.3.
[224] Refer to Section 4.2.

```
   OUTPUT MESSAGE TIMING MENU
   (Cn/m) Change Item n To Value m          (H) Help
   (Z)    Zeno Program Menu

   Item  1:  COM3        (Data Output Message #1 COM Port)
   Item  2:  COM1        (Data Output Message #2 COM Port)
   Item  3:  COM3        (Data Output Message #3 COM Port)
   Item  4:  COM3        (Data Output Message #4 COM Port)
   Item  5:  30.0        (Data Output Message #1 Period)
   Item  6:  30.0        (Data Output Message #2 Period)
   Item  7:  0.0         (Data Output Message #3 Period)
   Item  8:  0.0         (Data Output Message #4 Period)
   Item  9:  0           (Record Counter Starting Value)
   Item 10:  0           (Record Counter Reset Value)

   >
```

As shown, each message output is configured to a specific COM port.

10.7.1. Selecting the Communications Port for Each Output Message

Line Items #1 through #4 of the Output Message Timing Menu allow you to specify a COM port from which the ZENO®-3200 will transmit each output message respectively. Each Line Item can be set to one of three values: COM1, COM2, or COM3.

> **More than one output message can be transmitted on a single communications port.**

> **The port type and baud rate for each of the selected communications ports are the same as those specified in the Communications Menu.[225]**

10.7.2. Specifying the Time of Transmission for Each Output Message

Line Items #5 through #8 of the Output Message Timing Menu allow you to specify when the ZENO®-3200 will transmit each of the four output messages ***within the Sample Interval***. The value set for each Line Item is the ***number of seconds into the Sample Interval*** that the output message is to be transmitted.[226] The valid range of values for each of Line Items #5 through #8 is from 0 to 86400 at increments of 0.5 seconds.

---

[225] Refer to Section 6.1.
[226] For information about the Sample Interval, refer to Section 3.1.3.

> **REMEMBER: the ZENO®-3200 will automatically transmit output messages only when they have not been suppressed by the Real Time Output Format, found on Line Item #4 in the System Functions Menu.[227]**

If you specify a time in seconds, for the Sample Interval, that exceeds the length of the Sample Interval, the ZENO®-3200 will transmit the output message at the end of the Sample Interval.

If no time is specified for Output Message #1 (Line Item #5 would be set at 0), which is the default output message, the ZENO®-3200 will automatically transmit Output Message #1 at the end of the Sample Duration.

> **The ZENO®-3200 _will only_ automatically and regularly transmit Output Messages #2, #3 and #4 when a non-zero time is specified in their respective Line Items (#6, #7 and #8) in the Output Message Timing Menu.**
>
> **This DOES NOT include transmission of any of these messages when configured to transmit as an asynchronous alarm message using one of the Alarm Processes.[228]**

Any output message can be automatically transmitted on a regular schedule _and_ be transmitted as an asynchronous Alarm Message.[229]

> **Regular logging of data is ALWAYS done at the end of the Sample Duration regardless of the settings for output message timing in the Output Message Timing Menu.**

> **When you configure the ZENO®-3200 to transmit an output message several times during a Sample Interval, you are viewing snapshots of the current states of any referenced sensor or process data.**
>
> **Any output messages transmitted prior to the end of the Sample Duration do not necessarily contain the same data that will be logged at the end of the Sample Duration.**

Here are a few examples that demonstrate output message timing.

Example #1

Here are a few possibilities that demonstrate how can Output Message #1 be configured to transmit in accordance with the Sample Interval.

- Output Message #1 can be synchronized with the end of the Sample Duration simply by setting Line Item #5 in the Output Message Timing Menu to 0. If the Sample Interval is set to 30 minutes and the

---

[227] Refer to Section 4.4.2.
[228] Refer to Section 11.
[229] Refer to Section 11.

Sample Duration is set to 29 minutes and 45 seconds, Output Message #1 will be transmitted every 30 minutes at 29 minutes and 45 seconds after the half hour.

- Output Message #1 can be transmitted on a regular schedule independent of the Sample Interval. for example, an output message can be broadcasted once every 10 minutes, with the Sample Interval set to 30 minutes. Set the Data Output Message #1 Period (Line Item #5 in the Output Message Timing Menu) to 600 seconds.

- Additional types of Output Message #1 can be transmitted if they are configured to be transmitted when an alarm is triggered. To do this, you must use an Alarm Message Process (refer to Appendix D).

Example #2

Consider the following sensor suite:

- A wind direction monitor sampled once every 5 seconds;
- A wind speed monitor sampled once every 5 seconds, with each measurement being an average over 3 cycles;
- A thermistor sampled once every 10 seconds;
- A power-hungry barometer sampled twice, at a 5 second spacing.

Suppose that three different output messages are transmitted:

- Wind data are transmitted as Output Message #1 as soon as they are available.
- Summary wind, temperature and pressure data are transmitted as Output Message #2 every 5 minutes, even if no new measurements have been made (this could be to ensure transmission over an unreliable satellite link).
- Output Message #3 is transmitted if the wind speed exceeds a user-defined threshold.
- Output Message #4 is not used.

The following time-line illustrates the timing of the different output messages with respect to the ZENO®-3200's Sample Interval (set to 30 minutes):

Time   :10 :15 :20 :25 :30 :35 :40: 45   :50 :55 :00 :05 :10 :15 :20 :25 :30 :35 :40: 45   :50 :55

(minutes)

ZENO

Message #1

Message #2

Message #3

Message #4
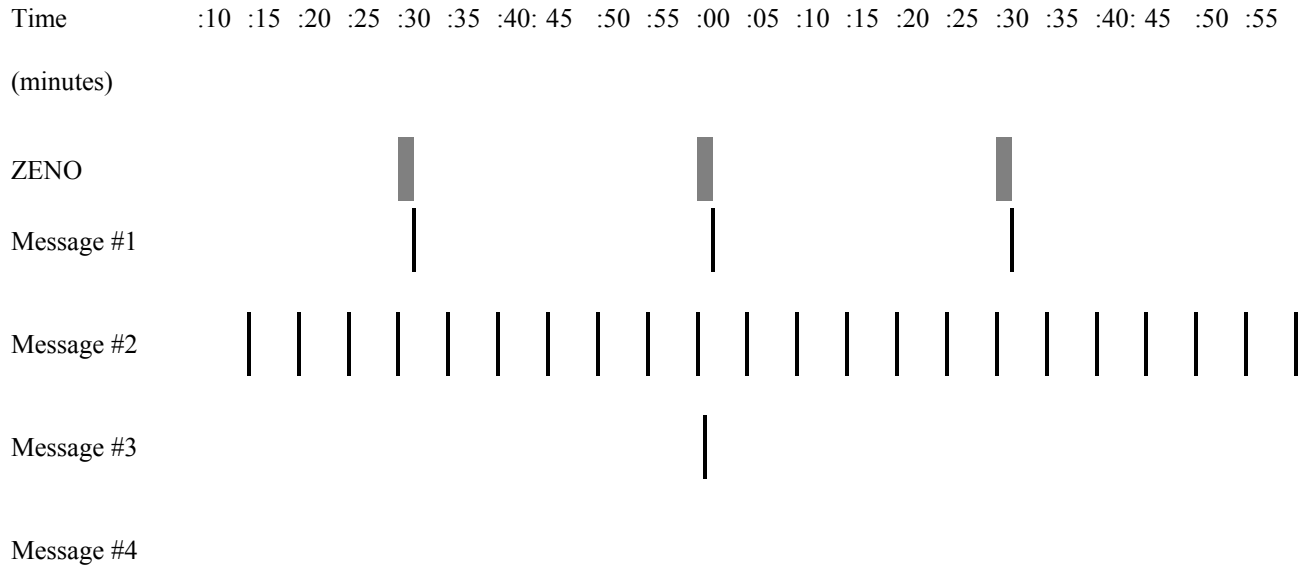
To set up this sampling scheme, the Sample Period Menu of the User Menu will require the following values:

- The *Sample Interval time* will be 1800 seconds, or 30 minutes
- The *Sample Duration time* will be 60 seconds
- The *Sample Offset* will be zero—sampling starts at the beginning of each half-hour period

The four Data Output Message Periods will then take the following values as shown in the table below. It is worth noting that message numbers 1, 3 and 4 are given the same data output message period, but only message #1 interprets 0 to mean "output at the end of the sampling period."

Message Number	Data Output Message Period
#1 (output at the end of the 1 minute sampling period)	0
#2 (output at the end of the half-hour)	300 seconds (5 minutes)
#3 (output when triggered by an alarm)	0
#4 (not used)	0

10.8.   RESETTING (REBOOTING) THE ZENO®-3200

After you have made changes to your configuration, it may be a good idea to reboot the ZENO®-3200 to ensure that everything has been properly initialized.

> **Before you reboot the ZENO®-3200, make sure that you save your configuration to EEPROM! Otherwise, the changes you made will be lost.**

There are two ways you can reboot the ZENO®-3200:

- Turn off the power, wait a few seconds, then turn it on again.
- Use menu option `R` in the Zeno Program Menu.

When you type **R{ENTER}** in the Zeno Program Menu, the ZENO®-3200 will stop all activity and the CPU will automatically reboot.

11.   <u>**ALARM MESSAGES**</u>

Coastal Environmental Systems

ZENO®-3200 User Manual

One of the most important features of the ZENO®-3200 is its ability to transmit unsolicited alarm messages.

A regular output message is transmitted by the ZENO®-3200 on a regular schedule.

But an alarm message is transmitted when a specific condition occurs, which makes them completely asynchronous.

An alarm condition is defined by configuring the appropriate processes, especially Alarm Processes. The alarm condition can be based upon more than one requirement.

Once the alarm condition is met, the ZENO®-3200 can transmit an alarm message via any of the following:

   • Simple terminal • Radio link • Telephone modem

   • Cellular modem or • GOES radio.

An alarm condition can also be used to turn on (or off) a digital output or a switched voltage.

> **You may configure as many as 4 alarm messages**
>
> **in your ZENO®-3200.**

11.1. CONFIGURING AN ALARM CONDITION

Configuring an alarm condition can be done by carrying out the following steps:

1. Identify the one or more parameters that constitute an alarm condition, including the valid ranges of the parameters.
2. Determine what sensor readings are required to measure the parameters.
3. Determine what processes are needed to process the parameters, including the Alarm Processes.

One example of an alarm condition is a ZENO®-3200 under-voltage. If you are powering your ZENO®-3200 with a battery, you will probably be monitoring the battery voltage. As a battery discharges through use over time, its voltage will drop. You can configure the ZENO®-3200 to automatically alert you that its battery is discharging by monitoring how low the battery voltage has dropped. for example, you might want the ZENO®-3200 to alert you that the battery voltage has dropped below 11 VDC. You have now defined an alarm condition and a valid range.

Therefore, to monitor the battery voltage, you can configure a 12-bit ADC Sensor Record to monitor the internal battery voltage.[230] This is the only reading needed for this example alarm condition.

To set an alarm condition, you need to set up an appropriate alarm process (or processes). Reviewing the available processes listed in Appendix D shows that the best process to use is the Alarm Process (Category 3, Process Number 3):

```
PROCESS MENU
(Cn/m) Change Item n To Value m           (Jn) Jump To Record n
(A)    Insert After This Record           (N)  Go To Next Record
(B)    Insert Before This Record          (P)  Go To Previous Record
(X)    Cut Record to Clipboard            (XA) Delete ALL Records
(C)    Copy Record To Clipboard           (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard        (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 3 of 3:
Item  1: Process Category                  3  : Alarm
Item  2: Process Number                    3  : Alarm Process
Item  3: User-defined Process Name
Item  4: Input for Data                   S0.1
Item  5: Alarm Setpoint                   0
Item  6: Alarm Reset                      0
Item  7: BIT Flag Number (1 - 31)         0
Item  8: Digital Output Channel 1         0
Item  9: Digital Output Channel 2         0
Item 10: Switched Voltage                 0

>
```

---

[230] Section 3.2.3 describes this procedure.

The description of this process in Appendix D, Line Item #5 (the Alarm Set-point) is set to 11 and Line Item #6 (the Alarm Reset) is set to 12. When the value referenced by Line Item #4 (the Input for Data) falls below 11, the Alarm Process will indicate that an alarm condition exists. Conversely, when the value referenced by Line Item #4 goes above 12, the alarm condition will be reset.

In this example, you are setting an alarm based upon measured battery voltage. You can set Line Item #4 to the actual Sensor Record reading the battery voltage, or you might want to base the alarm condition on an average of multiple battery voltage readings.

If you use the latter, the Alarm Process Record may look as follows:

```
PROCESS MENU
(Cn/m) Change Item n To Value m              (Jn) Jump To Record n
(A)    Insert After This Record              (N)  Go To Next Record
(B)    Insert Before This Record             (P)  Go To Previous Record
(X)    Cut Record to Clipboard               (XA) Delete ALL Records
(C)    Copy Record To Clipboard              (Z)  Zeno Program Menu
(V)    Paste Record From Clipboard           (H)  Help
(Sn/m) Search Item n for Value m

Process Items for Record 3 of 3:
Item  1: Process Category                     3  : Alarm
Item  2: Process Number                       3  : Alarm Process
Item  3: User-defined Process Name
Item  4: Input for Data                    P2.1 : AvgBatt
Item  5: Alarm Setpoint                      11
Item  6: Alarm Reset                         12
Item  7: BIT Flag Number (1 - 31)             0
Item  8: Digital Output Channel 1             0
Item  9: Digital Output Channel 2             0
Item 10: Switched Voltage                     0

>
```

Line Items 8 through 10 in the Alarm Process show that you can turn on one or two digital output channels, and/or a switched voltage, when an alarm condition is met. An example of this would be turning on a heater if the temperature falls below a critical value.

If you set a value in Line Item #7 it will set the specified bit in the Global Built-In-Test (BIT) when the data referenced in Line Item #4 goes beyond the alarm set-point in Line Item #5.

11.2.   CREATING AN ALARM MESSAGE

Once you identify the alarm condition, you will need to tell the ZENO®-3200 what information to transmit when the alarm condition is met.

Depending upon the type of communications interface used, there are several options available when you create an alarm message. If you are using a ***non-satellite communications link***, the following options are available to you:

• Transmit the same primary output message for your alarm message as for regular data.

- Use Conditional Start and Conditional Stop Data Output Records (refer to Section 10.6.9) to add additional information to a regular message for an alarm message.

- Transmit a completely different output message for your alarm message.

- Log the alarm message.

If you are using a satellite communications link, there are fewer options available to you:

- If you are using a GOES transmitter, you are limited to transmitting either regular (self-timed) messages OR alarm (random) messages ONLY. This is a limitation of the GOES transmitter, not the ZENO®-3200.[231]

- The ARGOS transmitter does not support alarm (random) messages, only regular (self-timed) messages.[232] Any alarm message sent to the ARGOS transmitter would only be transmitted as part of its regular schedule.[233] Further, ARGOS messages are limited to 32 characters.

11.2.1. Transmitting Your Regular Output Message As An Alarm Message

Transmitting (and possibly logging) your regular output message as an alarm message is simply a matter of setting up the correct process (or processes) that define the alarm condition, then following the instructions in Section 11.3.

11.2.2. Using Conditional Message Fragments In An Alarm Message

Your regular output message may not contain sufficient information when an alarm condition arises. If you need to transmit the regular output message information along with the alarm information when an alarm condition arises, you can set up one or more conditional message fragments to be transmitted by following the instructions in Section 10.6.9:

- Place all alarm information between two Data Output Records set up as Conditional Start and Conditional Stop field types.

- Configure the Data Input (Line Item #4 in the Data Output Menu) in the Conditional Start Data Output Record to reference the alarm state generated by your alarm condition process.

- If you need the alarm message to be transmitted immediately when the alarm condition is met (and possibly logged), then you need to follow the instructions in Section 11.3. Otherwise, you can simply have the regular output message transmit at its regular time with the addition of the conditional message fragment containing the alarm information.

11.2.3. Transmitting A Unique Alarm Message

You may need to transmit completely different information when an alarm condition arises as opposed to what you would transmit in a regular output message. for this procedure, you will need to use at least two output messages in which one is designated as the regular output message and the other is designated the alarm message.

---

[231] Refer to Section 6.7.
[232] Refer to Section 6.8.
[233] Unlike GOES satellites that sit in geo-synchronous orbits, the ARGOS system is installed on two polar-orbiting satellites. This means that when an alarm condition occurs, there is a very high probability that no satellite will be there to receive the alarm message when it occurs.

> **You can also configure a single output message to be an alarm message and not have a regularly transmitted output message.**

To distinguish each Data Output Record, for which an output message applies, you need to configure Line Item #2 in each Data Output Record (the Output Message) accordingly.[234]

To transmit (and possibly log) the unique alarm message, follow the instructions in Section 11.3.

11.3. CONFIGURING THE ZENO®-3200 TO TRANSMIT (AND POSSIBLY LOG) AN ALARM MESSAGE

> **You must use one of two processes in the Alarm Processes Category to cause the ZENO®-3200 to transmit (and possibly log) an alarm message: the Multiple Alarm Process or the Dial-out Alarm Process.[235]**

Both the Multiple Alarm Process and the Dial-out Alarm Process provide the means to declare which output message to transmit (and possibly log) when an alarm condition arises.

> **When you configure the ZENO®-3200 to log an alarm message, information that is provided by Data Retrieval Menu option C (Data Logging Capacity) will not necessarily be accurate.[236]**

The type of communications link you are using[237] will dictate what needs to be configured in the ZENO®-3200 to successfully transmit the alarm message when an alarm condition exists. The following table summarizes what needs to be configured for each type of communications link.

Type of Communication	Special Configuration Issues
Direct Terminal Access	Designate the desired communications port for the alarm message. (Refer to Sections 6.1 and 11.3.1.)
Telephone Modem	Follow the instructions in Section 11.3.2.
Cellular Modem	
One-way Radio	Designate the communications port for the alarm message as COM1. (Refer to Sections 6.6 and 11.3.1.)
Two-way Radio	
GOES Satellite	Follow the instructions in Section 11.3.3.
ARGOS Satellite	Follow the instructions in Section 11.3.4.

---

[234] Refer to Section 10.6.4.

[235] Refer to Appendix D.

[236] The ZENO®-3200 cannot predict how often or how many alarm messages will be logged.

[237] Refer to Section 6.

11.3.1. Selecting The Communications Port To Transmit The Alarm Message

If you have created a unique alarm message as a separate output message, you can transmit it on a different communications port from your regular output message. To do this, follow the instructions in Section 10.7.1.

> **You can configure your regular output message to be transmitted as an alarm message on a different communications port as your regular message. To do this, set Line Item #2 in all Data Output Records to include the output message numbers of both the regular output message and the alarm message.**

11.3.2. Dialing-out An Alarm Message Via A Telephone Or Cellular Modem

The ZENO®-3200 will perform the following actions when an alarm condition occurs if properly configured for a telephone or cellular modem:

1. The ZENO®-3200 will dial-out the first telephone numbers configured in the Modem Menu. If no connection is made, it will dial-out the second telephone number and so on until a successful connection is established. Each telephone number will be dialed up to three times before the ZENO®-3200 stops the dial-out attempt.

2. Once a successful connection is established, the ZENO®-3200 transmits the alarm output message specified by the Dial-out Alarm Process.

3. The ZENO®-3200 then hangs up the telephone or cellular modem connection.

To configure the ZENO®-3200 to dial-out and transmit an alarm message on a telephone modem or cellular modem, follow this procedure:

*   Follow the procedures to set up telephone modem communications[238] or cellular modem communications[239].

*   Follow the recommended procedures to define an alarm condition and create an alarm message, in Sections 11.1 and 11.2 respectively.

*   Designate which output message is the alarm message using a Dial-out Alarm Process[240].

*   Select which communications port (COM1, COM2 or COM3) through which the ZENO®-3200 will transmit the alarm message using the Output Message Timing[241].

---

[238] Refer to Section 6.4.
[239] Refer to Section 0.
[240] Refer to Section 11.3.
[241] Refer to Section 11.3.1.

> **You must select the same communications port in the Output Message
> Timing Menu for the alarm message that is specified as the Modem COM
> Port in the Modem Menu[242]!**

- Define up to four telephone numbers for the ZENO®-3200 to dial via the telephone modem or cellular modem in Line Items #5 through #8 in the Modem Menu. A valid telephone number is one that contains any of the digits **0** through **9**, and any of the extra characters **-*#,()**. A space is not a valid character. The telephone number must be at least 2 characters long.

```
MODEM MENU
(Cn/m) Change Item n To Value m                (U) User Menu
(E)    Save Parameters To EEPROM              (Q) Quit
(S)    Speech Interface Menu                  (H) Help

Item  1:  1                                    (System Modem Type)
Item  2:  COM3                                 (Modem COM Port)
Item  3:  5                                    (Modem Retry Period)
Item  4:  0                                    (Modem Hangup Delay)
Item  5:  1-206-555-1234                       (Modem Telephone Number 1)
Item  6:  NONE                                 (Modem Telephone Number 2)
Item  7:  NONE                                 (Modem Telephone Number 3)
Item  8:  NONE                                 (Modem Telephone Number 4)
Item  9:  NONE                                 (Modem Initialization String)
Item 10:  0                                    (Modem Switched Voltage)
Item 11:  0                                    (Modem Ring Detect Channel)

>
```

Line Items #3 and #4 in the Modem Menu are explained more fully below:

Line item #3, Modem Retry Period in seconds: a good minimum value for the retry period is 90 seconds, since it can take a minute or more for a phone modem to connect. If the ZENO®-3200 cannot connect on dial-out, it will try a total of 3 times before giving up.

Line item #4, Modem Hang-up Delay in seconds: this is the delay between when the ZENO®-3200 sends its message and when the ZENO®-3200 instructs the modem to terminate its communication. If you wish to communicate further with the ZENO®-3200 when an alarm condition occurs, set this to a non-zero value. This gives a delay time in which you (or the receiving computer) can send polling, user or other commands to the ZENO®-3200.

11.3.3. Transmitting An Alarm Message Via A GOES Transmitter

---

[242] Refer to Section 6.4.

> **A GOES transmitter is limited to transmitting self-timed (regularly scheduled) messages only or random (alarm) messages only. It cannot do both simultaneously.[243]**

If you need to transmit alarm messages via a GOES transmitter, you will need to set up its random message settings instead of the self-timed settings. When the ZENO®-3200 sends the alarm message to the GOES transmitter, it will be stored by the GOES transmitter in its random message buffer instead of the self-time message buffer.

You have the option of sending the alarm message in GOES binary format, like the regular (self-timed) output messages.[244]

To set up the ZENO®-3200 to send alarm messages via a GOES transmitter, use the following steps:

- Follow the procedures to set up the GOES transmitter communications link using random messages.[245]
- Follow the recommended procedures to define an alarm condition and create an alarm message in Sections 11.1 and 11.2 respectively.
- Designate which output message is the alarm message using a Dial-out Alarm Process or Multiple Alarm Process.[246]
- Select COM2 as the communications port using the Output Message Timing Menu, so that the ZENO®-3200 will send the alarm message to the GOES transmitter.[247] The GOES transmitter can only be connected to COM2.

11.3.4. Transmitting An Alarm Message Via An ARGOS Transmitter

> **Coastal Environmental Systems does NOT recommend use of the ARGOS transmitter and satellites for alarm messages. The satellites containing the ARGOS transceivers are in polar orbits reducing the likelihood that a satellite will be in range to receive an alarm message when an alarm condition occurs.**

If you choose to use the ARGOS transmitter with an alarm message, the alarm message will be transmitted to the satellite in the same manner that it would transmit a regular output message.

You have the option of sending the alarm message in ARGOS binary format, like the regular output messages.[248]

---

[243] Refer to Section 6.7.
[244] Refer to Section 6.7.11.
[245] Refer to Section 6.7.
[246] Refer to Section 11.3.
[247] Refer to Section 11.3.1.
[248] Refer to Section 6.8.6.

> **REMEMBER: a message to the ARGOS satellite is limited to 32 bytes!**

To configure the ARGOS transmitter for an alarm message, use the following steps:

- Follow the procedures to set up the ARGOS transmitter communications link.[249]

- Follow the recommended procedures to define an alarm condition and create an alarm message in Sections 11.1 and 11.2 respectively.

- Designate which output message is the alarm message using a Dial-out Alarm Process or Multiple Alarm Process.[250]

- Select COM2 as the communications port using the Output Message Timing Menu, so that the ZENO®-3200 will send the alarm message to the ARGOS transmitter.[251] The ARGOS transmitter can only be connected to COM2.

---

[249] Refer to Section 6.8.
[250] Refer to Section 11.3.
[251] Refer to Section 11.3.1.

12.   ADNANCED ZENO®-3200 CONFIGURATION TOPICS

Coastal Environmental Systems

ZENO®-3200 User Manual

This section describes several topics of an advanced nature. You should not read this section until you have a good understanding of creating basic ZENO®-3200 configurations.

The topics covered in this section are varied:

- Understanding ZENO®-3200 Timing
- The Universal Serial Interface
- Configurations with Multiple Serial Sensors
- Sharing Data between multiple ZENO®-3200's (multiprocessing)

12.1.   UNDERSTANDING ZENO®-3200 TIMING

The key to understanding timing in the ZENO®-3200 can be summarized by the following statements.

- Each function that the ZENO®-3200 is required to do by its configuration requires a certain amount of time for completion.
- The time that each function requires must be balanced with each other in order for the ZENO®-3200 to successfully carry out all the functions defined in a configuration.
- When the amounts of time various functions within a configuration are imbalanced, the ZENO®-3200 will be unable to carry out the various functions for a configuration, and errors will result.

> **Many of the errors that occur in a ZENO®-3200 configuration are the result of the user not understanding how much time each function will require within the configuration.**

12.1.1. ZENO®-3200 Timing Structure

ZENO®-3200 timing structure can be illustrated with the following diagram showing four different layers. Each layer is dependent upon the layers beneath it!
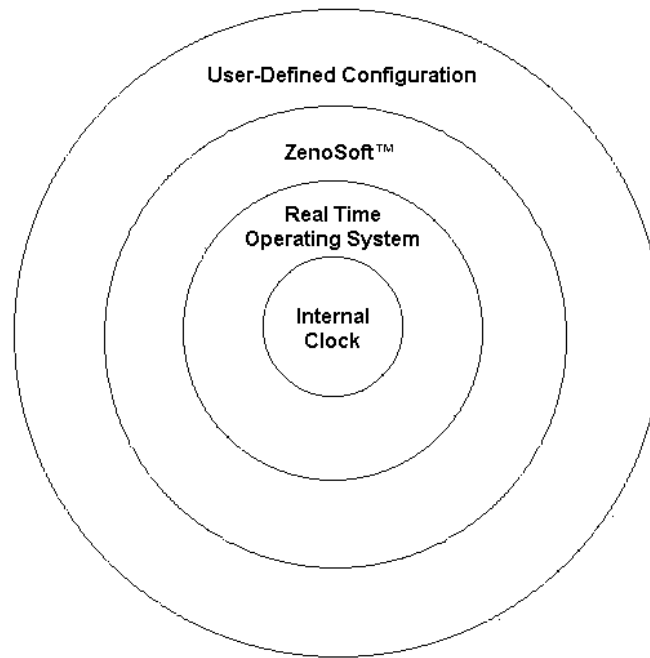
Figure 12.1. ZENO®-3200 Timing Structure Diagram.

12.1.2. The ZENO®-3200 Internal Clock

The basis of all ZENO®-3200 timing is its internal clock, which is a device on the ZENO®-3200 CPU board. The internal clock operates at a frequency of 16.777 MHz, meaning that the ZENO®-3200 requires approximately 0.119 microseconds to carry out each instruction of ZENOSOFT®. That may sound like an insignificant amount of time, but each function within the ZENO®-3200 requires many individual executable instructions within ZENOSOFT®. Hence, the amount of time that each function requires to exercise a complete ZENO®-3200 configuration is very significant.

12.1.3. The Real Time Operating System

The ZENO®-3200 contains a Real Time Operating System (RTOS) to implement a set of rules regarding the allocation of various computer system resources in an orderly and timely manner. System resources include memory, communication ports, and time allocated to tasks. The timing of the RTOS is controlled by the ZENO®-3200 internal clock.[252]

The RTOS allows a software application to be multitasking. A multitasking software application is one in which multiple functions are performed concurrently by a single CPU in a controlled and determined manner. In the case of the ZENO®-3200, the multitasking software application is ZENOSOFT®.

---

[252] Refer to Section 12.1.2.

The RTOS is analogous to the Microsoft Windows™ operating system that runs on most personal computers. However, an RTOS is designed and optimized to run with a minimal amount of code and using a very small amount of memory because software applications that require an RTOS have many time-critical functions. An RTOS allows a multitasking software application (such as ZENOSOFT®) to perform all of its functions within as little time as possible.

12.1.4. ZENOSOFT® and Multitasking

As mentioned in the previous section, ZENOSOFT® is a multitasking software application that controls the ZENO®-3200. It was designed to run within the operating parameters of the RTOS.

Different, major functions within ZENOSOFT® are defined within individual tasks. Each task is run by the RTOS according to the priority of the task and events that occur during data collection, data logging and communications with the User Interface. Several of the tasks include:

- The User Interface Task, which controls the User Interface.
- The Get-Data Task, which controls data collection and processing.
- The Output-Message Task, which controls the automatic transmission of output messages.

Each task requires a minimum amount of time dedicated by the CPU to perform all of its functions.

> **As a configuration becomes more complex, the amount of time required by each ZENOSOFT® task increases.**

> **If the amount of time required by a task to complete its functions exceeds a specified limit, the task will fail and cause the ZENO®-3200 to reboot!**
>
> **ZENOSOFT® will report which task has "timed-out" when the task exceeds its time limit.**

> **ZENOSOFT® task time-out errors are rare!**

> **If a task times out and causes the ZENO®-3200 to reboot, you should review the complexity of your configuration and find ways to simplify it.**

12.1.5. The User-Defined Configuration and Timing

The configuration that a user defines operates within the parameters specified by ZENOSOFT®.

> **Timing is an ever-present parameter that must be taken into account throughout any ZENO®-3200 configuration.**

As stated in Section 3.1.3, all data collection done by the ZENO®-3200 is based upon regular timed intervals controlled by the ZENO®-3200's internal clock. This regular timed interval is called the **Sample Interval**.

> **The Sample Interval defines the overall, recurring period of time during which all data collection, processing, data logging, and transmission occurs.**

Each Sample Interval is defined by three parameters accessible in the Sample Period Menu (accessible from the User Menu):

- The **Sample Interval Time** defines the length of each complete Sample Interval or the time between successive Sample Intervals.
- The **Sample Duration Time** defines the portion of the Sample Interval Time when the ZENO®-3200 actually performs all data collection, processing, data logging and transmission.
- The **Sample Offset Time** defines a time at the beginning of the Sample Interval that delays the start of the Sample Duration Time.

The following screen shows the an example set up of the three parameters in the Sample Period Menu:

```
SAMPLE PERIOD MENU
(Cn/m) Change Item n To Value m            (Q) Quit
(E)    Save Parameters To EEPROM           (H) Help
(U)    User Menu

Item  1:  30        (Sample Interval Time)
Item  2:  28        (Sample Duration Time)
Item  3:  2         (Sample Time Offset)

>
```

In addition to the Sample Interval, each sensor defined in the Sensor Menu requires an associated Sensor Timing Loop.[253]

---

[253] Refer to Section 10.3.7.

> **There are four Sensor Timing Loops. Each Sensor Timing Loop defines how often the ZENO®-3200 takes a reading from the sensor (or sensors) utilizing the Sensor Timing Loop during the Sample Duration.**

The time defined for each of the four Sensor Timing Loops is in the Sensor Timing Loop Menu, which is accessible from the Zeno Program Menu and will look something like this:

```
SENSOR TIMING LOOP MENU
(Cn/m) Change Item n To Value m          (H) Help
(Z)    Zeno Program Menu

Item  1:  0.5        (Timing Loop #1 Period)
Item  2:  1.0        (Timing Loop #2 Period)
Item  3:  1.5        (Timing Loop #3 Period)
Item  4:  2.0        (Timing Loop #4 Period)

>
```

As an example, configure the Sample Interval to be 20 seconds, the Sample Duration to be 19 seconds and the Sensor Timing Loop period to be 2.5 seconds. The ZENO®-3200 would operate according to the following timing diagram:

```
Sample Interval      |---------------------------------------|   20s
Sample Duration      |----------------------------------| |     19s
Sensor Timing Loop   ^     ^     ^     ^     ^     ^     ^     ^        2.5s

              Sensor Reading at each ^
```
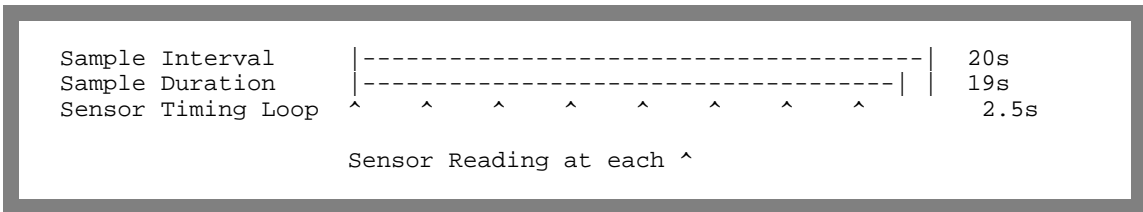
Each sensor type requires a certain amount of time to collect data. From the above example, let's say that the sensor requires up to 1 second to take a measurement. The addition of the time required by the sensor, to the timing diagram, results in the following:

```
Sample Interval      |---------------------------------------|   20s
Sample Duration      |----------------------------------| |     19s
Sensor Timing Loop   ^-◊   ^-◊   ^-◊   ^-◊   ^-◊   ^-◊   ^-◊   ^-◊     2.5s

              Sensor Reading at each ^
              Sensor reading complete at each ◊
```
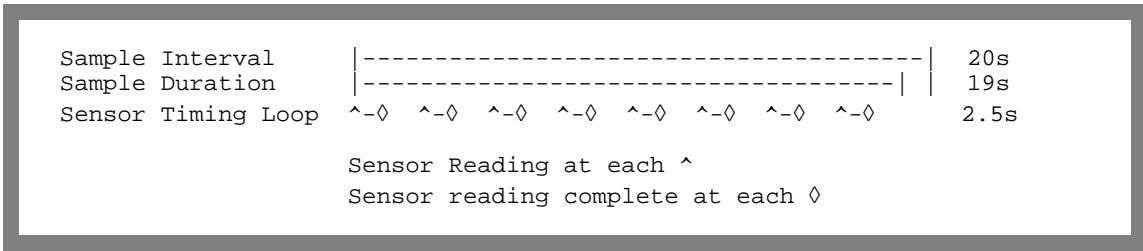
> **It is very important that the time set in the Sensor Timing Loop for the sensor is greater than the maximum amount of time that the sensor requires to collect data.**

> **If the Sensor Timing Loop time is less than the time that the sensor requires to collect data, the ZENO®-3200 will be unable to measure the sensor at the rate specified in the Sensor Timing Loop.**

12.1.6. Multiple Sensors and Timing

> **It is very important that sufficient time be allowed in the Sample Duration for the ZENO®-3200 to read each Sensor Record at least once.**

> **If the total time required by all Sensor Records exceeds the time set in the Sample Duration, the ZENO®-3200 WILL NOT be able to read all of the Sensor Records once in each Sample Interval!**

When the ZENO®-3200 determines that there is insufficient time to read all of the configured Sensor Records at least once, the ZENO®-3200 will warn the user to that effect.

12.1.7. Calculating The Total Time Required for The ZENO®-3200 To Measure All Sensor Records

Use the following steps to calculate the total time required by the ZENO®-3200 to measure all of the Sensor Records:

- Add all of the times required for measurement (t_i) required by each Sensor Record to calculate the total time required to read each sensor at least once (T_{Once}). If a Sensor Record defines an *analog sensor* or a *digital sensor*, the time required for measurement *must include any extra readings if the Sample Count is greater than one.*

- The Sample Count is defined by Line Item #10 in the Sensor Menu.[254] If a Sensor Record defines a *serial sensor*, the time required for measurement *must include any extra retries defined in Line Item #16 of the Sensor Menu*.[255]

$$T_{Once} = \sum_{i=1}^{n} t_i = t_1 + t_2 + \cdots + t_n$$

---

[254] Refer to Sections 10.3.1 and 10.3.2.
[255] Refer to Section 10.3.5.

> **The Sample Duration Time must be set to a value greater than or equal to**
> $\mathtt{T_{Once}}$ **in order for the ZENO®-3200 to collect data from each Sensor Record**
> **at least once.**

- If your Sample Duration Time is much greater than $\mathtt{T_{Once}}$ and the Maximum Sensor Readings, Line Item #11 in the Sensor Menu, of at least one Sensor Record is not set to one, the ZENO®-3200 will take multiple measurements. Use the following equations to calculate the time required by the ZENO®-3200 to make multiple measurements of each individual Sensor Record.

$$N_i = \min \begin{cases} \dfrac{T_{SD}}{S_i}; rounded \cdot down, & R_{MAX} = 0 \\[2mm] R_{MAX} - 1, & R_{MAX} > 0 \end{cases}$$

1. Determine how many times ($\mathtt{N_i}$, a whole number) the ZENO®-3200 will collect data from Sensor Record #$\mathtt{i}$ during a Sample Duration. $\mathtt{T_{SD}}$ is the Sample Duration Time, $\mathtt{S_i}$ is the Sensor Timing Loop time for the Sensor Record and $\mathtt{R_{MAX}}$ is the Maximum Sensor Readings (Line Item #11 in the Sensor Menu).
   If $\mathtt{R_{MAX}}$ is greater than zero, calculate both the top and bottom equations to make sure that the minimum value is used.
2. $\mathtt{T_i}$, the time required by the ZENO®-3200 to make all the measurements for Sensor Record #$\mathtt{i}$ is calculated by the next equation.

$$T_i = N_i t_i$$

3. Assuming that the Sensor Timing Loops are set so that all Sensor Records are read properly, the total time required to read ALL Sensor Records ($\mathtt{T_{Total}}$) is the same as the Sensor Record that requires the longest time. (These times were calculated in Step #2.)

12.1.8. Multiple Sensors Sharing The Same Resource and Timing

> **When multiple sensors are configured that share a common resource, the**
> **ZENO®-3200 can only take data from these sensors one at a time.**

> **The time that is required by each sensor to make a measurement must be taken into account for the ZENO®-3200 to measure each sensor properly when the sensors share a common resource.**

The following is a list of the single resources on the ZENO®-3200 that will be shared when more than one Sensor Record uses it.[256]

Potentially Shared Resource	Details	Time Critical
12-bit ADC	There is a single 12-bit ADC multiplexed between several channels. Each 12-bit ADC measurement requires only 0.1 milliseconds, so sharing this resource is not that critical.	No
18-bit ADC	There is a single 18-bit ADC multiplexed between several channels. Each 18-bit ADC measurement requires 100 milliseconds. When more than one 18-bit ADC sensor is specified, the time for each 18-bit ADC *MUST* be taken into account in the configuration.	Yes
COM1	COM1 is not multiplexed, nor does it support multi-drop serial communication. This resource cannot be shared by more than one Sensor Record.	N/A
COM2	COM2 is fully multiplexed to provide four separate links. One link is RS485, which supports multi-drop serial communication. More than one Sensor Record can share this resource.	Yes
COM3	COM3 is not multiplexed, but it does support RS485 for multi-drop serial communications. More than one Sensor Record can share this resource if the port type is always RS485.	Yes

If all Sensor Records are to be read equally, use the following steps when you configure more than one Sensor Record that uses the same resource:

• Make a list of all the Sensor Records that use a commonly shared resource.

• Add the time required for measurement (t_i) required by each of the listed Sensor Records to calculate the total time required to read each sensor at least once (T_{Once}). If a Sensor Record defines an *analog sensor* or a *digital sensor*, the time required for measurement *must include any extra readings if the Sample Count is greater than one.* The Sample Count is defined by Line Item #10 in the Sensor Menu (refer to Section 10.3.9).

$$T_{Once} = \sum_{i=1}^{n} t_i = t_1 + t_2 + \cdots + t_n$$

---

[256] Refer to Section 2.5 for the functional block-diagram of the ZENO®-3200 that illustrates these resources.

- If you plan to read each sensor N times, then the total time required to read all of the sensors N times is defined by the next equation:

$$T_{Total} = N \times T_{Once}$$

> **If the total time required to read all Sensor Records (T_{total}) exceeds the Sample Duration, the Sample Duration Time will need to be increased to a value greater than or equal to T_{total}. This may include increasing the Sample Interval Time.[257]**

- Use a common Sensor Timing Loop for the listed Sensor Records. Set the time of the Sensor Timing Loop to a value greater than or equal to the sum T_{Once}.

If the Sensor Records are to be read at different rates, use the following steps when you configure more than one Sensor Record that uses the same resource:

- Make a list of all the Sensor Records that use a shared resource.

- Arrange the list of Sensor Records in descending order according to how many times each one needs to be read within the Sample Duration. If possible, arrange the Sensor Records in the ZENO®-3200 in the same manner, as although this isn't necessary, it will make things easier to remember.

> **Remember: there are only four Sensor Timing Loops available.**

- If there are more than four Sensor Records that share the common resource, you will be limited to four groups of sensors where each group can be read a unique number of times during the Sample Duration. *(Each group will share the Sensor Timing Loop.)* Let N_1, N_2, N_3 and N_4 represent the number of times that you want to read the Sensor Records in each of the four possible groups respectively.

- Determine the total time (T_1, T_2, T_3 and T_4) required to read the Sensor Records in each of the four possible groups once respectively.

- Determine the overall total time (T_{total}) and total number of individual sensor reads (N_{total}) to read all of the Sensor Records in all of the four possible groups of Sensor Records by using the following equation:

$$T_{Total} = \sum_{i=1}^{4} N_i T_i = N_1 T_1 + N_2 T_2 + N_3 T_3 + N_4 T_4$$

---

[257] Refer to Section 3.1.3.

> **If T_{total} is less than the Sample Duration Time, the ZENO®-3200 will NOT be able to collect data from all of the Sensor Records at the rates specified by the Sensor Timing Loops.   Instead, the Sensor Records will be read less frequently than specified and with fewer collections than expected.**

> **To correct this unwanted situation, you must (1) reduce the number of times that you want to collect data from one or more Sensor Records, or (2) increase the available time in the Sample Duration.[258]**

> **To reduce the number of times you want to collect data from a Sensor Record, you can increase the time of its Sensor Timing Loop.[259]   Another possibility is to set the Maximum Sensor Readings to a value less than the possible number of times that the Sensor Record can be read during the Sample Duration.[260]**

12.1.9. Timing and Effects Upon The User Interface

> **A very busy, complex configuration contained in the ZENO®-3200 may periodically disrupt accessibility to the User Interface. This includes both the User Interface Menus and CCSAIL commands.**

As stated in Section 12.1.4, ZENOSOFT® is a multitasking software application and the ZENO®-3200 contains a single CPU. Since Data Collection Task has a higher priority than the User Interface Task, the RTOS will devote more time to the Data Collection Task than the User Interface Task.

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[258] Refer to Section 10.3.7.
[259] Refer to Section 10.3.7.
[260] Refer to Section 10.3.8.

> **If User Interface accessibility is periodically disrupted by your configuration, you have two options: 1) attempt to simplify the configuration to reduce timing stress, or 2) send more than one polling command to the ZENO®-3200 until you gain access to the User Interface.**

12.2. THE UNIVERSAL SERIAL INTERFACE

The Universal Serial Interface (USI) allows for programming the ZENO®-3200 to communicate with serial sensors using ASCII communications, which includes multiple poll-response commands, unsolicited data from the sensors and built-in checksum verification.

The USI largely retains the ZENO®-3200's existing menu-driven environment. Poll and response string formats are described using the C language **printf** formatting.[261] Asynchronous sensors, with no polling command, are also permitted. String, floating-point and long integer values can be read, logged, and transmitted; floating-point values can also be processed, with very limited processing permitted for the long integer values.

The ZENO®-3200 is designed to retrieve data from a finite number of serial sensors.

> **Since there is no universal standard that would allow communication to any type of sensor, the USI provides a generic means of retrieving data from most serial sensors.**

12.2.1. Three Menus Are Used To Configure The USI

Three separate menus are required to configure the Universal Serial Interface:

- The Sensor Menu to specify a Universal Serial Sensor.[262]
- The General Serial Script Menu to create the Script Record that provides parsing interface between the ZENO®-3200 and the serial sensor.[263]
- The Memory Management Menu to specify the amount of RAM memory required for the communications port configured with a General Serial Sensor.[264]

12.2.2. The Sensor Menu

To set up a Universal Serial Sensor, start with the standard ZENO®-3200 Sensor Menu, and choose the Sensor Type Code to be 16 (Universal Serial). The following Sensor Menu will then appear:

---

[261] **The C Programming Language**, Dennis W. Kernighan and Dennis M. Ritchie. Prentice Hall Software Series: 1988.
[262] Refer to Section 12.2.2.
[263] Refer to Sections 12.2.3 and 12.2.5.
[264] Refer to Section 12.2.4.

```
    SENSOR MENU
    (Cn/m) Change Item n To Value m              (Jn) Jump To Record n
    (A)    Insert After This Record             (N)  Go To Next Record
    (B)    Insert Before This Record            (P)  Go To Previous Record
    (X)    Cut Record to Clipboard              (XA) Delete ALL Records
    (C)    Copy Record To Clipboard             (Z)  Zeno Program Menu
    (V)    Paste Record From Clipboard          (H)  Help
    (Sn/m) Search Item n for Value m

    Sensor Items for Record 1 of 6:
    Item  1: Sensor Type Code                 16 (General Serial)
    Item  2: Sensor Name                      ritchie
    Item  3: Sensor Input Channel             COM2
    Item  6: Switched Power Code              1 (5V SW'D A)
    Item  9: Switched Power Warmup Time       6
    Item 10: Sensor Sample Count              2
    Item 11: Maximum Sensor Readings          2
    Item 12: Sensor Timing Loop               2 (1.0 seconds)
    Item 16: Retry Count                      6
    Item 17: Sensor Address                   0
    Item 18: Sensor Port Type                 RS232
    Item 19: Sensor Baud Rate                 4800
    Item 20: Sensor Bits Per Character        8
    Item 21: Sensor Parity                    N
    Item 22: Sensor Start Bits                1
    Item 23: Sensor Stop Bits                 1
    Item 24: Sensor GSI Script Number         1
    Item 25: Sensor Data Collection Control   P6.L2  (lt3ORte)

    >
```

Configuring the sensor channel and other communications settings is no different from other serial sensor types.[265]

However, Line Items #24 and #25 are unique to the General Serial Sensor type:

- Line Item #24, Sensor GSI Script Number, tells the ZENO®-3200 which Script Record to use from up to six unique Script Records defined using the General Serial Script Menu.[266]

- Line Item #25, Sensor Data Collection Control, allows conditional data collection from the General Serial Sensor.

> **When Line Item #25 is set to its default value of S0.1, the ZENO®-3200 will collect data from the sensor regularly as any other sensor.**

> **When Line Item #25 refers to a Process Record output, the ZENO®-3200 will ONLY collect data from the sensor when the Process Record output value is zero. If the Process Record output value is not zero, the ZENO®-3200 will NOT collect any data from the sensor.**

---

[265] Refer to Section 10.3.5.
[266] Refer to Section 12.2.3.

Examples of using Line Item #25 include:

- Only collecting data from a sensor when a specific condition exists.
- Using the General Serial Sensor type to send initialization commands to the sensor if no data is being collected from the sensor.

12.2.3. The General Serial Script Menu (In Brief)

The General Serial Script Menu is accessed from the Zeno Program Menu by typing the command **G{ENTER}**. Up to six independent scripts can be defined. Line Item #24 in the Sensor Menu refers to the script number.[267]

Each Script Record contains at least one Command Line, but it is more likely that a Script Record will contain multiple Command Lines.   A Script Record may look something like this:

```
GENERAL SERIAL SCRIPT MENU
(Cn/m) Change Line n to m              (X)  Delete this Script
(In)   Insert Line n                   (Jn) Jump to Script n
(Rn)   Remove Line n                   (N)  Go to Next Script
(En)   Erase Line n                    (P)  Go to Previous Script
(L)    Delete All Lines                (XA) Delete All Scripts
(A)    Insert After this Script        (Z)  Zeno Program Menu
(B)    Insert Before this Script       (H)  Help


Script 1 of 1
Line 1: FLOAT 3
Line 2: LONG 1
Line 3: STRING 2 ( 6, 1 )
Line 4: SET_CHECKSUM SIMPLE, 256
Line 5: SEND "\r\n\CS%1s,DATA NOW:\CS%2x\x03", sID, sCS
Line 6: WAIT 1000
Line 7: RECEIVE 1000, "\r\n\CS%*1s,%f,%f,%s,%ld,%f,%1s,\CS%2s", F1, F2, S1,
L1, F3, S2, sCS

>
```

This Script Record example corresponds to the following actions for a sensor with address Q.

- The ZENO sends the command **<CR><LF>Q,DATA now:xx^C**, where **xx** is a hexadecimal checksum evaluated by summing the ASCII values of all characters from the **Q** to the final colon.
- The ZENO waits 1000 ms before flushing the buffer.
- The ZENO waits for up to 1000 ms further, and attempts to receive a string of the type:
  <CR><LF>Q,15.2,55.999,YELLOW,256000,-15.3,F,xx^C
- (For space-delimited, the **RECEIVE** command include spaces rather than commas in the format specifier: "\r\n\CS%*1s %f %f.....").
- The ZENO tests that the checksum is correct.

---

[267] Refer to Section 12.2.2.

The ZENO®-3200 will return the floating-point values 15.2, 55.999, and -15.3; the string values YELLOW and F; and the long integer 256000. (Placing an * in a format field tells the ZENO®-3200 that the field is to be ignored.)

Most of the menu options in the General Serial Script Menu have identical functions to those for Sensor Record (refer to Section 10.2), but there are three menu options unique to the General Serial Script Menu:

- **In** *(Insert Line n)*: this option creates a new Command Line in position **n** within the currently viewed Script Record. Any Command Lines that follow the inserted Command Line will be shifted up beyond the inserted Command Line. Valid values for **n** are 1 through one more than the total number of existing Command Lines in the Script Record.
- **En** *(Erase Line n)*: this option erases Command Line n by setting the command to the default of **NO_COMMAND**. Valid values for **n** are 1 through the total number of existing Command Lines in the Script Record.
- **Rn** *(Remove Line n)*: this option removes Command Line **n** from the Script Record. It is the opposite of menu option **In**. Any Command Lines that follow the removed Command Line will be shifted down. Valid values for **n** are 1 through the total number of existing Command Lines in the Script Record.

A finite number of commands are available to create each Command Line in a Script Record. These commands are detailed in Section 12.2.5.

12.2.4. The Memory Management Menu

The Memory Management Menu, which is accessible from the Zeno Program Menu by typing the command **M{ENTER}**, allows the user to specify how much memory to allocate to each communications port for USI support as shown below:

```
MEMORY MANAGEMENT MENU
(Cn/m) Change Item n To Value m            (H) Help
(Z)    Zeno Program Menu

Item  1:  0            (COM1 GSI Memory Size in Bytes)
Item  2:  0            (COM2 GSI Memory Size in Bytes)
Item  3:  0            (COM3 GSI Memory Size in Bytes)

>
```

> **If you use a General Serial Sensor in your configuration, you MUST allocate memory for that sensor on the communications port that it uses.**

Each communications port can have up to 2048 bytes set aside for USI use.

> **Changing one of these parameters will change the total amount of memory available for data logging.   Hence, any logged data records will be deleted when a value is changed.   The number of data records that can be stored may also be changed.**

To determine the amount of memory required for a USI sensor, look at all the USI sensors configured on a single communications port. Determine how much memory is required to store an entire string from the remote sensor. Whichever USI sensor requires the greatest amount of memory, use that memory value to set in the appropriate communications port.

> **REMEMBER: if insufficient memory is set aside for a particular USI sensor, no data will be collected from that sensor.**

If memory has been allocated in the Memory Management Menu for a non-existent Universal Serial Sensor, ZENOSOFT® will report a warning to the user.

12.2.5. Changing Script Record Command Lines

Command Lines within a Script Record are inserted, changed, erased, or removed via the General Serial Script Menu.[268] When you view a newly created Script Record, or when no Script Records have been configured, a Script Record containing only one Command Line will be presented:

```
GENERAL SERIAL SCRIPT MENU
(Cn/m) Change Line n to m              (X)  Delete this Script
(In)   Insert Line n                   (Jn) Jump to Script n
(Rn)   Remove Line n                   (N)  Go to Next Script
(En)   Erase Line n                    (P)  Go to Previous Script
(L)    Delete All Lines                (XA) Delete All Scripts
(A)    Insert After this Script        (Z)  Zeno Program Menu
(B)    Insert Before this Script       (H)  Help

Script 1 of 1
Line 1: NO_COMMAND

>
```

> **The default command for a newly inserted Command Line or non-configured Script Record Command Line is always** NO_COMMAND**.**

When the ZENO®-3200 encounters the command **NO_COMMAND** in a Command Line, no action is taken. It is simply a placeholder for the Command Line.

---

[268] Refer to Section 12.2.3.

The contents of a Command Line are changed using menu option **Cn/m{ENTER}** in the General Serial Script Menu, where **n** is the Command Line number and **m** is the new command string for the Command Line n.

> **When you change the contents of a Script Record Command Line, you must adhere to the syntax specific to the command being specified.**

When you change the contents of a Command Line, the ZENO®-3200 verifies that the syntax is correct in the **Cn/m** command (or from a configuration file).

> **If the ZENO®-3200 detects any errors in Command Line syntax, the ZENO®-3200 will reject the changed Command Line, keep the current contents of the specified Command Line and report the error to the user.**

Command Line syntax is very important because the ZENO®-3200 must know exactly what it needs to do in order to successfully communicate with the desired serial sensor. Syntax issues include spacing and capitalization which depends upon the portion of the Command Line.

> **Script Record Command Line syntax usually includes spaces.   When you change a Command Line using the** Cn/m **menu option,** m **can includes spaces. for this reason, if you make a syntax mistake when changing a Script Record Command Line, the ZENO®-3200 will probably report several errors because it cannot distinguish space-delimited parts of a failed script.**

> **If a Command Line is longer than 200 characters, you will need to change it directly into a downloaded configuration file using a standard text editor.[269]**

> **Coastal Environmental Systems recommends that you hand-edit a configuration file ONLY AFTER you have gained experience with the USI.**

If you need to change a Script Record Command Line to something longer than 200 characters, use the following instructions:

- Download the configuration from the ZENO®-3200 into a text file.[270]

---

[269] The User Interface is limited to menu command lines of 200 characters.

- Hand-edit the downloaded configuration file using a standard text editor, such as Microsoft Notepad.
- Upload the edited configuration file back into the ZENO®-3200.[271]

> **When you upload the hand-edited configuration file into the ZENO®-3200, do NOT use the X-modem protocol so that you can view any possible reported syntax errors reported by the ZENO®-3200.**

12.2.6. Library of USI Commands

USI commands fall into two general categories:

- A *Value Declaration Command (VDC)* tells the ZENO®-3200 how many values of a particular type will be stored by the Script Record.
- An *Action Command (AC)* tells the ZENO®-3200 to perform the specified action.

> **Each Value Declaration Command (VDC) can only be used once within a Script Record, but each Action Command can be used multiple times.**

Any part of the command that is in italics is a placeholder for a value or string. Any part of a command that is contained in brackets [and] is optionally required depending upon the values preceding it. The brackets [and] are NOT actually used within the Command Line.

The following are the general syntax rules for Command Lines of anything *outside* of the Format Specifier:

- Capitalization is optional. The ZENO®-3200 will store all ASCII characters outside of a Format Specifier as upper case.
- The first word of a Command Line is ALWAYS followed by a space IF anything follows.
- Any secondary or tertiary words that are followed by another word are ALWAYS followed by a comma and a space, except for the TURN command.

The following are the general syntax rules anything *inside* the Format Specifier:

- A Format Specifier is regarded as a single word that is contained within two quotation marks (one at the beginning and one at the end).
- ASCII characters used within the Format Specifier are case specific.
- Any Data Fields specified within the Format Specifier must have matching Data Value Fields specified following the Format Specifier.

The following table summarizes the library of nine available USI commands.

---

[270] Refer to Section 9.1.
[271] Refer to Section 9.2.

Command	Category	Brief Description
FLOAT *n*	VDC	Declares "n" values to be stored for the specified value type.
LONG *n*		
STRING n (l1[, l2[, …,ln]])		
SET_CHECKSUM type, mod [, offset]		Declares the type of checksum verification is used in the serial sensor message.
NO_COMMAND	AC	No action is taken.
SEND "format_specifier" [,value1 [,value 2…]]		Instructs the ZENO®-3200 to transmit the message specified in the format specifier along with any other values referenced by the format specifier.
RECEIVE time, "format_specifier" [,value1 [,value 2…]]		Instructs the ZENO®-3200 to wait up to the specified time for the message described in the format specifier and to store the received data in the specified values.
WAIT *time*		Instructs the ZENO®-3200 to wait up to the specified time.[272]
TURN state channel		Instructs the ZENO®-3200 to turn on or off the specified channel.

The following list is a more detailed description of each USI command.

Value Declaration Commands

FLOAT *n*

> Declare *n* floating-point values. Up to 100 floating-point values can be specified. These will be referred to as **F1**, **F2**, etc. within the remainder of the Script Record. With respect to the Sensor Record that refers to this Script Record, these values can be inputs to Process Records and Data Output Records as specified in Section 10.4.4.
> This command can only be used once in a Script Record.

LONG *n*

> Declare *n* long integer (32-bit integer) values. Up to 100 long integer values can be specified. These will be referred to as **L1**, **L2**, etc. within the remainder of the Script Record. With respect to the Sensor Record that refers to this Script Record, these values can be inputs to Process Records and Data Output Records as specified in Section 10.4.4.
> This command can only be used once in a Script Record.

STRING n (l1[,l2[,...]])

> Declare *n* string values and their corresponding maximum string lengths *(l1, l2, etc.).* for correct syntax, the lengths of the strings must be contained within open and close parentheses; and the parentheses must be space delimited from everything. Further, the number of maximum string lengths must equal the number of strings specified by *n*.
> Up to 100 string values can be specified. Each maximum string length can be up to 256 characters.

---

[272] When the ZENO®-3200 is commanded to wait, it will continue to perform other tasks since it is multitasking. The wait applies only to the Sensor Record that specified the General Serial Sensor using the WAIT command in its Script Record.

Each string value will be referred to as **S1**, **S2**, etc. within the remainder of the Script Record. . With respect to the Sensor Record that refers to this Script Record, these values can be inputs to Data Output Records as specified in Section 10.4.4.

SET_CHECKSUM *type*, *modulus* [, *offset*]

Defines how checksums will be calculated within the Script Record. The permitted checksum types are listed below.[273] The checksum type can be entered in either uppercase or lowercase.

- **CRC_16** (standard CRC-16).

- **CRC_CCITT** (standard CRC-CCIT)

- **XOR** (Logical XOR between all characters within the delimiters is used in NMEA messages).

- **SIMPLE** (ASCII sum of all characters within the delimiters).

The modulus[274] defines which portion of the calculated checksum will be used. for example, a modulus of 100 means that only the portion of the calculated checksum that is below 100 will be used. As another example, a modulus of 256 means that only the portion of the calculated checksum that is below 256 will be used.
The **SIMPLE** checksum type requires both the modulus and the offset applied to the ASCII sum before the modulus is taken.

Action Commands

NO_COMMAND

No action is taken.

TURN state channel

Turn the specified *channel* to the *state* that is ON or OFF. *state* is either ON or OFF. *channel* is a value between 1 and 5 or 18 and 23.   The channels are as follows:

Channel	Meaning
1	5 V Switched Voltage A
2	5 V Switched Voltage B
3	12 V Switched Voltage A
4	12 V Switched Voltage B
5	12 V Switched Voltage C
18 – 23	Digital Output

WAIT *time*

Wait for the specified length of *time* in milliseconds, and then flush the buffer. Wait times from 1 millisecond to 5 minutes (300,000 milliseconds) are permitted.

---

[273] Contact Coastal Environmental Systems for other checksum types if none of these meet your requirements.
[274] A modulus is used to calculate the remainder generated when dividing two numbers.

> **The serial communications port specified in the Sensor Record is allocated to the serial sensor throughout this time – another sensor cannot use the port while the Script Record is waiting.**

SEND format_specifier [**,**value1 [**,**value 2. . . .]]

Instructs the ZENO®-3200 to transmit the string that is specified in the Format Specifier along with any optional values, to the sensor. The communications port used is the one specified in the Sensor Record referencing this Script Record.

Any Data Value Fields used in the Format Specifier string must match the Data Value Fields *[,value1 [,value 2. . . .]]* that follow the Format Specifier string. Otherwise a syntax error will be generated and the command will not be accepted into the ZENO®-3200.

The optional Data Value Fields are limited to the Special Values of **sCS** and **sID**, which are explained in detail in the Special Values section on the next page.

> **The checksum Special Value, sCS, may not be referenced before the SET_CHECKSUM command is used.**

RECEIVE time**,** format_specifier [**,**value1 [**,**value 2. . . .]]

Instructs the ZENO®-3200 to wait for up to the specified length of *time* in milliseconds, in an attempt to receive and parse a data line from the sensor. Wait times from 0 milliseconds to 5 minutes (300,000 milliseconds) are permitted.

> **If the time is specified as zero, the ZENO®-3200 will re-parse a sensor message received using a previous RECEIVE Command Line.**

> **The serial communications port specified in the Sensor Record is allocated to the serial sensor throughout this time – another sensor cannot use the port while the Script Record is waiting.**

Any Data Value Fields used in the Format Specifier string must match the Data Value Fields *[,value1 [,value 2. . . .]]* that follow the Format Specifier string. Otherwise a syntax error will be generated and the command will not be accepted into the ZENO®-3200.

Valid Data Value Fields include Special Values (checksum **sCS** or the sensor address **sID**), floating point values (**F1**, **F2**, etc.), long integer values (**L1**, **L2**, etc.) or string values (**S1**, **S2**, etc.).

> **Floating point values (F1, F2, etc.), long integer values (L1, L2, etc.) or string values (S1, S2, etc.) can only be used when the corresponding Value Declaration Command has been used in a previous Command Line.**

> **The checksum Special Value, `sCS`, may not be referenced before the `SET_CHECKSUM` command is used.**

If a Special Value (checksum **sCS** or the sensor address **sID**) is referenced in the value list, the ZENO®-3200 will check that the value was received correctly. If a specified Special Value is not properly received, the received sensor data line will be rejected.

If the string is not received in the specified time, the ZENO®-3200 will flag an error and quit the Command Line. If no values are received by a Script Record, the ZENO®-3200 may retry the Script Record if the Sensor Retry Count was specified within the Sensor Menu.[275]

For asynchronous sensors, a **RECEIVE** statement is specified with no prior **SEND** statement.

Special Values

sID

The sensor address, from Line Item #17 the Sensor Menu.[276] This is read-only. It is treated as a string value, so the format field in the Format Specifier string must also be a string format field; otherwise, a syntax error will be declared.

In **SEND** commands, the sensor address is formatted as specified, and transmitted.

In a **RECEIVE** command, the ZENO®-3200 checks that the value read from the received string equals the sensor address specified in Line Item #17 of the Sensor Menu.[277] If the values are different, the ZENO®-3200 flags an error, and quits the Comma.

An example of the **RECEIVE** Command Line might look something like this:

```
RECEIVE 1000, "\r\n\CS%1s,%f,%f,%s,%ld,%f,%1s,\CS%2s", sID, F1,
F2, S1, L1, F3, S2, sCS
```

This **RECEIVE** Command Line instructs the ZENO®-3200 to check that the first comma-delimited field matched the sensor ID.

sCS

The checksum calculated according to the **SET_CHECKSUM** command. If no **SET_CHECKSUM** command has been used in a previous Command Line, it is not valid to use the "\CS" codes within a script format string. The **sCS** identifier is used with a long integer data field within a Format Specifier in a **SEND** Command Line; but can only be used with string data fields in **RECEIVE** Command Lines.

In a **SEND** Command Line, the checksum is calculated as a long integer, formatted as specified, and transmitted.

In a **RECEIVE** Command Line, the checksum is read from the received string, and checked against a calculated value. If the values differ, the ZENO®-3200 does not use the rejects the received sensor data and quits the Command Line.

Format Specifier

The Format Specifier is a string used to describe the format of a message to be transmitted from the ZENO®-3200 using the **SEND** command, or received from a serial sensor using the **RECEIVE** command. The techniques used to describe the format are based upon those used in the C programming language.

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[275] Refer to Section 10.3.5.

[276] Ibid.

[277] Ibid.

Three types of information can be used in the Format Specifier:

Type of Information in Format Specifier	Description
Regular Text	Any literal, printable ASCII characters excluding the three characters `"`, `%` and `\`.
Special Characters	Non-printable, literal characters that are designated with at least two characters, the first one always being `\`.
Data Fields	Indicate that the characters will be translated numerically or as a string. Starting character is always a `%`.

The following table contains the Special Characters supported in the Format Specifier. Special characters *are* case sensitive--lowercase characters must be used.

Special Character	Description
`\r`	Carriage return.
`\n`	Linefeed.
`\\`	For a single `\` character.
`\t`	Tab.
`\xnn`	ASCII character whose 2-digit hexadecimal representation is stored in *nn*. (Refer to Appendix A for a complete ASCII table.) Valid values for *nn* range from 00 to ff. For example, if you need to receive or transmit a quotation mark (`"`), use Special Character `\x22`.
`\B`	Serial break lasting for 15 milliseconds.
`\VBnnnn`	Time-definable serial break lasting for *nnnn* milliseconds. Valid values for *nnnn* range from 0000 to 9999.
`\CS`	Indicates where to start a checksum or where to end a checksum. This must appear *either* not at all, *or* precisely twice, within a Format Specifier. If a checksum `sCS` is sent or received, the checksum bracket must appear twice. (If the bracket characters appear, but `sCS` is not sent or received, then the bracket characters are ignored). The `SET_CHECKSUM` command must be defined within the Script Record in order for the `\CS` field to be used; otherwise, a syntax error will be declared by the ZENO®-3200.

Since there are three supported data value types (floating-point, long integer and string), there are three basic corresponding Data Field types. These are listed in the following table.

Data Field	Description	Data Value Field
%%	Represents character %.	N/A
%f	Indicates a floating-point number will be retrieved. If *n* is used, it indicates the total number of characters used. If *m* is used, it indicates the number of characters that follow the decimal point.	**F1**, **F2**, etc.
%nf		
%n.mf		
%ld	Indicates a long integer number will be retrieved. If *n* is used, it indicates the total number of characters used.	**L1**, **L2**, etc.
%nld		
%lx, %lX	Indicates a hexadecimal, long integer number will be retrieved. If *n* is used, it indicates the total number of characters used. Using lowercase or uppercase **x** indicates whether lowercase or uppercase characters are used in the hexadecimal number.	
%nlx, %nlX		
%s	Indicates that a string will be retrieved. If *n* is used, it indicates the total number of characters used. Any printable or non-printable ASCII character is valid to be part of a string value.	**S1**, **S2**, etc.
%ns		

Data Fields within Format Specifier string must match their Data Value Fields following the Format Specifier string in the Command Line. If the Data Field type does not match the Data Value Field, ZenoSoft™ will generate an error.

To ignore a particular field in a received message, use an ***** immediately following the **%** sign, such as **%*2s** or **%*lX**.

The following is an example Command Line containing a RECEIVE command:

```
RECEIVE 6000, "\r\n%6.0f,%9.4f,%9.5f,%9.5f,%s,%s,", F2, F3, F4, F5, S2, S3
```

For the above Command Line, ZenoSoft™ will wait up to 60 seconds to receive a message from the sensor that is transmitting a comma-delimited message that starts with a carriage-return/linefeed and contains four floating-point values and two string values. Each of the Data Value Fields that follow the Format Specifier match the corresponding Data Fields inside of the Format Specifier.

12.2.7. Writing & Troubleshooting A USI Script

To write an effective USI script, it is crucial to understand how the sensor communicates. Use the following steps to assist you in writing a Script Record.

- Understanding the Sensor from Which to Collect Data
- How Many & What Types of Values Are Available & Needed?
  Determine the number of values that a sensor outputs in its output message. Integer values can be stored either as floating point or as long-integer values. Floating point values should always be stored as floating point values to prevent loss of precision. String values can only be stored as strings.
- Is the Sensor Polled?
  Determine whether the sensor requires a polling command to be sent before it will output any data. If the sensor can be configured to be polled or to continuously transmit data, determine which technique is best for the application.
- What Is the Format of the Sensor's Output & Input Messages?

Determine exactly what is contained in a sensor's data message. If not completely certain, store and/or view the entire sensor's message by storing the whole message in a single string.

- What Are Power & Communication Requirements?
  Determine the correct port type required (RS232, RS485, etc.), baud rate, number of start bits, number of stop bits required to talk to the sensor. If the sensor requires a lot of power and total power is limited, determine the necessary warm-up time for the sensor and its required voltage.

- Establishing Basic Communication with the Sensor

- Storing and/or Displaying A Received Sensor Message as a Single String
  If there is difficulty in retrieving the data from a sensor, store the entire received string from the sensor in a single string. If a string is received, this will indicate that the communication parameters are valid and that the problem is in parsing the received string. If no message is received, the problem is likely to be communication settings, timing, or hardware.
  The following Script Record example illustrates capturing an entire message from a sensor (up to 50 characters) after a polling command is sent to it (in this case, a linefeed character).

```
GENERAL SERIAL SCRIPT MENU
(Cn/m) Change Line n to m                (X)  Delete this Script
(In)   Insert Line n                     (Jn) Jump to Script n
(Rn)   Remove Line n                     (N)  Go to Next Script
(En)   Erase Line n                      (P)  Go to Previous Script
(L)    Delete All Lines                  (XA) Delete All Scripts
(A)    Insert After this Script          (Z)  Zeno Program Menu
(B)    Insert Before this Script         (H)  Help


Script 1 of 1
Line 1: STRING 1 ( 50 )
Line 2: SEND "\n"
Line 3: RECEIVE 1000, "%s", S1

>
```

Once you know you have communication with the sensor by receiving an entire message from the sensor, you can modify the Script Record to parse the message further.[278]

```
GENERAL SERIAL SCRIPT MENU
(Cn/m) Change Line n to m                (X)  Delete this Script
(In)   Insert Line n                     (Jn) Jump to Script n
(Rn)   Remove Line n                     (N)  Go to Next Script
(En)   Erase Line n                      (P)  Go to Previous Script
(L)    Delete All Lines                  (XA) Delete All Scripts
(A)    Insert After this Script          (Z)  Zeno Program Menu
(B)    Insert Before this Script         (H)  Help


Script 1 of 1
Line 1: STRING 3 ( 50, 10, 10 )
Line 2: FLOAT 4
Line 3: SEND "\n"
Line 4: RECEIVE 1000, "%s", S1
Line 5: RECEIVE 0, "\r\n%6.0f,%9.4f,%9.5f,%9.5f,%s,%s", F1, F2, F3, F4,
S2, S3

>
```

---

[278] Remember to add more Value Declaration Commands to store floating-point or long integer data or both.

- Troubleshooting the **RECEIVE** Command Format Specifier

  Once communication is established with a sensor, but the individual data fields cannot be parsed, the problem is with the primary **RECEIVE** command that parses the received string. Observe closely the message that has been received in the single string and compare it with the Format Specifier in the primary **RECEIVE** parsing line.

- Key Tips to Writing an Effective Format Specifier

  1. Keep the Format Specifier as simple as possible, but ensure you can still be able to identify the start of the message. It is not necessary to completely read a received sensor message-- ending characters that contribute no data don't need to be parsed unless they are needed to identify a message.

  2. Store the entire string received from a sensor and output it in the Data Retrieval Menu. Look for any non-printable characters or control characters that may need to be included as part of the Format Specifier for parsing the string accurately. Also, verify that the string outputted from the sensor is the expected string. If the sensor is configurable, make sure it is configured properly.

  3. Avoid using checksum verification until the base sensor string is parsed correctly. If the starting and stopping points for checksum verification are not set correctly, ZENOSOFT® will not accept the string because the checksums will be invalid.

12.3.   CONFIGURATIONS WITH MULTIPLE SERIAL SENSORS

Any sensor suite that includes multiple serial sensors can become complicated when determining not only which communication ports to use, but also the timing of how data will be collected from each serial sensor.

The following steps will simplify the creation of a configuration with multiple serial sensors.

1. Match each serial sensor to the supported serial sensor types in the ZENO®-3200. Any serial sensor that is not directly supported can be handled by the USI.
2. Identify the port type of each serial sensor whether it is RS232, RS485, TTL or radio. Make special note of any serial sensor that can support multiple port types.
3. Do not mix serial sensors with different communications protocols on the same multi-drop communications link (RS485 or radio) unless necessary. If the port type of more than one serial sensor is multi-drop (RS485 or radio) and they communicate using different protocols, there may be difficulty in connecting them to the same multi-drop port on the ZENO®-3200. Different protocols may cause interference on the same multi-drop communications link.
4. Coastal Environmental Systems recommends that any communications port that is being used with a serial sensor should be excluded from using the User Interface.[279] Allowing the User Interface Task to access the communications port that is being used for a serial sensor may inhibit the ZENO®-3200 from retrieving data from the serial sensor.
5. Do not mix serial sensor data collection with bi-directional User Interface communication on the same communications port. Using bi-directional communication with the User Interface on the same

---

[279] Refer to Section 6.12.

communications port that supports one or more serial sensors can cause interference with both data collection and User Interface communications.

> **Coastal Environmental Systems recommends that you reserve one communications port (either COM1 or COM3) for bi-directional User Interface communication.**

> **Since COM2 is fully multiplexed and since it provides four independent communication routes, Coastal Environmental Systems recommends that you start with COM2 for locating serial sensors.**

> **If COM1 or COM3 is NOT being used for any User Interface communication, Coastal Environmental Systems recommends that you locate at least one serial sensor on the unused communications port to relieve timing demands on COM2.**

6. Follow the procedure described in Section 12.1.8 for determining the timing for multiple serial sensors sharing the same communications port.

12.4.   SHARING DATA BETWEEN MULTIPLE ZENO®-3200'S (MULTIPROCESSING)

You may have a situation in which you are measuring data using one or more sensors connected to one ZENO®-3200, that is required by one or more other ZENO®-3200's in order process their data. Further, you may want to log all the data collected by all ZENO®-3200's on the first ZENO®-3200. Such a situation would be defined as multiprocessing.

> **Multiple ZENO®-3200s can share data by using a combination of regular CCSAIL Sensors and Asynchronous CCSAIL Sensors so that the bi-directional data messages don't interfere with one another.**

Setup the primary ZENO®-3200 to broadcast an automatic data message in the form of a CCSAIL data (sensor) message. Set the destination address in the CCSAIL data message to 9999.

In each of the secondary ZENO®-3200's, setup an Asynchronous CCSAIL Sensor to receive the data message from the primary ZENO®-3200.

Setup the data output message from each secondary ZENO®-3200 in the form of a CCSAIL sensor message that is NOT sent out automatically.

In the primary ZENO®-3200 setup a regular CCSAIL Sensor for each of the secondary ZENO®-3200's.

In operation and properly configured, the primary ZENO®-3200 will regularly broadcast its data message

to the secondary ZENO®-3200's. The secondary ZENO®-3200's will use the data received from the primary ZENO®-3200 as required. The primary ZENO®-3200 will then poll each of the secondary ZENO®-3200's for their data as required.

The following diagram illustrates this bi-directional flow of data:

CCSAIL "DL1" Poll Commands →   ← Data Messages

| | 1st Secondary ZENO-3200 |

| Primary ZENO-3200 | 2nd Secondary ZENO-3200 |

| | 3rd Secondary ZENO-3200 |

Automatic CCSAIL Data Output Message →
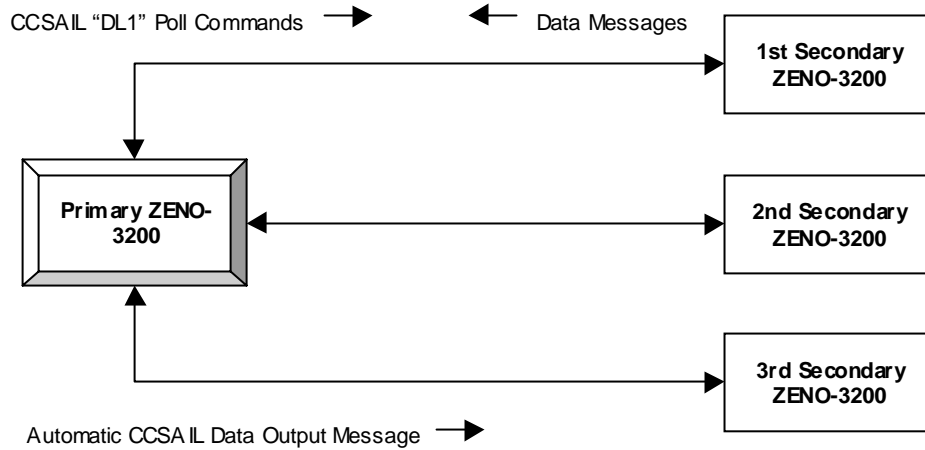
13. ELECTRICAL CONSIDERATIONS

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13.1. THE ZENO®-3200 ENCLOSURE

> **The ZENO®-3200 enclosure is NOT watertight, moisture-resistant or weatherproof!**

> **If you plan to install the ZENO®-3200 outdoors, it must be sheltered to protect it from condensation and weather.**

13.2. GROUNDING

> **Proper grounding is required to minimize errors in sensor readings and to protect the ZENO®-3200 from damage due to ESD[280], lightning-induced power surges, and other potential causes.**

Without proper grounding, interfering signals can couple to your sensor circuits, resulting in errors much greater than those due to thermal noise. These errors can be introduced as:

- *Noise induced from AC signals* typically arises from mutual inductance[281] or capacitive coupling[282] between different parts of the same circuit or different circuits. Using twisted pairs for signal and excitation leads greatly reduces noise created by mutual inductance. Capacitively coupled noise can be reduced by using shielded wire, with the shield grounded to earth at one end only.

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[280] ESD stands for electrostatic discharge.

[281] A varying current in a circuit will create a varying magnetic field surrounding the circuit. If a separate, nearby circuit is unprotected, the varying magnetic field from the first circuit can induce noise current in the unprotected circuit. This phenomenon is called inductive coupling or mutual inductance.

[282] Capacitive coupling occurs when the varying voltage of one circuit affects the voltage level of a nearby unprotected circuit because of the varying electric field created by the first circuit.

- *DC offset voltages* arise due to large currents flowing through the ground return paths that have a significant resistance. This resistive coupling can be reduced by providing separate ground wires for each sensor. Use a large enough wire gauge in the sensor leads to prevent voltage drops due to wire resistance; otherwise, more significant, resistive-coupling errors can arise.

- *Noise from radio frequency (RF) sources*[283] may cause measurement error due to rectification within the ZENO®-3200's sensitive amplifier circuitry. Bonding[284] the ZENO®-3200's enclosure to an earth ground system will prevent most of these errors by providing a return path for RF-induced currents that will be shunted through input protection circuitry.

The ZENO®-3200 provides multiple grounds, to minimize these sources of error and for protection against lightning. The following figure shows how the different grounds are connected to a central ground at the A/D converter.
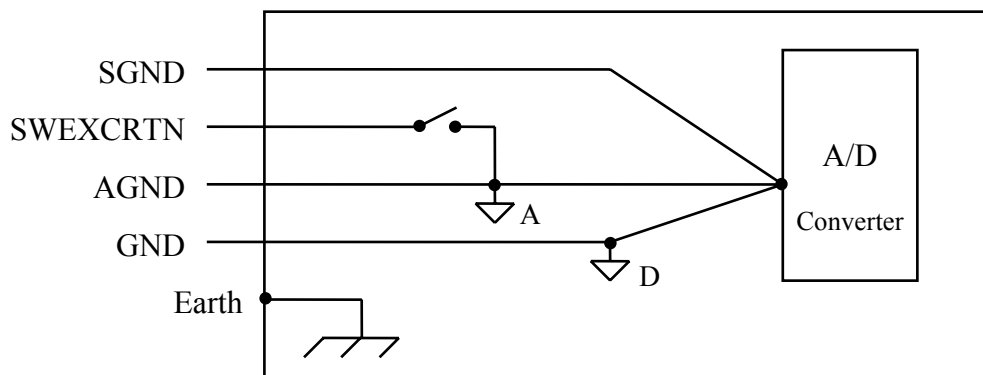
Figure 13-1. Grounds available on ZENO®-3200.

The different grounds are appropriate under the following circumstances.

- *Earth Ground*: the casing of the ZENO®-3200 is grounded to earth for protection against lightning and similar contingencies. Coastal Environmental Systems recommends that the ZENO®-3200's enclosure and earth grounding system should be bonded[285] to a 6 foot (2 meter) grounding rod, driven at least 5'6" (180 cm) into the ground. A to 2AWG wire, or larger, should be used for the connection.

- *Digital ground (marked GND)*: this is suitable only for digital inputs and outputs, and for power returns – it is too noisy for use with analog sensors.

- *Analog ground (marked AGND)*: this is the standard analog ground; it is much less noisy than GND. Use this ground for your analog sensors, unless you have a reason to use either SGND or SWEXCRTN.

- *Switched excitation return (abbreviated SWEXCRTN)*: this ground is equivalent, in terms of noise, to the standard analog ground. Use this ground for sensors which are cycled on and off to conserve power during normal operation – the switch in this circuit is software-configured to cycle excitation power to the sensor while it is being used.

---

[283] This includes RF noise from handheld radios, motors, motor controllers, relays, welders, broadcast transmitters, and heavy machinery.
[284] Bonding is a bare metal-to-bare metal connection whose electrical resistance does not exceed 1 milli-ohm.
[285] Ibid.

- *Sensor ground (marked SGND)*: this ground should be used only for sensitive, single-ended sensors. Typically, sensors with a full scale voltage less than 50 mV and source impedance greater than 10 kΩ would be suitable for SGND. No harm will be caused by grounding less sensitive sensors to SGND; however, sensors returning greater currents through SGND may disturb those returning smaller currents.

13.3.   CONNECTING DIFFERENTIAL INPUTS

Connecting the ZENO®-3200 inputs in differential mode is usually done only with sensors that are inherently ground-referenced. The following bridge circuit is an example of this.
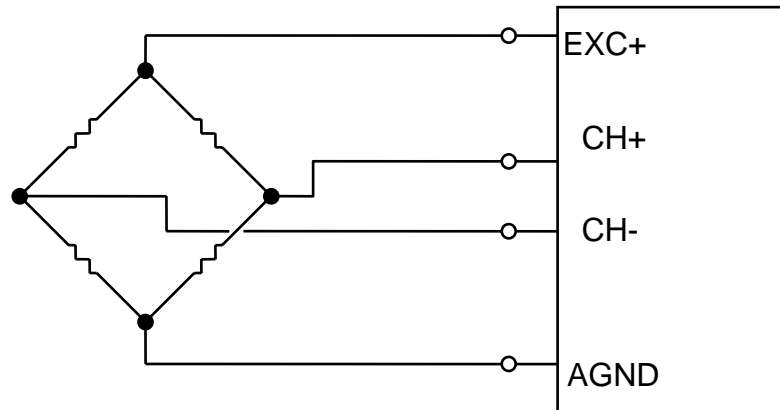
ZENO®-3200

Figure 13-2. Connecting a Differential Circuit with Excitation Voltage.

When making a differential measurement using a sensor or source that is not ground-referenced you *must* provide a return path for the leakage currents. If this path is not provided, those currents will charge stray capacitances, causing the output to drift uncontrollably or to saturate. There are several ways to provide this path, depending on the output configuration of the source/sensor being measured.

If the source "low" output is connected to ground (either directly or through a high resistance) then the connection shown in the following figure will work.
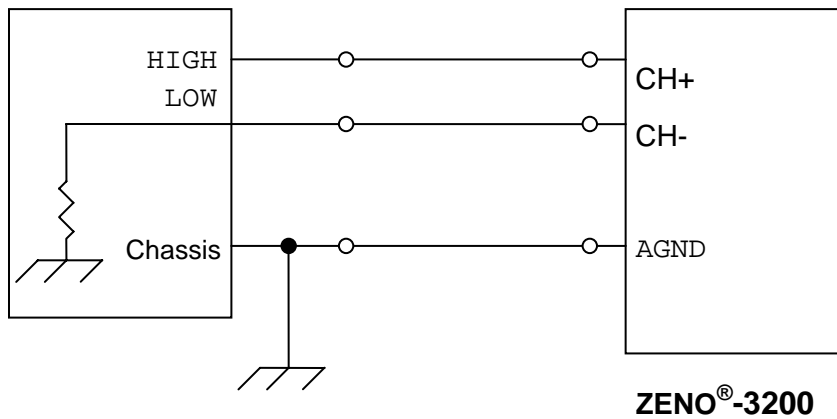
ZENO®-3200

Figure 13-3. Connecting a Differential Circuit.

However, in quite a few cases the output will be fully floating. In these cases you must provide a return path by adding a resistor between the ZENO®-3200 analog ground and the sensor/source. This resistor should be about 10^4 times greater than the source resistance. The simplest option is to connect a single resistance between the source low and the ZENO®-3200 analog ground as shown below. This connection will work well if the source resistance is low.
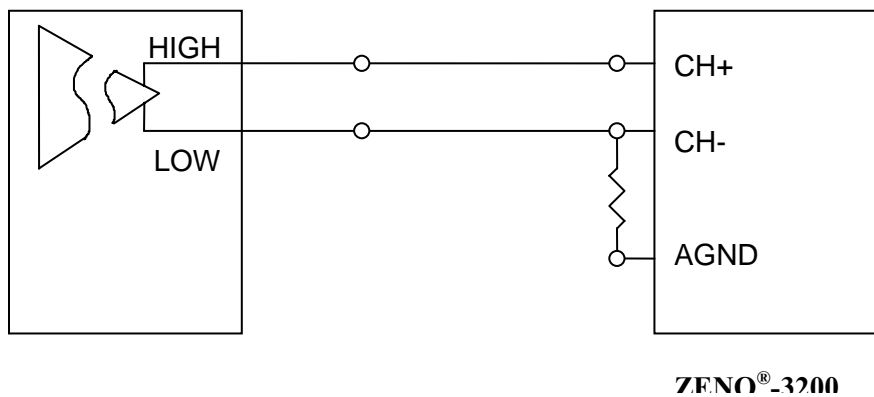
ZENO®-3200

Figure 13-4. Providing a Return Path to a Differential Circuit.

In conclusion, although the ZENO®-3200 has differential inputs, there must be a return path for the leakage currents. Using one of the connections shown in this section should allow you to make accurate differential measurements.

13.4.   THE ZENO®-3200 CPU BOARD

The following is a diagram of the ZENO®-3200 Revision A CPU board. The Revision D CPU board differs slightly in appearance in that there is a flash memory chip instead of a removable PROM, which stores the ZENOSOFT® firmware.
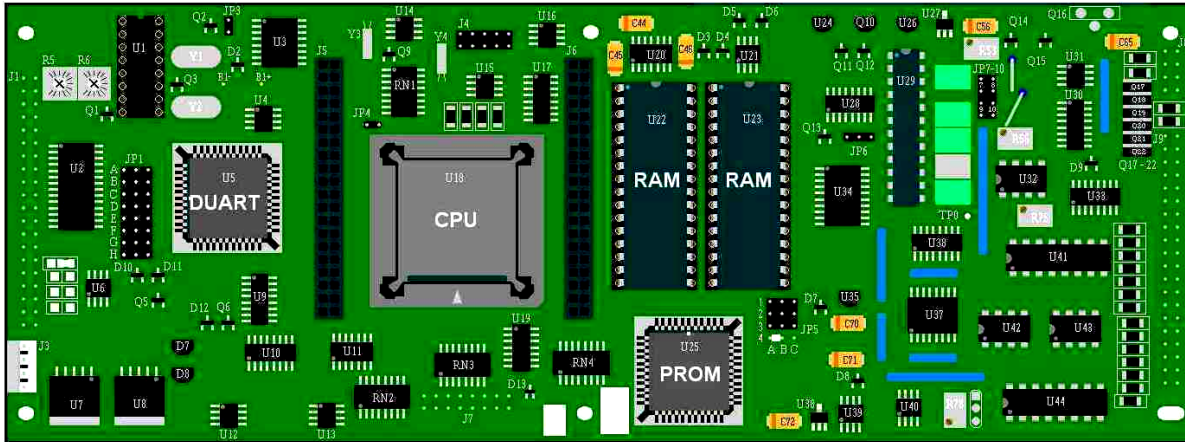
Figure 13-5. ZENO®-3200 Revision A CPU Board.

13.5.   SERIAL PORT WIRING

The ZENO®-3200 data logger has three communications (COM) ports designated as COM1, COM2 and COM3. Access to each of these ports is generally accessible via the ZENO®-3200 Front Panel:
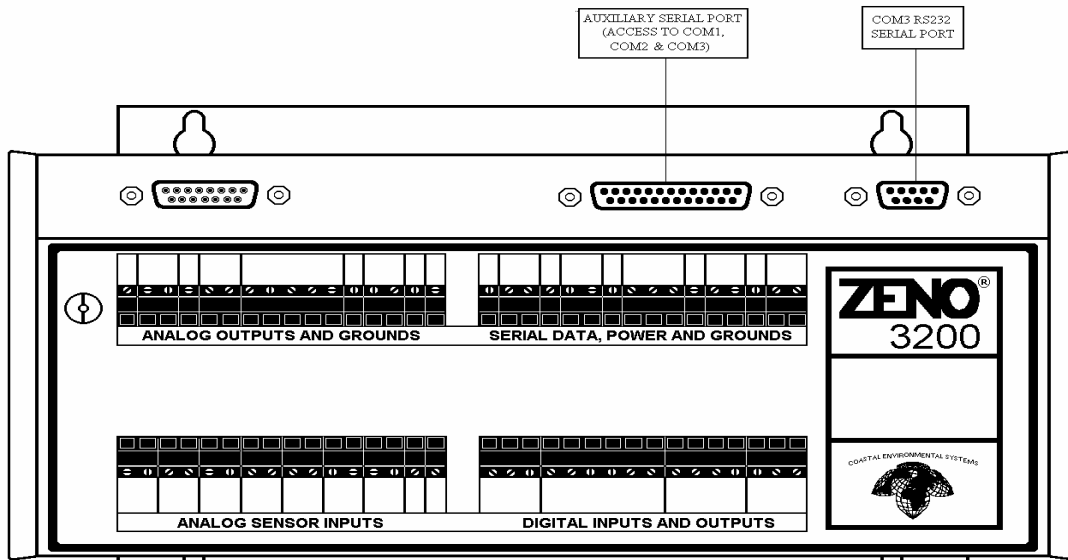
Figure 13-6. ZENO®-3200 Front Panel.

Each COM port provides unique communications link access, which is summarized in the following table. (For complete details about communications, refer to Section 6.)

COM1	COM2	COM3
RS232, RS232H[286], RADIO[287], TW-RADIO	RS232, RS232H, RS485, GOES[288], CGOES[289], ARGOS[290]	RS232, RS232H, RS485 (RS422 on Rev. D only)

13.5.1. COM3 RS232 SERIAL PORT

COM3 is the default ZENO serial port. It uses a male DE-9 connector and is wired as follows:
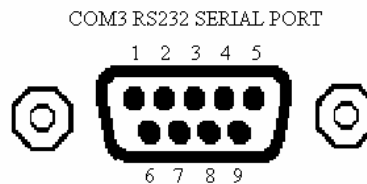
Figure 13-7. COM3 RS232   *Serial Port Male DE-9 Connector.*

The nine pins have the following functions:

---

[286] RS232H is the ZENO®-3200 designation for half-duplex RS232. Refer to Section 6.1.

[287] RADIO and TW-RADIO are the ZENO®-3200 designations for connecting a unidirectional or bi-directional radio to COM1 via RS232. Refer to Section 6.6.

[288] GOES is the ZENO®-3200 designation for a TTL port multiplexed to COM2 and used by the ZENO®-3200 for communication with a Telonics GOES transmitter. Refer to Section 6.7.

[289] CGOES is the ZENO®-3200 designation for a RS232 port multiplexed to COM2 and used by the ZENO®-3200 for communication with a Campbell Scientific GOES transmitter. Refer to Section 6.7.

[290] ARGOS is the ZENO®-3200 designation for a TTL port multiplexed to COM2 and used by the ZENO®-3200 for communication with a Telonics ARGOS transmitter. Refer to Section 6.8.

Pin	Rev. A Function	Rev. D Function
1	DCD (Data Carrier Detect)	DCD3 (COM3 Data Carrier Detect)
2	RXD (COM3 Receive Data)	RXD (COM3 Receive Data)
3	TXD (COM3 Transmit Data)	TXD (COM3 Transmit Data)
4	+12 VDC (Power) — emulates DTR	+12 VDC (Power) — emulates DTR
5	GND (Ground)	GND (Ground)
6	NC (Not connected)	NC (Not connected)
7	RTS (Request To Send), not supported by ZENOSOFT	RTS (Request To Send), not supported by ZENOSOFT
8	CTS (Clear To Send)	CTS (Clear To Send)
9	DCD (Same as Pin 1)	RI (Ring Indicator)

13.5.2. AUXILIARY SERIAL PORT

The Auxiliary Serial Port provides access to all three COM ports according to specific port types. It uses a male DB-25 connector wired as follows:
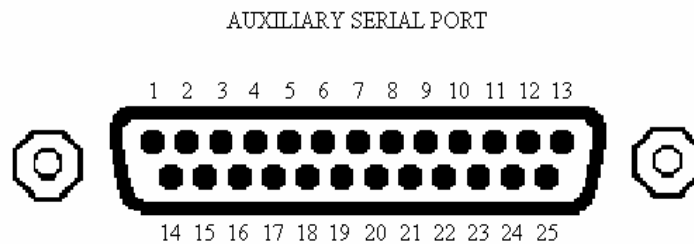
Figure 13-8. Auxiliary Serial Port Male DB-25 Connector.

The 25 pins have the following functions:

Pin	Revision A COM Port	Revision A Function	Revision D COM Port	Revision D Function
1	—	Earth Ground	COM2	RI (Ring Indicator) or COM2 DCD asserted low
2	COM2 (RS232)	TXD (Transmit Data)	COM2 (RS232)	TXD (Transmit Data)
3	COM2 (RS232)	RXD (Receive Data)	COM2 (RS232)	RXD (Receive Data)
4	—	PTT (Push-To-Talk, asserted low)	—	PTT (Push-To-Talk, asserted low)
5	COM2 (TTL)	RXD (Receive Data for GOES, ARGOS)	COM2 (TTL)	RXD (Receive Data for GOES, ARGOS)
6	COM2 (TTL)	TXD (Transmit Data for GOES, ARGOS)	COM2 (TTL)	TXD (Transmit Data for GOES, ARGOS)
7	—	DGND (Digital Ground)	—	DGND (Digital Ground)
8	—	DCD (Data Carrier Detect, asserted low)	—	DCD2 (COM2 Data Carrier Detect)
9	COM1	TXA (Audio Transmit for Radio)	COM1	TXA (Audio Transmit for Radio)
10	COM1	RXA (Audio Receive for Radio)	COM1	RXA (Audio Receive for Radio)
11	—	PTT (Same as Pin 4, asserted low)	COM1	DCD1 (COM1 Data Carrier Detect)
12	—	DGND (Digital Ground)	—	DGND (Digital Ground)
13	—	+12 VDC Switched A	—	+12 VDC Switched A
14	COM2 or COM3* (RS422)	Z	COM1	TXD TTL
15	COM2 or COM3* (RS422)	Y	COM1	RXD TTL
16	COM3	CTS (Clear To Send, same as COM3-Pin 8)	COM3	CTS (Clear To Send, same as COM3-Pin 8)
17	COM2 (TTL)	RXD (Receive Data, not same as Pin 5)	COM2 (TTL)	RXD (Receive Data, not same as Pin 5)
18	COM2 (TTL)	TXD (Transmit Data, not same as Pin 6)	COM2 (TTL)	TXD (Transmit Data, not same as Pin 6)
19	—	+12 VDC	—	+5 VDC Switched B
20	COM2 or COM3* (RS422)	B	COM3 (RS422)	Z
21	COM2 or COM3* (RS422)	A	COM3 (RS422)	Y
22	COM3 (RS485)	B	COM3 (RS485)	B
23	COM3 (RS485)	A	COM3 (RS485)	A
24	—	+12 VDC Switched C	—	+12 VDC Switched C
25	—	Input Power	—	Input Power

* Note: Jumper JP1 on main ZENO®-3200 board sets which port to use. It is normally set to COM3. Consult with Coastal Environmental Systems about its usage and using RS422.

13.5.3. Revision A and Revision D, ZENO®-3200 Communication Wiring Setups

> **The three COM ports on a Revision A ZENO®-3200 share a common carrier detect (DCD) line. This single DCD must be asserted before any COM port on the ZENO®-3200 will respond.**

> **The three COM ports on a Revision D ZENO®-3200 have independent carrier detect (DCD) lines. Each COM port's DCD must be asserted correctly before the ZENO®-3200 will respond on that port.**

Connecting To COM1

COM1 Port Type	Lines Required	Where to Connect	
		Rev A ZENO®-3200	Rev D ZENO®-3200
RS232, RS232H	Receive Data	SERIAL DATA, POWER AND GROUNDS terminal strip, pin labeled COM1 RXD	
	Transmit Data	SERIAL DATA, POWER AND GROUNDS terminal strip, pin labeled COM1 TXD	
	DCD	AUX Serial Port Pin 8	AUX Serial Port Pin 11
	Ground	SERIAL DATA, POWER AND GROUNDS terminal strip, any pin labeled GND	
RADIO, TW-RADIO	Receive Audio	AUX Serial Port Pin 10	
	Transmit Audio	AUX Serial Port Pin 9	
	Push-To-Talk (PTT)	AUX Serial Port Pin 11	AUX Serial Port Pin 4
	DCD	AUX Serial Port Pin 8	AUX Serial Port Pin 11
	Ground	AUX Serial Port Pin 7	

Connecting To COM2

To connect a TTL sensor to COM2, use pins 17 and 18 on the Auxiliary Serial Port.

The Compass Port (part of COM2) is a 4-pin connector located on the ZENO®-3200 CPU board and is labeled as J3. It is located on the lower left-hand corner of the CPU board as shown in Section 13.4.   The pins are as follows:

Compass Port (J3 on CPU Board)	
Pin #	Description
1	12 V Switched Voltage C
2	Ground
3	Receive Data (TTL)
4	Transmit Data (TTL)

COM2 Port		Where to Connect	
Type	Lines Required	Rev A ZENO®-3200	Rev D ZENO®-3200
RS232, RS232H	Receive Data	AUX Serial Port Pin 3	
	Transmit Data	AUX Serial Port Pin 2	
	DCD	AUX Serial Port Pin 8	AUX Serial Port Pin 1
	Ground	AUX Serial Port Pin 7	
GOES, ARGOS	Receive Data	AUX Serial Port Pin 5	
	Transmit Data	AUX Serial Port Pin 6	
	Push-To-Talk (PTT)	AUX Serial Port Pin 4	
	DCD	AUX Serial Port Pin 8	AUX Serial Port Pin 1
	Ground	AUX Serial Port Pin 7	
RS485[291]	A	SERIAL DATA, POWER AND GROUNDS terminal strip, pin labeled COM2 A	
	B	SERIAL DATA, POWER AND GROUNDS terminal strip, pin labeled COM2 B	
	DCD	AUX Serial Port Pin 8	AUX Serial Port Pin 1
	Ground	SERIAL DATA, POWER AND GROUNDS terminal strip, any pin labeled GND	

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[291] For an SDI-12 sensor, you also need to connect a 10-kΩ resistor between SERIAL DATA, POWER AND GROUNDS terminal strip, pin labeled COM2 B and DIGITAL INPUTS AND OUTPUTS terminal strip pin labeled RTN.

Connecting To COM3

COM3 Port Type	Lines Required	Where to Connect	
		Rev A ZENO®-3200	Rev D ZENO®-3200
RS232, RS232H	Receive Data	COM3 Pin 2	
	Transmit Data	COM3 Pin 3	
	DCD	COM3 Pin 1	
	Ground	COM3 Pin 5	
	Ring Indicator (when a Modem is used)	Configured To Digital Input (18 to 23)[292]	COM3 Pin 9
RS485[293]	A	AUX Serial Port Pin 23	AUX Serial Port Pin 23 and shorted to AUX Serial Port Pin 21
	B	AUX Serial Port Pin 22	AUX Serial Port Pin 22 and shorted to AUX Serial Port Pin 20
	DCD[294]	AUX Serial Port Pin 8	COM3 Pin 1
	Ground	AUX Serial Port Pin 12	
RS422[295]	Y	AUX Serial Port Pin 21	
	Z	AUX Serial Port Pin 20	
	DCD[296]	AUX Serial Port Pin 8	COM3 Pin 1
	Ground	AUX Serial Port Pin 12	

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[292] For more information about connecting a modem, refer to Section 6.4.

[293] For a SDI-12 sensor, you also need to connect a 10-kΩ resistor between Auxiliary Port Pin 22 and DIGITAL INPUTS AND OUTPUTS terminal strip pin labeled RTN.

[294] DCD is not part of the formal definition of RS485, but the ZENO®-3200 requires it to be asserted for User Interface communication.

[295] Consult Coastal Environmental Systems before using RS422 on a Rev A ZENO®-3200.

[296] DCD is not part of the formal definition of RS422, but the ZENO®-3200 requires it to be asserted for User Interface communication.

A.   CONSTANTS, CONVERSIONS & ASCII TABLE

Coastal Environmental Systems

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1.   PHYSICAL & MATHEMATICAL CONSTANTS

- Avagadro Constant (N_A) 6.022045×10^{23} mol^{-1}
- Boltzmann Constant (k) 1.380662×10^{-23} J/K
- Elementary Charge (e) $1.6021892 \times 10^{-19}$ Coulomb
- Exponential (ε)   2.718281828
- Gravitational Constant (G) 6.6720×10^{-11} N•m^2/kg^2
- Permittivity Constant (ε_0) $8.85418782 \times 10^{-12}$ F/m
- Permeability Constant (μ_0) $1.25663706144 \times 10^{-6}$ H/m
- Pi (π)   3.141592654
- Plank Constant (h) 6.626176×10^{-34} J•s
- Speed of Light (c) 2.99792458×10^8 m/s
- Stefan-Boltzmann Constant (σ) 5.67032×10^{-8} W/m^2•K^4
- Universal Gas Constant (R)   8.31 J/mol•K

Physical Properties of Dry Air (1 atm @ 20 °C)	
Property	Value
Density	1.20 kg/m^3
Specific heat capacity at constant pressure	1010 J/kg·K
Ratio of specific heat capacities	1.40
Speed of sound	343 m/s
Electrical Breakdown strength	3×10^6 V/m
Effective molecular weight	0.0289 kg/mol

Physical Properties of Water	
Property	**Value**
Density	1000 kg/m^3
Specific heat capacity at constant pressure	4190 J/kg·K
Heat of fusion (0 °C)	333 kJ/kg
Heat of vaporization (100 °C)	2260 kJ/kg
Speed of sound	1460 m/s
Index of refraction (λ = 589 nm)	1.33
Molecular weight	0.0180 kg/mol

Physical Properties of the Earth	
Property	**Value**
Density	5.98×10^{34} kg
Mean radius	6.37×10^{6} m
Standard gravity	9.81 m/s^2
Standard atmosphere	1.01×10^{5} Pa

2.   CONVERSION CONSTANTS

2.1.   United States Measurements

LENGTH

- 1 foot (ft.) = 12 inches
- 1 yard (yd.) = 3 feet = 36 inches
- 1 rod (rd.) = 5.5 yards = 16.5 feet = 198 inches
- 1 chain (ch.) = 4 rods = 22 yards = 66 feet = 792 inches
- 1 mile = 80 chains = 320 rods = 1760 yards = 5280 feet = 63360 inches
- 1 nautical mile[297] = 1.150757576 miles = 6076 feet

AREA

- 1 square foot = 144 square inches
- 1 square yard = 9 square feet = 1296 square inches
- 1 square rod = 30.25 square yards = 272.25 square feet
- 1 square chain = 8 square rods = 242 square yards = 1089 square feet
- 1 acre = 8 square chains = 160 square rods = 4840 square yards = 43,560 square feet
- 1 square mile = 640 acres

PHYSICAL VOLUME

- 1 cubic foot = 1728 cubic inches

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[297] A nautical mile is based upon 1 minute of arc of a great circle.

- 1 cubic yard = 27 cubic feet = 46,656 cubic inches

LIQUID VOLUME (US)

- 1 cup = 8 ounces
- 1 pint = 2 cups = 16 ounces
- 1 quart = 2 pints = 4 cups = 32 ounces
- 1 gallon = 4 quarts = 8 pints = 16 cups = 128 ounces

PHYSICAL VOLUME TO LIQUID VOLUME

- 1 cubic inch = 0.554 ounces
- 1 cubic foot = 7.481 US gallons = 957.568 ounces

WEIGHT

- 1 pound (lbs.) = 16 ounces
- 1 short ton = 2000 lbs.
- 1 long ton = 1.12 short tons = 2240 lbs.

POWER

- 1 horsepower = 2545 BTU/hour

PRESSURE

- 1 lb./sq. inch = 0.06805 atm. = 2.03602 inches Hg
- 1 atm. = 14.6959 lbs./sq. inch = 29.92126 inches Hg

VELOCITY

- 1 mph = 1.467 ft/sec = 0.869 knots
- 1 knot = 1.151 mph = 1.688 ft/sec

2.2.   United States Measurements to Metric System

LENGTH

- 1 inch = 2.54 centimeters
- 1 foot = 30.48 centimeters = 0.3048 meters
- 1 yard = 91.44 centimeters = 0.9144 meters
- 1 rod = 502.92 centimeters = 5.0292 meters
- 1 chain = 2011.68 centimeters = 20.1168 meters
- 1 mile = 1,609.344 meters = 1.6093 kilometers
- 1 nautical mile = 1,851.965 meters = 1.8520 kilometers

AREA

- 1 square inch = 6.4516 sq. cm
- 1 square foot = 929.03 sq. cm
- 1 square yard = 8,361.27 sq. cm = 0.8361 sq. meters

- 1 acre = 4,046.85 sq. meters
- 1 square mile = 2.59 sq. km

PHYSICAL VOLUME

- 1 cubic inch = 16.387 cubic cm.
- 1 cubic foot = 28,316.85 cubic cm
- 1 cubic yard = 764,554.95 cubic cm = 0.7645 cubic meters

LIQUID VOLUME (US)

- 1 ounce = 29.573 milliliters
- 1 cup = 236.59 milliliters
- 1 pint = 473.18 milliliters = 0.47318 liters
- 1 quart = 946.35 milliliters = 0.94635 liters
- 1 gallon = 3.7854 liters

WEIGHT (to MASS)

- 1 ounce = 28.35 grams
- 1 pound (lbs.) = 453.6 grams = 0.4536 kg
- 1 short ton = 907.2 kg
- 1 long ton = 1,016.064 kg

POWER

- 1 horsepower = 745.7 watts
- 1 watt = 3.413 BTU/hour
- 1 kilowatt = 238.8 calories/second

ENERGY

- 1 BTU = 0.293 watt-hours = 0.000293 kilowatt-hours = 252 calories = 1055 joules
- 1 kilowatt-hour = 3413 BTU = 859,800 calories = 3,600,000 joules

PRESSURE

- 1 inch Hg = 0.03386 bars = 0.03453 kg/sq. cm = 3386.388 pascals = 3.3864 kilopascals
- 1 atm. = 101325 newtons/sq. meter (pascals) = 1.03323 kilograms/sq. cm = 1.01325 bars

VELOCITY

- 1 mph = 1.609 kph = 0.447 m/sec
- 1 knot = 1.852 kph = 0.5144 m/sec

3.   ASCII CODES

ASCII codes are defined from 0 through 127 decimal (0 through FF hexadecimal). To use the following table:

- HEX is the hexadecimal (base 16) value

- DEC is the decimal (base 10) value
- CHR is the actual character
- CTRL designates which key on the keyboard you would press in conjunction with the CTRL key to obtain the particular character for the first 27 ASCII characters.

HEX	DEC	CHR	CTRL	HEX	DEC	CHR	HEX	DEC	CHR	HEX	DEC	CHR
00	0	NUL	^@	20	32	SP	40	64	@	60	96	`
01	1	SOH	^A	21	33	!	41	65	A	61	97	a
02	2	STX	^B	22	34	"	42	66	B	62	98	b
03	3	ETX	^C	23	35	#	43	67	C	63	99	c
04	4	EOT	^D	24	36	$	44	68	D	64	100	d
05	5	ENQ	^E	25	37	%	45	69	E	65	101	e
06	6	ACK	^F	26	38	&	46	70	F	66	102	f
07	7	BEL	^G	27	39	'	47	71	G	67	103	g
08	8	BS	^H	28	40	(	48	72	H	68	104	h
09	9	HT	^I	29	41	)	49	73	I	69	105	i
0A	10	LF	^J	2A	42	*	4A	74	J	6A	106	j
0B	11	VT	^K	2B	43	+	4B	75	K	6B	107	k
0C	12	FF	^L	2C	44	,	4C	76	L	6C	108	l
0D	13	CR	^M	2D	45	—	4D	77	M	6D	109	m
0E	14	SO	^N	2E	46	.	4E	78	N	6E	100	n
0F	15	SI	^O	2F	47	/	4F	79	O	6F	111	o
10	16	DLE	^P	30	48	0	50	80	P	70	112	p
11	17	DC1	^Q	31	49	1	51	81	Q	71	113	q
12	18	DC2	^R	32	50	2	52	82	R	72	114	r
13	19	DC3	^S	33	51	3	53	83	S	73	115	s
14	20	DC4	^T	34	52	4	54	84	T	74	116	t
15	21	NAK	^U	35	53	5	55	85	U	75	117	u
16	22	SYN	^V	36	54	6	56	86	V	76	118	v
17	23	ETB	^W	37	55	7	57	87	W	77	119	w
18	24	CAN	^X	38	56	8	58	88	X	78	120	x
19	25	EM	^Y	39	57	9	59	89	Y	79	121	y
1A	26	SUB	^Z	3A	58	:	5A	90	Z	7A	122	z
1B	27	ESC		3B	59	;	5B	91	[	7B	123	{
1C	28	FS		3C	60	<	5C	92	\	7C	124		
1D	29	GS		3D	61	=	5D	93	]	7D	125	}
1E	30	RS		3E	62	>	5E	94	^	7E	126	~
1F	31	US		3F	63	?	5F	95	_	7F	127	DEL

B.   ZENO®-3200 MENU LISTING

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This appendix provides a map of all ZENO®-3200 menu functions.

The following is a map of the User Interface Menus.
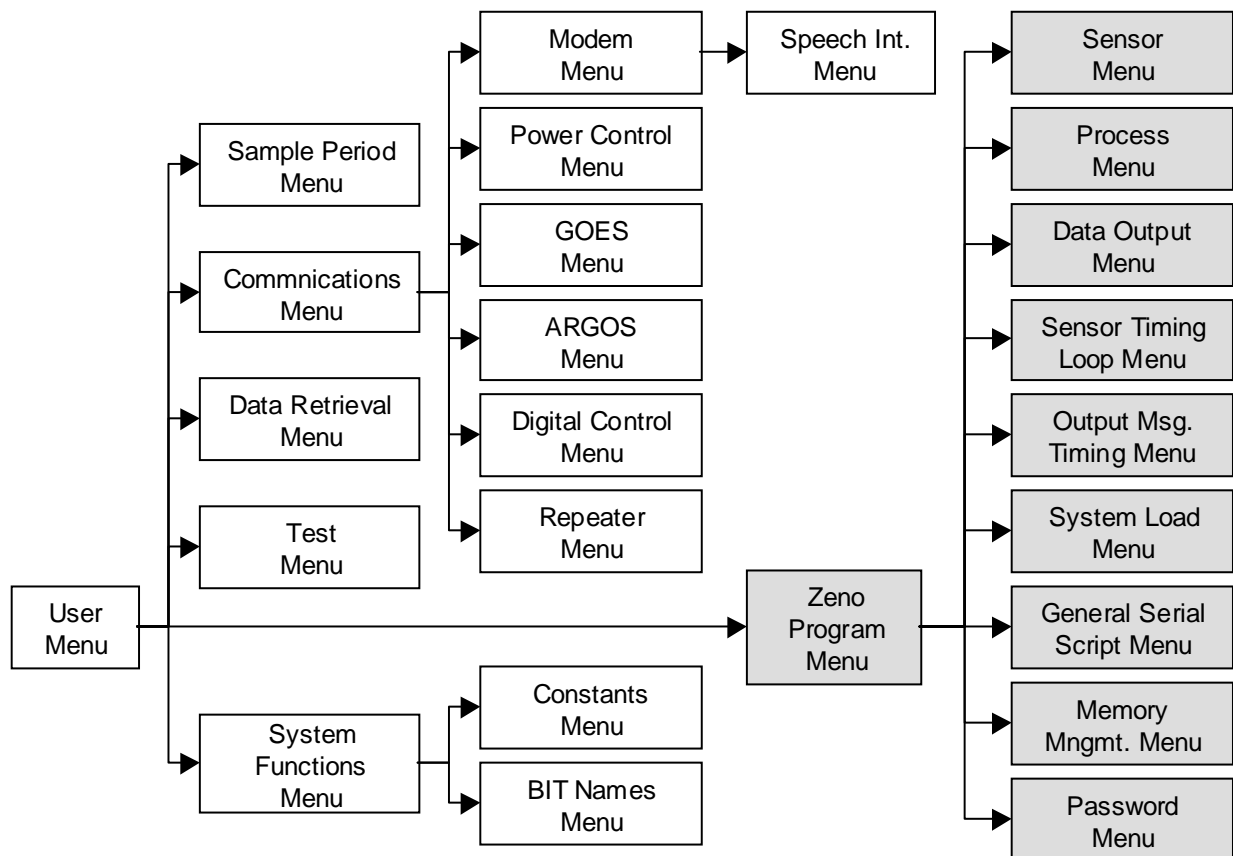
Figure B-1. User Interface Menu Map. (Shaded menus require Administrative Password Access.)

The following is a table of all menu options & line items.

USER MENU			
C	**COMMUNICATIONS MENU**		
1	Baud rate for COM 1	300 to 19200 baud	Section 6.1
2	Baud rate for COM 2		
3	Baud rate for COM 3		
4	Port type of COM 1	RS232, RS232H, RADIO or TW-RADIO	
5	Port type of COM 2	RS232, RS232H, RS485, GOES, CGOES, ARGOS	
6	Port type of COM 3	RS232, RS232H, RS485, RS422* or RS422 AND RS232*	
7	COM Ports to Exclude from User Interface	NONE; COM1; COM2; COM3; COM1,COM2; COM1,COM3; COM2,COM3	Section 6.12
8	Enable Exclusive CCSAIL Access	NO or YES	
Tn	Enter terminal passthrough mode to communications port "n"	n is 1 = COM1, 2 = COM2, 3 = COM3, or Sm, where m is Sensor Record #m	Section 6.9.1
M	**MODEM MENU**		
1	System Modem Type	0 - no modem; 1 - phone modem	Section 6.4.1
2	Modem COM Port	NONE, COM1, COM2 or COM3	
3	Modem Retry Period	0 to 3600	Section 11.3.2
4	Modem Hang-up Delay	0 to 3600	
5-8	Modem Telephone Numbers 1 through 4	Any 50-character string	
9	Modem Initialization String	Any 50-character string	Section 6.4.2
10	Modem Switched Voltage	- 0 (none). - 3 (12 V, sw'd A). - 4 (12 V, sw'd B). - 5 (12 V, sw'd C). - 18 to 23 (inclusive, digital outputs).	Section 6.4.1
11	Modem Ring Detect Channel	0 (none), 12 to 23 (inclusive, digital input)	
S	**SPEECH MENU**		
1	Speech Interface Installed	YES or NO	Section 6.11
2	Speech Activity Channel	0 (none) or 12 to 23 (inclusive, digital input)	
3	Speech Tone Detect Channel		
4	Speech Switched Voltage	- 0 (none). - 1 (5 V, sw'd A). - 2 (5 V, sw'd B). - 3 (12 V, sw'd A). - 4 (12 V, sw'd B). - 5 (12 V, sw'd C). - 18 to 23 (inclusive, digital outputs).	
G	**GOES MENU**		
D	Run GOES DIAGNOSTICS	Retrieve information from GOES radio.	Section 6.7.6
R	RESET GOES errors	Reset GOES radio error counter.	
I	INITIALIZE GOES radio	Set the ZENO®-3200 clock to GMT & initialize all GOES radio parameters.	
1	Data Collection Platform address	8-digit HEX value	
2	Self-Timed Transmit Channel Number	1 - 199	

		format is 'dd:hh:mm:ss', where:	
3	Self-Timed Transmission Interval	- 'dd' is the days (00 to 31). - 'hh' is the hours (00 to 23). - 'mm' is the minutes (00 to 59). - 'ss' is the seconds (00 to 59). Valid values are 00:00:01:00 to 31:23:59:59 (inclusive)	
4	Self-Timed Transmission Offset	format is 'hh:mm:ss', where: - 'hh' is the hours (00 to 23). - 'mm' is the minutes (00 to 59). - 'ss' is the seconds (00 to 59). Valid values are 00:00:00 to Self-Timed Transmission Interval less minute (inclusive)	
5	Transmission Window Length	Window length (in minutes), 1 or 2	
6	Satellite Link Parameter: Preamble	SHORT or LONG	
7	Random Transmit Channel Number	1 to 199	
8	Random Transmission Interval In Minutes	Same format as Line Item #4, range is 00:00:00 to 23:59:59 (inclusive)	
9	Random Transmission Disable Time		
10	GOES Bit Rate	100, 300 or 1200 (CGOES only)	
11	GOES Interleaver	NONE, SHORT or LONG (CGOES only)	
A	**ARGOS MENU**		
1	Transmission Repeat Interval	49 to 297 (seconds)	
2	Transmission Repeat Count	1 to 255	
3	Radio Push-to-talk Delay Time	10 to 5000 milliseconds	Section 6.8.5
4	Radio Push-to-talk Digital Port	0 (none) or 18 to 23	
5	Use Hour/Min Time Stamp in Message	0 = NO, 1 = YES	
6	Use Checksum in Final Message Byte		
P	**POWER CONTROL MENU**		
1	COM1 PTT setup time	0 to 1000 ms	Section 6.6.5
2	COM1 switched power source	0 - none (use fixed power) 1 - 5 V switched A	
3	COM2 switched power source	2 - 5 V switched B 3 - 12 V switched A (default)	Section 6.6.3
4	COM3 switched power source	4 - 12 V switched B 5 - 12 V switched C	
5	Response Delay Time (milliseconds)	0 to 5000	Section 6.6.6
D	**DIGITAL CONTROL MENU**		
1	Power-on interval	0 to 168 hours (0 = disabled)	
2	Power-on duration	1 second to Power-on Interval	
3	Start of first power-on	1970/01/01 12:00:00 a.m. to 2030/12/31 11:59:59 p.m.	
4	Control channel	- 0 (no channel). - 1 (5 V, sw'd A). - 2 (5 V, sw'd B). - 3 (12 V, sw'd A). - 4 (12 V, sw'd B). - 5 (12 V, sw'd C). - 18 to 23 (inclusive, digital outputs)	Section 6.6.4
R	**REPEATER MENU**		
1	Repeater Transmit Delay	0 to 10000 (milliseconds)	Section 6.10
2	Network Source Address	-1 to 9998 (-1 = disabled)	

3	Alternative Source Address		
4-11	Remote ZENO Address #1 - #8		
R	Reset All Repeater Values	Resets all repeater values to defaults.	
F	**SYSTEM FUNCTION MENU**		
1	Primary Unit/Experiment ID	0 to 9998	Section 5.5
2	Secondary Unit/Experiment ID	0 to 9998	Section 5.6
3	Data Dump Format	1 - space delimited 2 - comma delimited 3 - match the real-time format	Section 4.4.1
4	Real Time Output Format	0 - none 1 - ASCII 2 - formatted ASCII 3 - CCSAIL	Section 4.4.2
5	Add Compass To Vane	0 - no; 1 - yes	Section 5.7
6	Compass Offset	-180 to +180	
7	Barometer Elevation	0 to 5000 meters	Section 5.8
8	Bad Sensor Value Replace	Any string up to 50 characters.	Section 4.5
9	Passhthrough Mode Escape Character	- 0 - 9, A - Z, a - z (case sensitive), any - any punctuation mark - the escape character: <ESC> - or any non-printable character represented as <CTRL-x>, where 'x' is between A and Z NOTE: Don't use a character that is used within any message. <ESC> or <Ctrl-Z> are usually the best choices.	Section 6.9.3
S	**SAMPLE PERIOD MENU**		
1	Sample Interval Time	1 to 86400 seconds	Section 3.1.3
2	Sample Duration Time	1 second to sample interval time	
3	Sample Time Offset	0 to sample interval time	
D	**DATA RETRIEVAL MENU**		
A	Show records AFTER specified time	Precede by X for X-modem transfer	Section 4.1.5
B	Show records BETWEEN specified times		
Ln	Show LAST n records		Section 4.1.2
*	Show all records		Section 4.1.4
@n	Show n unmarked records		Section 4.1.3
M	MARK recently shown data		
C	COMPUTE data logging capacity		Section 4.2
D	DELETE all data records		Section 4.3
N	Show NUMBER of records logged		Section 4.2
F	Flash Memory Information	Only applicable when flash logging memory installed.	Section 4.7.2
T	**TEST MENU**		
Rx,y	Display RAW data values for sensors x through y		Section 7.1
Sx,y	Display SCALED data values for sensors x through y		
Cx	CALIBRATE sensor number x		Section 7.2
P	SDI-12 PASS-THROUGH mode		Section 6.9.2
Vx	VIEW process record number x		Section 7.3
D	View Data Collection Counters		Section 7.5

B	Display BIT Status		Section 7.6
Ex	Display Sensor x Error Codes		Section 7.4
B	**BIT NAMES MENU**		
1-32	Bit Names 1 through 32	Any string up to 50 characters.	Section 7.6
	ZENO PROGRAM MENU		
R	Reset System	Function reboots ZENO®-3200	Section 10.8
	SENSOR MENU, PROCESS MENU, DATA OUTPUT MENU & GENERAL SERIAL SCRIPT MENU		
Cn/m	Change Item n to Value m		
A	Insert After This Record		
B	Insert Before This Record		
X	Cut Record to Clipboard		
C	Copy Record to Clipboard		
V	Paste Record From Clipboard		Section 10.2
Sn/m	Search Item n for Value m	(not in the General Serial Script Menu)	
Jn	Jump To Record n		
N	Go to Next Record		
P	Go to Previous Record		
XA	Delete ALL Records		
S	**SENSOR MENU**		
1	Sensor Type	0 (No Sensor) 1 (12-bit Analog to Digital) 2 (18-bit Single-Ended A to D) 3 (18-bit Differential A to D) 4 (Digital Period, f > 10 KHz) 5 (Digital Frequency, f > 10 KHz) 6 (Digital Period, f < 10 KHz) 7 (Digital Frequency, f < 10 KHz) 8 (Digital State) 9 (Digital Edge) 10 (Tipping Bucket) 11 (Serial Compass) 12 (CCSAIL) 13 (SDI-12 Serial) 14 (Differential Encoder) 15 (GPS Receiver) 16 (General Serial) 17 (Continuous SDI-12 Serial) 18 (Concurrent SDI-12 Serial) 19 (Asynchronous CCSAIL)	Sections 10.3.1 through 10.3.5
2	Sensor Name	Arbitrary 8-character sensor name	Section 10.3.6
3	Sensor Input Channel	Values dependent on sensor type: 1: CH8, CH9, INTERNAL BATTERY, INTERNAL TEMPERATURE SENSOR 2: CH1+ through CH7+; CH1- through CH7- 3: CH1 through CH7 4 to 9: CH10 through CH17 10: CH24 11: COM1, COM2, COM3 or Compass Interface	Sections 10.3.1 through 10.3.5

		12: COM1, COM2, COM3 13,17,18: COM2, COM3 14: CH10 through CH16 (uses two inputs) 15,16: COM1, COM2 or COM3	
4	Analog Channel Gain	1, 10 or 100	Section 10.3.1
5	Analog Channel Attenuation	1, 2, 4 or 10	
6	Switched Power Code	0 - no power 1 - 5 V switched "A" 2 - 5 V switched "B" 3 - 12 V switched "A" 4 - 12 V switched "B" 5 - 12 V switched "C"	Section 10.3.10
7	Sensor Excitation Voltage Code	0 - no excitation voltage 1 - 1.25 V DC 2 - 2.50 V DC 3 - 5.00 V DC	Section 10.3.12
8	Switched Excitation Return Codes	0 - no excitation voltage A, B, C, D, E	
9	Switched Power Warm-Up Time	0 to 255 seconds	Section 10.3.11
10	Sensor Sample Count	1 to 255	Section 10.3.9
11	Maximum Sensor Readings	0 (measurements throughout sample duration), 1 to 32767	Section 10.3.8
12	Sensor Timing Loop	1 to 4	Section 10.3.7
13-15	Conversion Coefficients A, B, C	-3.4×10^{38} to 3.4×10^{38}	Section 10.3.13
16	Retry Count	0 to 7	
17	(Depends upon sensor type)	(Range depends upon sensor type)	
18	Sensor Baud Rate	300 to 19200 baud	
19	Sensor Port Type	(range depends upon sensor type)	
20	Sensor Bits Per Character	5 to 8	Section 10.3.5
21	Sensor Parity	N (none), E (even) or O (odd)	
22	Sensor Start Bits	1 or 2	
23	Sensor Stop Bits	1 or 2	
24	Sensor GSI Script Number	1 to 6	
25	Sensor Data Collection Control	S0.1 or reference to process output	Section 12.2.2
P	**PROCESS MENU**		
1	Process Category Code	1 - General 2 - Environmental 3 - Alarm 4 - Special Sensors 5 - Arithmetic 6 - Output and Control	Section 10.4.1 Appendix D
2	Process Type Code	(Values dependent on process category code) 1 - General Processes Category 1 - Immediate Data 2 - Average (over Sample Time) 3 - Running Average 4 - Block Average 5 - Accumulate Data (over Sample Time) 6 - Rate of Change	Section 10.4.1 Appendix D

7 - Differential
8 - Free-Running Average
9 - Collection
10 -Trend Data
11 - Multiple Input
Minimum/Maximum
12 - Previous Sample Data
13 - Multiple Data Validation
14 - Single Data Validation

2 - Environmental Processes Category
1 - Wind Vector Average
2 - Running Wind Vector Average
3 - Block Average Direction
4 - True Wind Vector Avg. (Car
Mounted)
5 - Barometric Pressure
6 - Rainfall
7 - Dewpoint
8 - Evapotranspiration
9 - Free Running Wind Vector Average
10 - Altimeter Setting
11 - FAA SAWS Wind Gust
12 - NWS Running Average Wind
Speed
13 - NWS Running Vector Avg. Wind
Dir.
14 - FAA Running Wind Average

3 - Alarms Processes Category
1 - Built-In-Test (BIT)
2 - Data Range
3 - Alarm
4 - Data Time-Out
5 - Alarm Reset
6 - Two-Range Alarm
7 - Two-Range Alarm Constants
8 - Missing Sensor
9 - Multiple Alarm
10 - Dial-Out Alarm
11 - Incremental Alarm
12 - Error Checking
13 - Timed Event
14 - One-shot Daily Timed Event
15 - Static Alarm

4 - Special Sensor Processes Category
1 - NTC Thermistor
2 - Paroscientific Barometer
3 - Thermocouple
4 - Raw GPS to Real Number
5 - UV Biometer
6 - PIR Temperature Correction
7 - Four-pole Switch

		5 - Arithmetic Processes Category 1 - U-V Vectors To Magnitude-Direction 2 - Add Constant Value 3 - Add Two Data Values 4 - Subtract Two Data Values 5 - Multiply By A Constant 6 - Multiple Two Data Values 7 - Divide Two Data Values 8 - Quadratic 9 - Invert Data Value 10 - Raise Data Value To A Constant Power 11 - Add Multiple Data Values 12 - Polynomial 13 - Conditional Select 14 - Boolean Combine Data & Constant 15 - Boolean Combine Data 16 - Data Rounding 6 - Output and Control Processes Category 1 - Digital-To-Analog Output	
3	User Defined Process Name	Any string up to 8 characters	Section 10.4.2
4 - ?	(Data input or user input value)	(Depends upon process type)	Section 10.4.4 Appendix D
D	**DATA OUTPUT MENU**		
1	Field Type Code	0 - Null Field 1 - Checksum 2 - NMEA Checksum 3 - Time Stamp 4 - Primary Unit/Experiment ID 5 - Secondary Unit/Experiment ID 6 - Literal Value 7 - Data Transmit Only 8 - Data Log Only 9 - Data Transmit and Log 10 - Conditional Start 11 - Conditional Stop 12 - Data in GOES Binary Format 13 - Data in ARGOS Binary Format 14 - Start Checksum 15 - Selectable Data Transmit and Log 16 - Message Number 17 - Resetable Record Number 18 - Backspace 19 - FAA Wind Data Transmit Only	Section 10.6.3
2	Output Messages	Chosen from 1, 2, 3, 4 -- comma-separated	Section 10.6.4
3	Name	Any string up to 8 characters	Section 10.6.5

4	Input Record	Depends on number & type of Sensor & Process Records	
5	Field Decimal Places	1 to 6	
6	Field Width	1 to 10 (expanded if an overflow occurs)	
7	Data Storage Class	1 - 1 Byte Signed Integer 2 - 1 Byte Unsigned Integer 3 - 2 Byte Signed Integer 4 - 2 Byte Unsigned Integer 5 - 4-Byte Signed Integer 6 - 4-Byte Unsigned Integer 7 - 2 Byte Compressed Float 8 - 4 Byte Floating Point 9 - n-Byte String ("n" set by Line Item #6)	Section 10.6.6
G	GENERAL SERIAL SCRIPT MENU		
In	Insert Script Line #n		Section 12.2.3
En	Erase Script Line #n		
Rn	Remove Script Line #n		
1-?	(each line item is a GSI command)	(depends upon type of GSI command)	Sections 12.2.5, 12.2.6 & 12.2.7
T	SENSOR TIMING LOOP MENU		
1	Timing loop #1 period	Fixed at 0.5 s	Section 10.3.7
2	Timing loop #2 period	0.5 - 86400 s	
3	Timing loop #3 period		
4	Timing loop #4 period		
O	OUTPUT MESSAGE TIMING MENU		
1	Output message #1 communication port	COM1, COM2 or COM3	Section 10.7.1
2	Output message #2 communication port		
3	Output message #3 communication port		
4	Output message #4 communication port		
5	Output message #1 period	0 to 86400 seconds -- 0 implies transmission after sampling	Section 10.7.2
6	Output message #2 period	0 to 86400 seconds -- 0 implies no transmission	
7	Output message #3 period		
8	Output message #4 period		
9	Record Counter Starting Value	0 to 1000	Section 10.6.3
10	Record Counter Reset Value		
L	SYSTEM LOAD MENU		
R	RECEIVE configuration file from disk	Precede by X for X-modem transfer	Section 9.1
T	TRANSMIT configuration file from ZENO		Section 9.2
V	View configuration file from ZENO		Section 9.3
W	PASSWORD MENU		
A	Change ADMINISTRATOR password	(Requires administrator password)	Section 8.2
U	Change USER password		
V	VIEW all passwords		
M	MEMORY MANAGEMENT MENU		
1	COM1 GSI Memory Size in Bytes	0 to 2048 (bytes of RAM)	Section 12.2.4
2	COM2 GSI Memory Size in Bytes		
3	COM3 GSI Memory Size in Bytes		

C. SENSOR CONFIGURATIONS

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This appendix gives the ZENO®-3200 configurations for a number of common sensor types.

1. AIR TEMPERATURE YSI 44203 THERMISTOR

SENSOR MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	2 (18-bit Single Ended A to D)	**c1/2**
Item 2: Sensor Name =	At	**c2/at**
Item 3: Sensor Input Channel =	2+	**c3/2+**
Item 4: Analog Channel Gain =	1	**c4/1**
Item 5: Analog Channel Attenuation =	10	**c5/10**
Item 6: Switched Power code =	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage =	2 (EXC = 2.50 VDC)	**c7/2**
Item 8: Switched Excitation Return =	A	**c8/A**
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	**c12/2**
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	-58.8529 [1]	**c14/-58.8529 [1]**
Item 15: Conversion Coefficient C =	95.7935	**c15/95.7935**

1 Output is in: CENTIGRADE

PROCESS MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	1 : General	DEFAULT
Item 2: Process Type code =	2 : Averaging Process	**c2/2**
Item 3: User-defined Process Name =	3 : AvgAT	**c3/AvgAT**
Item 4: Input for Air Temperature =	S1 : at [2]	**c4/S1 [2]**

2 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

DATA OUTPUT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	c1/9
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	at	c3/at
Item 4: Data Process Record =	P1.1 [3]	c4/P1.1 [3]
Item 5: Field Decimal Places =	1	c5/1
Item 6: Field Width =	5	c6/5
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	c7/7

DEFAULT = Default Data, it is not necessary to enter a command for this Item.
3 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

* Refer to the Sensor Manual for Signal Names.

R1 and R2 are supplied with the YSI 44203.

2.   SENSORS WITH 0 TO 12 VDC OR -12 TO +12 VDC ANALOG OUTPUT

SENSOR MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	2 (18-bit Single-Ended A to D)	**c1/2**
Item 2: Sensor Name =	analog	**c2/analog**
Item 3: Sensor Input Channel =	1+	**c3/1+**
Item 4: Analog Channel Gain =	1	**c4/1**
Item 5: Analog Channel Attenuation =	10	**c5/10**
Item 6: Switched Power code =	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage =	0 (NO EXCITATION)	DEFAULT
Item 8: Switched Excitation Return =	NONE	DEFAULT
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	**c12/2**
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	3	**c14/3**
Item 15: Conversion Coefficient C =	0	DEFAULT

PROCESS MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	1 : General	DEFAULT
Item 2: Process Type code =	2 : Averaging Process	**c2/2**
Item 3: User-defined Process Name =	3 : AvgAnlg	**c3/AvgAnlg**
Item 4: Input for Relative Humidity =	S1 : analog [1]	**c4/S1** [1]

DEFAULT = Default Data, it is not necessary to enter a command for this Item.
1 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

DATA OUTPUT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	**c2/1**
Item 3: Field Name =	AvgAnlg	**c3/AvgAnlg**
Item 4: Data Process Record =	P1.1 [2]	**c4/P1.1** [2]
Item 5: Field Decimal Places =	1	**c5/1**
Item 6: Field Width =	4	**c6/4**
Item 7: Data Storage Class Code =	8:Floating Point (4)	**c7/8**

2 This data will vary depending on the number of sensors being connected to the ZENO®.
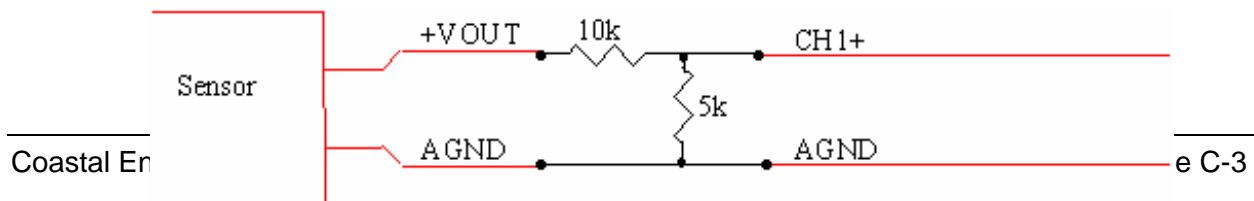
* When changing resistor values to measure different voltage ranges,
keep the source impedance less than 50 kΩ

3.   BAROMETRIC PRESSURE

SENSOR MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	2 (18-bit Single Ended A to D)	c1/2
Item 2: Sensor Name =	BP	c2/BP
Item 3: Sensor Input Channel =	4+	c3/4+
Item 4: Analog Channel Gain =	1	c4/1
Item 5: Analog Channel Attenuation =	10	c5/10
Item 6: Switched Power code =	4 (12 V SW'D B)	c6/4
Item 7: Sensor Excitation Voltage =	3 (EXC = 5.00 VDC)	c7/3
Item 8: Switched Excitation Return =	0	DEFAULT
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	c12/2
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	112.7 [1]	c14/112.7 [1]
Item 15: Conversion Coefficient C =	N [2]	C15/N [2]

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
1 Output is in: mB.
2 N must be set to the calibration coefficient supplied with each unit (a typical value is 556).

PROCESS MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code	1 : General	DEFAULT
Item 2: Process Type code =	2 : Averaging Process	c2/2
Item 3: User-defined Process Name =	3 : AvgAnlg	c3/AvgAnlg
Item 4: Input for Barometric Pressure =	S1 : bp [3]	c4/S1 [3]

3 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

DATA OUTPUT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	bp	**c3/bp**
Item 4: Data Process Record =	P1.1 [4]	**c4/P1.1** [4]
Item 5: Field Decimal Places =	0	**c5/0**
Item 6: Field Width =	4	**c6/4**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
4 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

4.   20MA CURRENT LOOP

SENSOR MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	3	**c1/3**
Item 2: Sensor Name =	current	**c2/current**
Item 3: Sensor Input Channel =	1	**c3/1**
Item 4: Analog Channel Gain =	1	DEFAULT
Item 5: Analog Channel Attenuation =	1	DEFAULT
Item 6: Switched Power code =	0 [1]	DEFAULT [1]
Item 7: Sensor Excitation Voltage =	0	DEFAULT
Item 8: Switched Excitation Return Code =	0	DEFAULT
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	**c12/2**
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	40 [2]	**c14/40** [2]
Item 15: Conversion Coefficient C =	0	DEFAULT
Item 16: Retry Count =	N/A	N/A

DEFAULT = Default Data, it is not necessary to enter a command for this Item.
1 Switched power at 5V or 12V is probably needed for these sensors.
2 Gives result in mA for nominal 25.0Ω resistor. for maximum accuracy, use value of 1000/R where R is the measured resistance of the current sense resistor from the resistor calibration data.

PROCESSING MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category code =	1 (general)	**c1/1**
Item 2: Process Type code =	1 (immediate)	**c2/1**
Item 3: User-defined Process Name =	3 : Current	**c3/Current**
Item 4: Sensor Input Channel =	S1.1[3] current	**c3/S1.1[3]**

3 This value will vary depending on the number of sensors being connected to the ZENO®-3200. To output multiple values, repeat this menu as required. You can also refer directly to the sensor outputs, rather than going through a process. In this case, enter **S1.1** (for example to obtain the value output by the 1st defined sensor.

DATA OUTPUT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	cur	**c3/cur**
Item 4: Data Process Record =	P1.1[4]	**c4/P1.1[4]**
Item 5: Field Precision =	1	**c5/1**
Item 6: Field Width =	6	**c6/6**
Item 7: Data Storage Class Code =	8 : Compressed Float	**c7/8**

DEFAULT = Default Data, it is not necessary to enter a command for this Item.

4 This value will vary depending on the number of sensors being connected to the ZENO®-3200. To output multiple values, repeat this menu as required. You can also refer directly to the sensor outputs, rather than going through a process. In this case, enter **S1.1** (for example to obtain the value output by the 1st defined sensor.

Wiring Connections for 4 - 20 mA current loop interface.

1.   4 - wire sensor
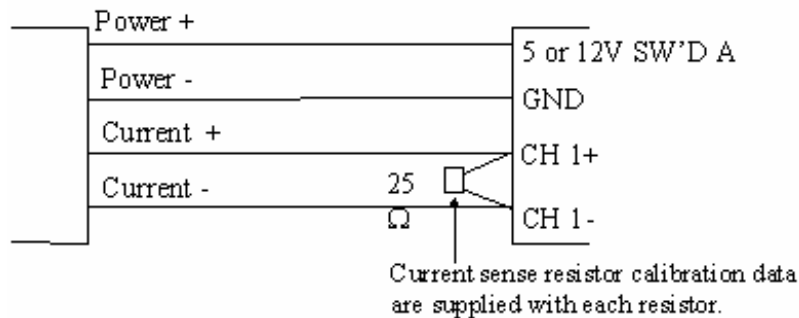
2. 2 - wire sensor
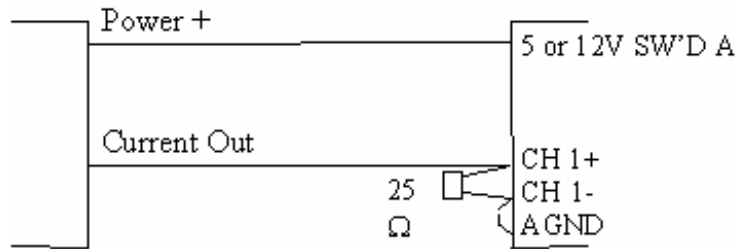
Coastal Environmental Systems (CES) supplies a precision, low temperature coefficient, 25.0Ω, .1%, current sense resistor for 4 - 20 mA applications (CES P/N 1008Z). Sensor and resistor leads should be twisted together and soldered or crimped together in a crimp ferrule prior to connection into terminal block to provide a proper Kelvin connection.

Commonly used ferrules are:

Wire Size AWG	Phoenix Contact P/N
#24	200179
#22	3009215
#20	3200014
#18	3200519

A Phoenix contact Model ZA3 crimping tool or equivalent is recommended.

5.   RAIN GAUGE / TIPPING BUCKET

SENSOR MENU

ITEM	DATA		COMMAND ENTERED
Item 1: Sensor Type code =	10 (Tipping Bucket)		**c1/10**
Item 2: Sensor Name =	rain		**c2/rain**
Item 12: Sensor Timing Loop =	1		**c12/1**
Item 13: Conversion Coefficient A =	0		DEFAULT
Item 14: Conversion Coefficient B =	0.254 [1]		**c14/0.254** [1]
Item 15: Conversion Coefficient C =	0		DEFAULT

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
1 Output is in: mm, as required by the rain process.

PROCESS MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category code =	2 : Meteorological	**c1/2**
Item 2: Process Type code =	6:Rain Process	**c2/6**
Item 3: User-defined Process Name =	3: Rain	**c3/Rain**
Item 4: Input for Rain Gauge =	S1:Rain [2]	**C4/S1 [2]**
Item 5: Accumulation Interval (Hours) =	24	**C5/24**
Item 6: Accumulation Offset (Hours) =	0	**C6/0**
Item 7: Sensor Type (1-TB, 2-RMY, 3=ORR) =	1	**C7/1**

2 This data will vary depending on the number of sensors being connected to the ZENO®.

DATA OUTPUT MENU

Settings for Rain Rate

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	rr	**c3/rr**
Item 4: Data Process Record =	P1.2 [3]	**c4/P1.2 [3]**
Item 5: Field Decimal Places =	1	**c5/1**
Item 6: Field Width =	4	**c6/4**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
3 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

Settings for Rain Accumulation

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	ra	**c3/ra**
Item 4: Data Process Record =	P1.1 [4]	**c4/P1.1 [4]**
Item 5: Field Decimal Places =	1	**C5/1**
Item 6: Field Width =	4	**c6/4**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
4 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

6.   HYGROMETRICS 10205H/HT RELATIVE HUMIDITY

SENSOR MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code	2 (18-bit Single-Ended A to D)	**c1/2**
Item 2: Sensor Name	Rh	**c2/rh**
Item 3: Sensor Input Channel	2-	**c3/2-**
Item 4: Analog Channel Gain	1	**c4/1**
Item 5: Analog Channel Attenuation	2	**c5/2**
Item 6: Switched Power code	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage	1 (EXC = 1.25 VDC)	**c7/1**
Item 8: Switched Excitation Return	B	**c8/B**
Item 9: Sensor Warm up Time	0	DEFAULT
Item 10: Sensor Sample Count	1	DEFAULT
Item 11: Maximum Sensor Readings	0	DEFAULT
Item 12: Sensor Timing Loop	2	**c12/2**
Item 13: Conversion Coefficient A	0	DEFAULT
Item 14: Conversion Coefficient B	See below [1]	**c14/ see below** [1]
Item 15: Conversion Coefficient C	See below [1]	**c15/see below** [1]

DEFAULT = Default Data: it is not necessary to enter a command for this Item.

1 Output: Each sensor is supplied with a unique calibration. To convert the manufacturer's calibration values to ZENO®-3200 coefficients, set B to *sensor slope*/1.25, and C to the *sensor offset*.

PROCESS MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code	1 : General	DEFAULT
Item 2: Process Type code	2 : Averaging Process	**c2/2**
Item 3: User-defined Process Name =	3: RH	**c3/RH**
Item 4: Input for Relative Humidity	S1 : rh [2]	**C4/S1** [2]

2 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

DATA OUTPUT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code	9 : Transmit and Log Data Field	c1/9
Item 2: Output Message(s)	1	c2/1
Item 3: Field Name	rh	c3/rh
Item 4: Data Process Record	P1.1 [3]	c4/P1.1 [3]
Item 5: Field Decimal Places	0	DEFAULT
Item 6: Field Width	3	c6/3
Item 7: Data Storage Class Code	7: Compressed Floating Point (2)	c7/7

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
3 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

* Refer to the Sensor Manual for Signal Names

7.   100Ω PLATINUM RTD

SENSOR MENU

Settings for RTD Probe

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	3 (18-bit Differential A to D)	c1/3
Item 2: Sensor Name =	RTD	c2/RTD
Item 3: Sensor Input Channel =	1	c3/1
Item 4: Analog Channel Gain =	1	DEFAULT
Item 5: Analog Channel Attenuation =	1	DEFAULT
Item 6: Switched Power code =	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage =	1 (EXC = 1.25 VDC)	c7/1
Item 8: Switched Excitation Return =	A	c8/A
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	c12/2
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	1	DEFAULT
Item 15: Conversion Coefficient C =	0	DEFAULT
Item 16: Retry count =	N/A	N/A

N/A = These ITEMS are not applicable for this sensor.
DEFAULT = Default Data, it is not necessary to enter a command for this Item.

Settings for Temperature-Stable 1-kΩ Resistor

ITEM	DATA		COMMAND ENTERED
Item 1: Sensor Type code =	3 (18-bit Differential A to D)		c1/3
Item 2: Sensor Name =	R0		c2/R0
Item 3: Sensor Input Channel =	2		c3/2
Item 4: Analog Channel Gain =	1		DEFAULT
Item 5: Analog Channel Attenuation =	4		c5/5
Item 6: Switched Power code =	0 (NO SWITCHED POWER)		DEFAULT
Item 7: Sensor Excitation Voltage =	1 (EXC = 1.25 VDC)		c7/1
Item 8: Switched Excitation Return =	A		c8/A
Item 9: Sensor Warm up Time =	0		DEFAULT
Item 10: Sensor Sample Count =	1		DEFAULT
Item 11: Maximum Sensor Readings =	0		DEFAULT
Item 12: Sensor Timing Loop =	2		c12/2
Item 13: Conversion Coefficient A =	0		DEFAULT
Item 14: Conversion Coefficient B =	1		DEFAULT
Item 15: Conversion Coefficient C =	0		DEFAULT
Item 16: Retry count =	N/A		N/A

N/A = These ITEMS are not applicable for this sensor.
DEFAULT = Default Data: it is not necessary to enter a command for this Item.

PROCESS MENU

Settings for RTD Resistance Ratio

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category =	5 (Arithmetic)	c1/5
Item 2: Process Number =	7 (Divide Data1 by Data2 Process)	c2/7
Item 4: Input for Data1 =	S1 [1] : RTD	C4/S1 [1]
Item 5: Input for Data2 =	S2 [1] : R0	C5/S2 [1]

1: This value will vary depending on the number of sensors being connected to the ZENO®-3200.

Settings for Temperature

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category =	5 (Arithmetic)	c1/5
Item 2: Process Number =	8 (Quadratic process)	c2/8
Item 4: Input for Data =	P1.1 [2]	C4/P1.1 [2]
Item 5: A Coefficient =	0 [3]	C5/0 [3]
Item 6: B Coefficient =	2597.4 [3]	C6/2597.4 [3]
Item 7: C Coefficient =	-259.74 [3]	C7/-259.74 [3]

2: This value will vary depending on the number of sensors being connected to the ZENO®-3200.
3: Assumes output in ºC, a temperature coefficient $\alpha = 0.00385\Omega/\Omega/ºC$ (European standard), and R0 accurately
     1000Ω. for linear systems, more generally $A = 0$, $B = R0/100\alpha$, $C = -1/\alpha$. for nonlinear systems, refer to
     the manufacturer's calibrations, noting that the quadratic process outputs $AR^2/R0^2 + BR/R0 + C$.

DATA OUTPUT MENU

Settings for Temperature

ITEM	DATA		COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field		**c1/9**
Item 2: Output Message(s) =	1		DEFAULT
Item 3: Field Name =	RTD_Temp		**c3/RTD_Temp**
Item 4: Data Process Record =	P2.1 [4]		**c4/P2.1** [4]
Item 5: Field Precision =	1		**c5/1**
Item 6: Field Width =	6		**c6/6**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)		**c7/7**

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
4: This value will vary depending on the number of sensors being connected to the ZENO®-3200.

8.   SDI-12 SENSOR[298]

SENSOR MENU

Settings for SDI-12 SENSOR on COM2

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	13 (SDI-12 Serial Sensor)	**c1/13**
Item 2: Sensor Name =	sdi-12	**c2/sdi-12**
Item 3: Sensor Input Channel =	COM2	**c3/COM2**
Item 10: Sensor Sample Count =	4 [1]	**c10/4**
Item 11: Maximum Sensor Readings =	1	**c11/1**
Item 12: Sensor Timing Loop =	4 (5.0 seconds)	**c12/4**
Item 16: Retry Count =	3	**c13/3**
Item 17: SDI-12 Address =	0 [2]	DEFAULT
Item 18: Port Type =	RS485	**C18/RS485**
Item 19: Baud Rate =	1200	**C19/1200**

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
1 Set the Sensor Sample Count equal to the number of outputs returned by the sensor (between 1 and 9). This
         configuration assumes that the sensor returns 4 values.
2 A different value should be used for each sensor being connected to the ZENO®-3200. You may have to change
         the SDI-12 address of one or more of the sensors: go into SDI-12 pass-through mode to do this.

DATA OUTPUT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	sdi-12	**C3/sdi-12**
Item 4: Data Process Record =	S1.1 [4]	**C4/S1.1** [4]
Item 5: Field Decimal Places =	1	**c5/1**
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default value: it is not necessary to enter a command for this item.
4 This value will vary depending on the number of sensors being connected to the ZENO®-3200. To output
         multiple values, repeat this menu as required. You can also refer directly to the sensor outputs, rather than
         going through a process. In this case, enter **S1.3** (for example to obtain the 3rd value output by the 1st
         defined sensor.

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[298] Refer to Section 10.3.4.

Notes on Connection

The SDI-12 data line uses negative logic 0 to 5V level signals. This is obtained from the inverting data line of the RS-485 transceiver provided by the ZENO®-3200. The following connection is valid for ZENO systems with serial numbers above 310. (For older ZENO systems, you may need to swap the A and B connections).
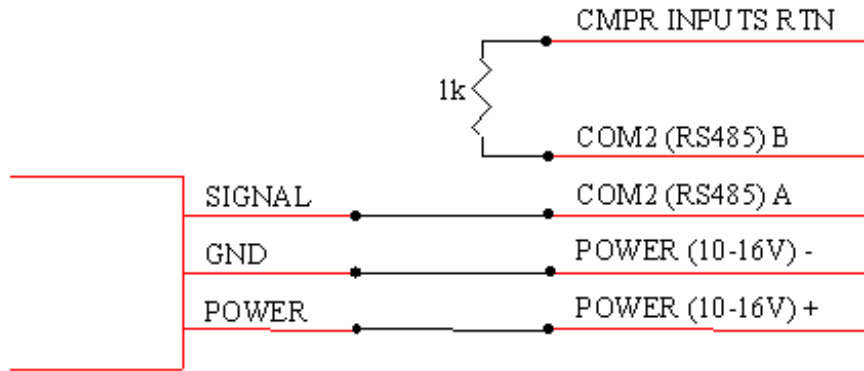
9.   YSI 44034 THERMISTOR (AIR AND OTHER TEMPERATURE READINGS)

SENSOR MENU

Settings for Temperature

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	2 (18-bit Single Ended A to D)	**c1/2**
Item 2: Sensor Name =	TEMP	**c2/TEMP**
Item 3: Sensor Input Channel =	2+	**c3/2+**
Item 4: Analog Channel Gain =	1	**c4/1**
Item 5: Analog Channel Attenuation =	4	**c5/4**
Item 6: Switched Power code =	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage =	2 (EXC = 2.50 VDC)	**c7/2**
Item 8: Switched Excitation Return =	0	DEFAULT
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	**c12/2**
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	0.4	**c14/0.4**
Item 15: Conversion Coefficient C =	0	DEFAULT

DEFAULT = Default value, it is not necessary to enter a command for this item.

PROCESS MENU

Settings for Temperature

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code	4 : Special Sensor	**c1/4**
Item 2: Process Type code =	1 : NTC Thermistor	**c2/1**
Item 3: Input for Thermistor Voltage =	S1 : TEMP [1]	**c3/S1** [1]
Item 4: a-coefficient	0.001288	**c4/0.001288**
Item 5: b-coefficient	0.0002356	**c5/0.0002356**
Item 6: c-coefficient	9.557E-08	**c6/9.557E-08**
Item 7: R2 resistance	4990	**c7/4990**

1 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

DATA OUTPUT MENU

Settings for Temperature

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	TEMP	**c3/TEMP**
Item 4: Data Process Record =	P1.1 [2]	**c4/P1.1** [2]
Item 5: Field Decimal Places =	1	**c5/1**
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default value, it is not necessary to enter a command for this item.
2 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

EXC+

Thermistor

CH2+

4.99 kΩ

AGND

10.   R.M. YOUNG 05103 WIND MONITOR

SENSOR MENU

Settings for Wind Direction

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	1 (12-bit ADC)	c1/1
Item 2: Sensor Name =	wnddir	c2/wnddir
Item 3: Sensor Input Channel =	8	c3/8
Item 6: Switched Power code =	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage =	2 (EXC = 2.50 VDC)	c7/2
Item 8: Switched Excitation Return =	E	c8/E
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	c12/2
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	142	c14/142
Item 15: Conversion Coefficient C =	1	c15/1

DEFAULT = Default value: it is not necessary to enter a command for this item.

Settings for Wind Speed

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	7 (Digital Freq., f<10kHz)	c1/7
Item 2: Sensor Name =	wndspd	c2/wndspd
Item 3: Sensor Input Channel =	10	c3/10
Item 6: Switched Power code =	0 (NO SWITCHED POWER)	DEFAULT
Item 7: Sensor Excitation Voltage =	0 (NO EXCITATION VOLTAGE)	DEFAULT
Item 8: Switched Excitation Return =	0 (NO EXCITATION RETURN)	DEFAULT
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	3	c10/3
Item 11: Maximum Sensor Readings =	0	DEFAULT
Item 12: Sensor Timing Loop =	2	c12/2
Item 13: Conversion Coefficient A =	0	DEFAULT
Item 14: Conversion Coefficient B =	0.098[1]	c14/0.098
Item 15: Conversion Coefficient C =	1	c15/1

DEFAULT = Default value: it is not necessary to enter a command for this item.
1 Output is in m/s when B=0.098, mph when B=0.2192, knots when B=0.1904, kph when B=0.3528.

PROCESS MENU

Settings for Wind Direction/Wind Speed

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code	2 : Environmental	**C1/2**
Item 2: Process Type code	1 : Wind Vector Average	DEFAULT
Item 3: User-defined Process Name =	3: AvgWind	**c3/AvgWind**
Item 4: Input for Wind Speed	S2 : wndspd [2]	**C4/S2** [2]
Item 5: Input for Wind Direction	S1 : wnddir [2]	**C5/S1** [2]
Item 6: Input for Compass	S0.1 (Not specified) [3]	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.

2 This data will vary depending on the number of sensors being connected to the ZENO®-3200.

3 If a serial compass is included, specify the output from the Sensor Record specifying the compass. Also, Line
  Items #5 and #6 from the System Functions Menu will need to be specified (refer to Section 5.7).

DATA OUTPUT MENU

Settings for Average Wind Speed

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	WS	**c3/WS**
Item 4: Data Process Record =	P1.1 [4]	**c4/P1.1** [4]
Item 5: Field Decimal Places =	1	**c5/1**
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default value: it is not necessary to enter a command for this item.

4 This value will vary depending on the number of sensors being connected to the ZENO®-3200. Further, if you
  want scalar average wind speed instead of vector average wind speed, use data output #3; i.e., P1.3.

Settings for Average Wind Direction

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	WD	**c3/WD**
Item 4: Data Process Record =	P1.2 [5]	**c4/P1.2** [5]
Item 5: Field Decimal Places =	0	DEFAULT
Item 6: Field Width =	4	**c6/4**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default value: it is not necessary to enter a command for this item.

5 This value will vary depending on the number of sensors being connected to the ZENO®-3200. Further, if you
  want independent wind vector average instead of component wind vector average, use data output #12; i.e.,
  P1.12.

```
┌──────────────┐                                          ┌──────────────┐
│              │  WS REF        CMPR Inputs RTN           │              │
│              │                                          │              │
│              │  WS SIG        CMPR Inputs CH10          │              │
│              │                                          │              │
│ Wind Sensor* │  AZ EXC              EXC+                │  ZENO®-3200  │
│              │                                          │              │
│              │  AZ SIG              CH8                 │              │
│              │                                          │              │
│              │  AZ REF   Switched Exc. Return E         │              │
└──────────────┘                                          └──────────────┘
```

* Refer to the sensor's manual for correct signal names.

11.   ELLIASON CEILOMETER

The ceilometer requires s General Serial Script[299] to be written for the ZENO®-3200 to collect data from it.

The following example configuration takes 10 measurements from the ceilometer. The ten measurements are processed so that the lowest non-zero cloud height is found at the three reported cloud levels.

SENSOR MENU

---

[299] Refer to Section 12.2.

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	16 (General Serial Script)	**c1/16**
Item 2: Sensor Name =	ceil	**c2/ceil**
Item 3: Sensor Input Channel =	COMPASS INTERFACE	**c3/COMP**
Item 6: Switched Power code =	1 (5V SW'D A)	**C6/1**
Item 9: Sensor Warm up Time =	220	**C9/220**
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	10	**C11/10**
Item 12: Sensor Timing Loop =	3 (17 seconds)	**c12/3**
Item 16: Retry Count =	4	**C16/4**
Item 17: Sensor Address =	0	DEFAULT
Item 18: Sensor Port Type =	RS232	DEFAULT
Item 19: Sensor Baud Rate =	1200	**C19/1200**
Item 20: Sensor Bits Per Character =	8	DEFAULT
Item 21: Sensor Parity =	N	DEFAULT
Item 22: Sensor Start Bits =	1	DEFAULT
Item 23: Sensor Stop Bits =	1	DEFAULT
Item 24: Sensor GSI Script Number =	1	DEFAULT
Item 25: Sensor Data Collection Control =	S0.1	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.

SENSOR TIMING LOOP MENU

ITEM	DATA	COMMAND ENTERED
Item 1: Timing Loop #1 Period =	0.5	DEFAULT
Item 2: Timing Loop #2 Period =	1	DEFAULT
Item 3: Timing Loop #3 Period =	17	**c3/17**
Item 4: Timing Loop #4 Period =	2	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.

GENERAL SERIAL SCRIPT MENU

LINE	DATA
Line 1	STRING 4 (90, 1, 2, 4)
Line 2	FLOAT 9
Line 3	RECEIVE 1000, "%s", S1
Line 4	SEND "FL\r"
Line 5	WAIT 10
Line 6	RECEIVE 5000, "%s", S1
Line 7	RECEIVE 0, "%s,%f,%f,%f,%f,%f,%f,%f,%f,%s,%f,%s,", S2, F1, F2, F3, F4, F5, F6, F7, F8, S3, F9, S4

COMMANDS TO ENTER
I1 C1/STRING 4 (90, 1, 2, 4)
I2 C2/FLOAT 9
I3 C3/RECEIVE 1000, "%s", S1
I4 C4/SEND "FL\r"
I5 C5/WAIT 10
I6 C6/RECEIVE 5000, "%s", S1
I7 C7/RECEIVE 0, "%s,%f,%f,%f,%f,%f,%f,%f,%s,%f,%s,", S2, F1, F2, F3, F4, F5, F6, F7, F8, S3, F9, S4

MEMORY MANAGEMENT MENU

ITEM	DATA		COMMAND ENTERED
Item 1: COM1 GSI Memory Size in Bytes =	0		DEFAULT
Item 2: COM2 GSI Memory Size in Bytes =	100		**C1/100**
Item 3: COM3 GSI Memory Size in Bytes =	0		DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.

PROCESS MENU

Settings for First Cloud Level

ITEM	DATA		COMMAND ENTERED
Item 1: Process Category Code =	3 : Alarm		**C1/3**
Item 2: Process Type code =	8 : Missing Sensor Data Process		**C2/8**
Item 3: User-defined Process Name =	3 : noceil1		**c3/noceil1**
Item 4: Input for Sensor Data	S1.3 : ceil [1]		**C4/S1.3** [1]
Item 5: Default Data	-1		**C5/-1**
Item 6: Digital Output Channel	0		DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.
1 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

ITEM	DATA		COMMAND ENTERED
Item 1: Process Category Code =	1 : General		DEFAULT
Item 2: Process Type code =	9 : Collect Process		**C2/9**
Item 3: User-defined Process Name =	3 : cld1col		**c3/cld1col**
Item 4: Input for Sensor Data	P1.2 : noceil1 [2]		**C4/P1.2** [2]

DEFAULT = Default value: it is not necessary to enter a command for this item.
2 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	1 : General	DEFAULT
Item 2: Process Type code =	11 : Multiple-Input Min/Max	C2/11
Item 3: User-defined Process Name =	3 : cld1min	c3/cld1min
Item 4: Input for Data1 =	P2.1 : cld1col [3]	C4/P2.1 [3]
Item 5: Input for Data2 =	P2.2 : cld1col [3]	C5/P2.2 [3]
Item 6: Input for Data3 =	P2.3 : cld1col [3]	C6/P2.3 [3]
Item 7: Input for Data4 =	P2.4 : cld1col [3]	C7/P2.4 [3]
Item 8: Input for Data5 =	P2.5 : cld1col [3]	C8/P2.5 [3]
Item 9: Input for Data6 =	P2.6 : cld1col [3]	C9/P2.6 [3]
Item 10: Input for Data7 =	P2.7 : cld1col [3]	C10/P2.7 [3]
Item 11: Input for Data8 =	P2.8 : cld1col [3]	C11/P2.8 [3]
Item 12: Input for Data9 =	P2.9 : cld1col [3]	C12/P2.9 [3]
Item 13: Input for Data10 =	P2.10 : cld1col [3]	C13/P2.10 [3]
Item 14: Minimum Allowed Value	0.1	C14/0.1
Item 15: Maximum Allowed Value	20000	C15/20000

DEFAULT = Default value: it is not necessary to enter a command for this item.
3 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	5 : Arithmetic	C1/5
Item 2: Process Type code =	13 : Conditional Select Process	C2/13
Item 3: User-defined Process Name =	3 : cld1	c3/cld1
Item 4: Input for Control Data =	P1.2 : noceil1 [4]	C4/P1.2 [4]
Item 5: Input for Output if Control=0 (X)	P3.2 : cld1min [4]	C5/P3.2 [4]
Item 6: Input for Output if Control<0 (Y)	P1.2 : noceil1 [4]	C5/P1.2 [4]
Item 7: Input for Output if Control<0 (Y)	P3.2 : cld1min [4]	C5/P3.2 [4]

4 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	3 : Alarm	C1/3
Item 2: Process Type code =	8 : Missing Sensor Data Process	C2/8
Item 3: User-defined Process Name =	3 : cld1z	c3/cld1z
Item 4: Input for Sensor Data	P4.1 : cld1 [5]	C4/P4.1 [5]
Item 5: Default Data	0	DEFAULT
Item 6: Digital Output Channel	0	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.
5 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

Settings for Second and Third Cloud Levels

Repeat these 5 Process Records for Sensor Record outputs S1.3 and S1.5 to have the other two cloud height values. Change the Process Record references appropriately. This will be a total of 15 processes.

DATA OUTPUT MENU

Settings for First Cloud Level

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	cldbs1	**c3/cldbs1**
Item 4: Data Process Record =	P5.2 [6]	**c4/P5.2 [6]**
Item 5: Field Decimal Places =	0	DEFAULT
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	8 : 4-byte floating point	**c7/8**

DEFAULT = Default value: it is not necessary to enter a command for this item.
6 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

Settings for Second Cloud Level

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	cldbs2	**c3/cldbs2**
Item 4: Data Process Record =	P10.2 [7]	**C4/P10.2 [7]**
Item 5: Field Decimal Places =	0	DEFAULT
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	8 : 4-byte floating point	**c7/8**

DEFAULT = Default value: it is not necessary to enter a command for this item.
7 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

Settings for Third Cloud Level

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	cldbs3	**c3/cldbs3**
Item 4: Data Process Record =	P15.2 [8]	**c4/P15.2 [8]**
Item 5: Field Decimal Places =	0	DEFAULT
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	8 : 4-byte floating point	**c7/8**

DEFAULT = Default value: it is not necessary to enter a command for this item.
8 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

12.   VAISALA[300] 425AH OR 425AHW ANEMOMETER

The Vaisala 425AH anemometer is a SDI-12 sensor.[301] When it powers up, it boots up in "Sub-mode A", which means it operates as a regular SDI-12 sensor.

If you require using this sensor as a Continuous SDI-12 Sensor[302], the Vaisala 425AH anemometer needs to be initialized into "Sub-mode B" immediately after it powers up, which requires a series of custom SDI-12 commands.[303] A General Serial Script Sensor[304] can be used to send the series of SDI-12 initialization commands. This example illustrates this procedure.

Settings to Collect Data From Vaisala 425AH Sensor on COM2

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	17 (Continuous SDI-12)	c1/17
Item 2: Sensor Name =	425AH	c2/425AH
Item 3: Sensor Input Channel =	COM2	c3/COM2
Item 10: Sensor Sample Count =	8 [1]	c10/8 [1]
Item 11: Maximum Sensor Readings =	1	c11/1
Item 12: Sensor Timing Loop =	1 (0.5 seconds)	DEFAULT
Item 16: Retry Count =	2	c13/2
Item 17: SDI-12 Address =	0 [2]	DEFAULT
Item 18: Port Type =	RS485	DEFAULT
Item 19: Baud Rate =	1200	DEFAULT

DEFAULT = Default Data: it is not necessary to enter a command for this Item.
1 Set the Sensor Sample Count equal to the number of outputs returned by the sensor (between 1 and 9). This configuration assumes that the sensor returns 4 values.
2 A different value should be used for each sensor being connected to the ZENO®-3200. You may have to change the SDI-12 address of one or more of the sensors: go into SDI-12 pass-through mode to do this.

Settings to Initialize Vaisala 425AH Sensor on COM2

[300] This sensor was formerly produced by Handar.
[301] Refer to Section 10.3.4.
[302] Ibid.
[303] Refer to the Vaisala 425AH Anemometer User Manual.
[304] Refer to Section 12.2.

ITEM	DATA	COMMAND ENTERED
Item 1: Sensor Type code =	16 (General Serial Script)	c1/16
Item 2: Sensor Name =	Init425	c2/Init425
Item 3: Sensor Input Channel =	COM2	c3/COM2
Item 6: Switched Power code =	0	DEFAULT
Item 9: Sensor Warm up Time =	0	DEFAULT
Item 10: Sensor Sample Count =	1	DEFAULT
Item 11: Maximum Sensor Readings =	1	C11/1
Item 12: Sensor Timing Loop =	1 (0.5 seconds)	DEFAULT
Item 16: Retry Count =	0	DEFAULT
Item 17: Sensor Address =	0	DEFAULT
Item 18: Sensor Port Type =	RS485	C18/RS485
Item 19: Sensor Baud Rate =	1200	C19/1200
Item 20: Sensor Bits Per Character =	7	C20/7
Item 21: Sensor Parity =	E	C21/E
Item 22: Sensor Start Bits =	1	DEFAULT
Item 23: Sensor Stop Bits =	1	DEFAULT
Item 24: Sensor GSI Script Number =	1	DEFAULT
Item 25: Sensor Data Collection Control =	P3.1 : AddFlag [3]	C25/P3.1 [3]

DEFAULT = Default value: it is not necessary to enter a command for this item.
3 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

GENERAL SERIAL SCRIPT MENU

Settings to Initialize Vaisala 425AH Sensor on COM2

LINE	DATA
Line 1	STRING 1 (50)
Line 2	SEND "\B "
Line 3	WAIT 75
Line 4	SEND "%1sXH1!", sID
Line 5	RECEIVE 500, "%s", S1
Line 6	SEND "\B "
Line 7	WAIT 75
Line 8	SEND "%1sXU1!", sID
Line 9	RECEIVE 500, "%s", S1
Line 10	SEND "\B "
Line 11	WAIT 75
Line 12	SEND "%1sXQ1;3.3;3;0005!", sID
Line 13	RECEIVE 500, "%s", S1

COMMANDS TO ENTER
I1 C1/STRING 1 (50)
I2 C2/SEND "\B "
I3 C3/WAIT 75
I4 C4/SEND "%1sXH1!", sID
I5 C5/RECEIVE 500, "%s", S1
I6 C6/SEND "\B "
I7 C7/WAIT 75
I8 C8/SEND "%1sXU1!", sID
I9 C9/RECEIVE 500, "%s", S1
I10 C10/SEND "\B "
I11 C11/WAIT 75
I12 C12/SEND "%1sXQ1;3.3;3;0005!", sID
I13 C13/RECEIVE 500, "%s", S1

MEMORY MANAGEMENT MENU

ITEM	DATA	COMMAND ENTERED
Item 1: COM1 GSI Memory Size in Bytes =	0	DEFAULT
Item 2: COM2 GSI Memory Size in Bytes =	100	C1/100
Item 3: COM3 GSI Memory Size in Bytes =	0	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.

PROCESS MENU

Settings to Initialize Vaisala 425AH Sensor on COM2

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	3 : Alarm	**C1/3**
Item 2: Process Type code =	8 : Missing Sensor Data Process	**C2/8**
Item 3: User-defined Process Name =	3 : Miss425	**c3/Miss425**
Item 4: Input for Sensor Data	S1.1 : 425AH [4]	**C4/S1.1** [4]
Item 5: Default Data	0	DEFAULT
Item 6: Digital Output Channel	0	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.
4 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	3 : Alarm	**C1/3**
Item 2: Process Type code =	12 : Previous Sample Data Process	**C2/12**
Item 3: User-defined Process Name =	3 : Prev	**c3/Prev**
Item 4: Input for Data =	P1.1 : Miss425 [5]	**C4/P1.1** [5]

DEFAULT = Default value: it is not necessary to enter a command for this item.
5 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code =	5 : Arithmetic	C1/5
Item 2: Process Type code =	3 : Add Data Values Process	C2/3
Item 3: User-defined Process Name =	3 : AddFlag	c3/AddFlag
Item 4: Input for Augend (X) =	P1.1 : Miss425 [6]	C4/P1.1 [6]
Item 5: Input for Addend (Y) =	P2.1 : Prev [6]	C5/P2.1 [6]

DEFAULT = Default value: it is not necessary to enter a command for this item.
6 This value will vary depending on the number of sensors being connected to the ZENO®-3200.

Settings to Collect Data From Vaisala 425AH Sensor on COM2

ITEM	DATA	COMMAND ENTERED
Item 1: Process Category Code	2 : Environmental	**C1/2**
Item 2: Process Type code	1 : Wind Vector Average	DEFAULT
Item 3: User-defined Process Name =	3: AvgWind	**c3/AvgWind**
Item 4: Input for Wind Speed	S1.1 : 425AH [7]	**C4/S1.1** [7]
Item 5: Input for Wind Direction	S1.2 : 425AH [7]	**C5/S1.2** [7]
Item 6: Input for Compass	S0.1 (Not specified) [8]	DEFAULT

DEFAULT = Default value: it is not necessary to enter a command for this item.
7 This data will vary depending on the number of sensors being connected to the ZENO®-3200.
8 If a serial compass is included, specify the output from the Sensor Record specifying the compass. Also, Line
     Items #5 and #6 from the System Functions Menu will need to be specified (refer to Section 5.7).

DATA OUTPUT MENU

Settings to Collect Data From Vaisala 425AH Sensor on COM2, Average Wind Speed

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	WS	**c3/WS**
Item 4: Data Process Record =	P4.1 : AvgWind[9]	**c4/P4.1** [9]
Item 5: Field Decimal Places =	1	**c5/1**
Item 6: Field Width =	5	**c6/5**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default value: it is not necessary to enter a command for this item.
9 This value will vary depending on the number of sensors being connected to the ZENO®-3200. Further, if you
     want scalar average wind speed instead of vector average wind speed, use data output #3; i.e., P4.3.

Settings to Collect Data From Vaisala 425AH Sensor on COM2, Average Wind Direction

ITEM	DATA	COMMAND ENTERED
Item 1: Field Type code =	9 : Transmit and Log Data Field	**c1/9**
Item 2: Output Message(s) =	1	DEFAULT
Item 3: Field Name =	WD	**c3/WD**
Item 4: Data Process Record =	P4.2 : AvgWind [10]	**c4/P4.2** [10]
Item 5: Field Decimal Places =	0	DEFAULT
Item 6: Field Width =	4	**c6/4**
Item 7: Data Storage Class Code =	7 : Compressed Floating Point (2)	**c7/7**

DEFAULT = Default value: it is not necessary to enter a command for this item.

10 This value will vary depending on the number of sensors being connected to the ZENO®-3200. Further, if you want independent wind vector average instead of component wind vector average, use data output #12; i.e., P4.12.

D.   ZENO®-3200 PROCESS LIBRARY

Coastal Environmental Systems

ZENO®-3200 User Manual

This appendix lists all the processes, their inputs and outputs. The process outputs are meaningful throughout the sample interval times -- for example, averages are maintained throughout, rather than being calculated at the end of the sample duration.

> **Enter HPTn.m to obtain help on Process Type number m in Category n.**

> **Bad Sensor Values (BSV)[305] are NOT processed, including any process that requires cumulative data in its calculations.**

1.   GENERAL PROCESSES CATEGORY

1.1.   Immediate Data Process

Inputs:	4	Any sensor or process output
Outputs:	1	The most recent value
	E1	Process Error Code
Assumptions:	None.	

Each time the Immediate process is called, it simply moves the data value from the input into its own output data address.

1.2.   Averaging Process

Inputs	4	Any sensor or process output
Outputs	1	Average value
	2	The most recent input value
	3	Standard deviation
	4	Maximum value
	5	Minimum value
	E1	Process Error Code
Assumptions:	None.	

---

[305] Refer to Section 10.4.5.

The Averaging Process calculates the average of the data referenced in Line Item #4, including the standard deviation, maximum value and minimum value. At the beginning of each new Sample Interval, the outputs of the Averaging Process are all reset.

To calculate the average and the standard deviation, the equations listed below are used. In each equation, x_i represents each input data referenced in Line Item #4 through the Sample Interval, n represents the total number of data values inputted to the process, x_{avg} is the average and σ is the standard deviation.

$$x_{avg} = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}}$$

1.3.   Running Average Process

Inputs:	4	Any sensor or process output	
	5	Running Average Time (2 to 10 minutes)	
	6	Percent Valid Data (0 to 100)	
	7	BIT Flag Number (1 - 31)	
Outputs:	1	True Average value over sample interval	
	2	Standard deviation over sample interval	
	4	Maximum value over the sample interval	
	5	Minimum value over the sample interval	
	6	Running average value	
	7	Data Invalid Flag	
	8	Running Total	
	9	Array Size	
	10	Array Index	
	E1	Process Error Code	
Assumptions:		This process must allocate RAM to hold the running average array data.	

The Running Average Process is very similar to the Averaging Process[306], but with several exceptions:

- Data Outputs #1 through #5 are calculated in exactly the same manner as the Averaging Process.[307]
- Data Output #6, the Running Average ($x_{running}$), is calculated by averaging all of the data values stored within a circular array of size A_{size}:

---

[306] Refer to Category 1, Process Number 2.
[307] Ibid.

$$T_{running} = \sum_{i=1}^{A_{suze}} x_i$$

$$x_{running} = T_{running} \div A_{size}$$

The Running Average will not contain an average specified by the Running Average Time in Line Item #5 until at least that much time has elapsed. Before the amount of time has elapsed as specified by the Running Average Time, the Running Average will contain an average of fewer values over less time.

The circular array contains the inputted data values that are referenced by Line Item #4. ZENOSOFT® calculates the size of the circular array from Line Item #5, the Running Average Time and the apparent frequency of how often new data is received by Line Item #4. The size of the circular buffer is directly proportional to the Running Average Time and inversely proportional to the frequency that data is inputted into the process.

The apparent frequency of how often data is inputted into the process is determined by the Sensor Record which is the source of the data.[308] Determination of the apparent frequency (t_{freq}) depends upon the Sensor Timing Loop time[309] (t_{loop}), the Sample Interval Time[310] (t_{int}), the Sample Duration Time[311] (t_{dur}), and the Maximum Number of Readings[312] taken (n_{max}).

$$n_{poss} = t_{dur} \div t_{loop}$$

$$t_{freq} = \begin{cases} \dfrac{t_{int}}{n_{poss}}, & n_{max} = 0, n_{max} > n_{poss} \\ \dfrac{t_{int}}{n_{max}}, & 0 < n_{max} < n_{poss} \end{cases}$$

Using the Running Average Time (A_{time}) specified in Line Item #5, the size of circular buffer (A_{size}) is calculated using the following equation:

$$A_{size} = \frac{A_{time}}{t_{freq}}$$

- Data Output #7, the Data Invalid Flag ($F_{invalid}$), is set high (1) when the Running Average is invalid or is set low (0) when the Running Average is valid. Validity is determined by when the number of values contained within the circular buffer (n_{buff}) exceeds the value set in the Percent Valid Data (P_{valid}), specified in Line Item #6:

---

[308] Data that originates from a Sensor Record may be pre-processed before being inputted into this Process Record.
[309] Refer to Section 10.3.7.
[310] Refer to Section 3.1.3.
[311] Ibid.
[312] Refer to Section 10.3.8.

$$F_{invalid} = \begin{cases} 1, & n_{buff} < \dfrac{A_{size}P_{valid}}{100} \\ 0, & n_{buff} \geq \dfrac{A_{size}P_{valid}}{100} \end{cases}$$

Since Bad Sensor Values (BSVs) are NOT processed[313], they are NOT entered into the circular buffer. Hence, many BSVs can cause the Data Invalid Flag to be set to 1.

- Data Output #8, the Running Total ($\mathbf{T_{running}}$), is the sum total of all the values contained within the circular buffer.
- Data Output #9, the Array Size ($\mathbf{A_{size}}$), is the number of values that the circular buffer can contain.
- Data Output #10, the Array Index, is the current value being pointed to in the circular array that was updated.

1.4.   Block Average Process

Inputs:	4	Any sensor or process output
	5	User parameter: the number of averaging blocks (1-10)
	6	User parameter: the number of minutes per block (1- 60)
Outputs:	1	Average value
	2	Most recent data input
	3	Standard deviation
	E1	Process Error Code
Assumptions:		None.

This process reads, sums, and averages input data referenced by Line Item #4. Unlike the Averaging Process that stores a single accumulative sum across the Sample Interval, the Block Averaging Process divides the Sample Duration[314] into blocks of time as specified by Line Items #5 and #6.

To work properly, the product of Line Items #5 and #6 must be less than or equal to the Sample Duration Time[315].

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[313] Refer to Section 10.4.5.
[314] Refer to Section 3.1.3.
[315] Refer to Section 3.1.3.

Each block contains the sum total (T_{block}) of the values that were read during that block. The data for each block includes the number of values (n_{block}) summed in the block and the sum of each value squared (TS_{block}).

$$T_{block} = \sum_{i=1}^{n_{block}} x_i$$

$$TS_{block} = \sum_{i=1}^{n_{block}} x_i^2$$

When time expires for one block, ZENOSOFT® calculates the individual block average (x_{block}) and block standard deviation (σ_{block}):

$$x_{block} = T_{block} \div n_{block}$$

$$\sigma_{block} = \sqrt{\frac{TS_{block} - \dfrac{(T_{block})^2}{n_{block}}}{n_{block} - 1}}$$

The average value (x_{avg}) and standard deviation (σ) reported by the process are obtained from all of the sums & data counts stored in all blocks (M) as specified in Line Item #5:

$$x_{max} = \frac{1}{M} \sum_{block=1}^{M} x_{block}$$

$$\sigma = \sqrt{\sum_{block=1}^{M} \sigma_{block}^2}$$

This process may be used to comply with the EPA standard for calculating hourly averages: data is read and averaged in four 15-minute blocks, the four blocks are averaged producing the hourly average value. This requires a Sample Duration of 60 minutes (3600 seconds).

1.5.   Accumulation Process

Inputs:	4	Any sensor or process output
Outputs:	1	The sum total of the data input over the collection interval
	E1	Process Error Code
Assumptions:		none

Each time this process is called it adds the input value to an accumulative total value. The accumulation is reset at the start of each sample interval time.

1.6.   Rate of Change Process

Inputs:	4	Any sensor or process output
Outputs:	1	Average rate of change within collection interval
	2	Most recent rate of change since last call to this process
	E1	Process Error Code
Assumptions:		The data input should not be updated more often than once per second.

This process calculates the difference between the current input value (x_i) and the input value from the previous call to this function (x_{i-1}). The difference is divided by the time elapsed between the consecutive inputted values (t_i and t_{i-1}):

$$\Delta x = x_i - x_{i-1}$$
$$\Delta t = t_i - t_{i-1}$$

The immediate rate of change (r) and average rate of change (r_{avg}) are calculated as follows:

$$r_i = \frac{\Delta x}{\Delta t} = \frac{x_i - x_{i-1}}{t_i - t_{i-1}}$$

$$r_{avg} = \frac{1}{n}\sum_{i=1}^{n} r_i$$

The average rate of change is reset at the beginning of each Sample Duration.

1.7.   Differential Process

Inputs:	4	Any sensor or process output
	5	Any sensor or process output
Outputs:	1	The average difference value
	2	The most recent difference value
	E1	Process Error Code
Assumptions:		The data inputs should both be on same sample timing loop.

The second input value (y_i) is subtracted from the first value (x_i) to find the immediate difference (Δ_i), and an average difference (Δ_{avg}) is calculated over the course of the Sample Duration:

$$\Delta_i = x_i - y_i$$

$$\Delta_{avg} = \frac{1}{n}\sum_{i=1}^{n}\Delta_i$$

The average difference value is reset at the start of each Sample Duration.

1.8.   Free-Running Average Process

Inputs:	4	Any sensor or process output
	5	Processing interval (hours)
	6	Processing offset (hours)
Outputs:	1	The average value during the processing interval
	2	The most recent input value
	3	The standard deviation during the processing interval
	4	The maximum value during the processing interval
	5	The minimum value during the processing interval
	6	Accumulation since the start of the processing interval
	7	Process Completion Flag
	L1	Time of maximum value (seconds after midnight 1/1/1970)
	L2	Time of minimum value (seconds after midnight 1/1/1970)
	L3	Process completion time (seconds after midnight 1/1/1970)
	E1	Process Error Code
Assumptions:	none.	

The Free-Running Average Process provides essentially the same information as the Averaging Process[316] except that it is not linked to the Sample Interval[317] or Sample Duration[318] times. Instead, it maintains its own time interval as defined by Line Items #5 and #6 and the ZENO®-3200 internal clock.

The Processing Interval, Line Item #5, defines the length of time in hours that the process maintains its averaging information. The maximum value for the Processing Interval is 24 hours. The Processing Offset, Line Item #6, defines the offset after midnight in hours when the next Processing Interval begins.

For example, daily (24-hour) averages as well as maximum and minimum values, can be calculated when the sample duration is only 15 minutes.

Since the Free-Running Average Process operates independently of the Sample Interval, the Process Completion Flag output was added to indicate when the Processing Interval is complete. The Process Completion Flag will remain at zero until the end of the Processing Interval when it is set to one.

1.9.   Collection Process

Inputs:	4	Any sensor or process output
Outputs:	1-64	The first 64 samples of the input value
	E1	Process Error Code
Assumptions:	None	

The collection process stores up to 64 sensor or process values within a Sample Duration. for example, if the Sample Duration is one hour and a sensor is measured every 5 minutes, the process collects 12 data values each hour. Each value can later be logged or processed separately. The collection process is useful for logging values more frequently than the Sample Interval permits.

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[316] Refer to Category #1, Process #2.
[317] Refer to Section 3.1.3.
[318] Ibid.

1.10. Trend Data Process

Inputs:	4	Any sensor, process or constant output
	5	Trend time scale in hours
	6	Significant trend per hour
Outputs:	1	Hourly data trend
	2	Immediate hourly trend
	3	Trend direction
	E1	Process error code
Assumptions:	None	

The Trend Data Process calculates the directional trend of the incoming data with respect to time. The Immediate Trend data (output 2, indicated by 'r') is the trend of the most recent data with the previous data and is calculated using the following equation:

$$r = \frac{D_0 - D_1}{(t_0 - t_1)/3600}$$

D_0 is the most recent data, D_1 is the previous data, t_0 is the time of the most recent data and t_1 is the time of the previous data.

The Hourly Data Trend (output 1, indicated by 'R') is the trend over the indicated time scale in hours (input 2, indicated by T_s). The following equations are used to calculate the Hourly Trend Data:

$$x = \frac{t_0 - t_1}{3600 T_S}$$

$$R_0 = (1-x)R_1 + xr$$

R_0 is the current, hourly data trend and R_1 is the past-hourly data trend.

The Trend Direction (output 3, indicated by D_d) takes on one of three values (+1, −1 or 0) which indicates whether the trend is rising, falling or unchanged as compared to the significant trend (input 3 indicated by D_s. The following equation calculates the trend direction:

$$D_d = \begin{cases} -1, R_0 < -D_S \\ 0, |R_0| \le D_S \\ 1, R_0 > D_S \end{cases}$$

1.11. Multiple-Input Minimum/Maximum Process

Inputs:	4-11	Any sensor, process or constant output.
	12	Minimum Allowed Value
	13	Maximum Allowed Value
Outputs:	1	Maximum
	2	Minimum
	E1	Process error code

Assumptions: Null inputs are not processed

The Multiple Input Minimum/Maximum Process returns the maximum and minimum values of the up to eight inputs to the process.

1.12.   Previous Sample Data Process

Inputs:	4	Any sensor, process or constant output.
Outputs:	1	Most recent data
	2	Second most recent data
	3	Third most recent data
	4	Fourth most recent data
	5	Fifth most recent data
	6	Sixth most recent data
	7	Seventh most recent data
	8	Eighth most recent data
	L1	Most recent long integer data
	L2	Second most recent long integer data
	L3	Third most recent long integer data
	L4	Fourth most recent long integer data
	L5	Fifth most recent long integer data
	L6	Sixth most recent long integer data
	L7	Seventh most recent long integer data
	L8	Eighth most recent long integer data
	E1	Process error code
Assumptions:	None	

The Previous Sample Data Process saves the inputted data at the end of the Sample Interval and shifts the data collected in the previous Sample Interval down one output until the eighth output is reached. Hence, the process stores a single data value for up to eight consecutive Sample Intervals. The stored data can be retrieved as either a floating-point value or a long integer value.

1.13.   Multiple Data Validation Process

Inputs:	4	Control Data = any sensor, process or constant output
	5-16	Data 1 through Data 12 = any sensor, process or constant output.
Outputs:	1-12	Validated Data 1 through Data 12 (respectively) or all BSV
	E1	Process error code
Assumptions:	None	

The process takes one control data input and 12 other data inputs. When the control data is 0, each of the twelve Validated Data outputs will be the same as their corresponding non-control data inputs. When the control data is not 0, all twelve Validated Data outputs will be Bad Sensor Values (BSV = -1,000,000.0).

1.14.   Single Data Validation Process

Inputs:	4	Control Data = any sensor, process or constant output
	5	Data any sensor, process or constant output
Outputs:	1	Validated Data
	E1	Process error code

      Assumptions: None

When the control data is 0, the Validated Data output will be the same as the non-control input data. When the control data is not 0, the Validated Data output will be a Bad Sensor Value, or -1,000,000.0.

2.   ENVIRONMENTAL PROCESSES CATEGORY

2.1.   Wind Vector Average Process

Inputs:	4	Wind Speed (D)
	5	Wind Direction (D)
	6	Optional Compass Input (D)
	7	Gust Sample Window, 1 to 5 seconds (U)
Outputs:	1	Vector Average Wind Speed
	2	Vector Average Independent Wind Direction
	3	Average Scalar Wind Speed
	4	Most Recent Wind Speed
	5	Most Wind Direction
	6	Sigma-theta[319]
	7	Maximum Wind Gust
	8	Average U vector
	9	Average V vector
	10	Most Recent Compass Reading
	11	Wind Gust Direction
	12	Vector Average Component Wind Direction
	L1	Time of Maximum Wind Gust (seconds after midnight, 1/1/1970)
	E1	Process Error Code
Assumptions:		Compass input may be from a sensor, or left as a NULL input. If a compass is defined, the compass input is used only if the field Add Compass To Vane -- in the System Functions Menu of the User Menu -- is set to YES. In this case, each wind direction value is adjusted for the latest compass reading. Note that wind direction is the direction from which the wind is blowing.
		If a null compass is defined, the value of Add Compass To Vane[320] has no effect.

Many different wind statistics are in common use. Vector averaging of some sort is necessary for reliable wind direction estimates. You cannot simply average the vane measurement directly. As an example if the wind blew half the time from 359° and the other half from 1°, the simple vane average would yield a mean direction of 180°!

The different wind statistics calculated by the wind vector average and related processes are described below. They are all based upon the wind speed s and direction θ (including the compass bearing). From these, the ZENO calculates the following quantities for each measurement i:

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[319] Sigma-theta is the approximate Standard Deviation of the wind direction using the Yamartino equation.
[320] Refer to Section 5.7.

$$x_i = \sin\theta_i;$$
$$y_i = \cos\theta_i;$$
$$u_i = s_i x_i;$$
$$v_i = s_i y_i;$$

giving x_i and y_i, the unit vector components corresponding to east and north respectively, and u_i and v_i, the wind speed vector components. The vector components are summed over the averaging period, and the vector averages are computed at the end of the averaging interval:

$$X = \frac{1}{N}\sum_{i=1}^{N} x_i;$$

$$Y = \frac{1}{N}\sum_{i=1}^{N} y_i;$$

$$U = \frac{1}{N}\sum_{i=1}^{N} u_i;$$

$$V = \frac{1}{N}\sum_{i=1}^{N} v_i.$$

The *X*, *Y*, *U* and *V* terms are available as outputs 8 and 9. These are used to compute the vector average wind speed (S_V), vector average independent wind direction (θ_{VI}), vector average component wind direction (θ_{VC}), outputs 1, 2 and 12 respectively:

$$S_V = \sqrt{\left(U^2 + V^2\right)}$$
$$\Theta_{VI} = \arctan\left(Y/X\right)$$
$$\Theta_{VC} = \arctan\left(V/U\right)$$

When the arctangent is taken, the result is calculated to provide a full four-quadrant result with the range 0-360°.

The (scalar) average wind speed S_S, output 3, is computed from the speed measurements alone:

$$S_S = \frac{1}{N}\sum_{i=1}^{N} s_i.$$

The average wind speed is always larger than the vector average wind speed. However, S_S is usually only a few percent greater than S_V and it serves as a backup measurement if the compass or vane fails and S_V is invalidated.

The standard deviation of the wind direction σ_θ, output 6 (also known as sigma-theta), is based on the time series of wind direction measurements, θ_i. and the average wind direction, θ_V. A formal definition of σ_θ is:

$$\sigma_\theta^2 = \frac{1}{N} \sum_{i=1}^{N} \Delta_i^2 - \left[\frac{1}{N} \sum_{i=1}^{N} \Delta_i \right]^2,$$

with Δ_i defined such that each $|\Delta_i|$ is the smaller of $|\theta_i - \theta_V|$ and $2\pi - |\theta_i - \theta_V|$. Calculating this exactly requires two passes over the data: first to calculate θ_V, and then to find σ_θ. The ZENO uses a single pass method so that data can be processed in real time without storing all the wind samples in memory. Yamartino[321] compared several single pass computations and showed that the most accurate equation, which is used in the ZENO, is as follows:

$$\sigma_\Theta = \arcsin\left[\varepsilon \left(1 + \frac{2}{\sqrt{3}} \varepsilon^3 \right) \right]$$

$$\varepsilon = \sqrt{1 - \left(X^2 + Y^2 \right)}$$

The maximum wind gust (output 7) is computed from a 1 to 5 second running average of the wind speed. On each pass, the running average gust is computed and compared to the current maximum value. If the new gust average is larger than the previous gust average, then the current gust is recorded as the latest maximum gust. The gust is reset at the start of each sample interval time.

2.2.   Running Wind Vector Average Process

Inputs:	4	Wind Speed (D)
	5	Wind Direction (D)
	6	Optional Compass Input (D)
	7	Gust Sample Window, 1 to 5 seconds (U)
	8	Running Average Time in Minutes (U)
	9	Percent Valid Data (U)
Outputs:	1	Vector Average Wind Speed
	2	Vector Average Independent Wind Direction
	3	Average Scalar Wind Speed
	4	Most Recent Wind Speed
	5	Most Recent Wind Direction
	6	Sigma-theta[322]
	7	Maximum Wind Gust
	8	Average U vector
	9	Average V vector
	10	Most Recent Compass Reading
	11	Running Vector Average Wind Speed
	12	Running Vector Average Independent Wind Direction
	13	Running Average Sigma-theta
	14	Running Maximum Wind Gust Speed

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[321] R. J. Yamartino: "A Comparison of Several 'Single-Pass' Estimators of the Standard Deviation of Wind Direction", **Journal of Climate and Applied Meteorology, Volume 23**. American Meteorological Society, 1984. Pp. 1362-1366.

[322] Sigma-theta is the approximate Standard Deviation of the wind direction using the Yamartino equation. Refer to the Vector Average Wind Process for details regarding this equation.

15	Wind Direction during Running Maximum Wind Gust Speed
16	Running Vector Average Component Wind Direction
17	Vector Average (Not Running) Component Wind Direction
18	Data Invalid Flag
E1	Process Error Code

Assumptions: This process must allocate RAM to hold the running average array data.

This process is nearly identical to the Wind Vector Average Process[323], but with the addition of the processing required to hold up to 10 minutes worth of running vector wind speed and direction data.

The first 10 data outputs and Data Output #17 of the Running Wind Vector Average Process are calculated exactly the same way as the Wind Vector Average Process.[324] Data outputs #11 through #16, and #18 are calculated using circular buffers of data similar to the Running Average Process[325], but using vector calculations.

Five circular buffers are maintained, whose values are calculated from the inputted wind speed and wind direction using the same equations as described in the Wind Vector Average Process[326]:

1.   Unit vector x-component wind direction (x_i).

2.   Unit vector y-component wind direction (y_i).

3.   Magnitude vector u-component wind direction (u_i).

4.   Magnitude vector v-component wind direction (v_i).

5.   Scalar wind speed (s_i).

The sizes of the circular buffers are identical. ZENOSOFT® calculates the size of each circular buffer (A_{size}) from Line Item #8, the Running Average Time and the apparent frequency of how often new data is received by Line Item #5, the wind direction. Calculating the size of each circular buffer is done using the same equations as used in the Running Average Process[327].

The process will validate the calculated data by determining what percentage of the inputted wind speed and wind direction data is valid using the same technique as described in the Running Average Process[328]. (Valid data is any data that is not a Bad Sensor Value.)

2.3.   Block Average Direction Process

Inputs: 4   Wind Direction data
                          5   Compass data (optional)
                          6   The number of averaging blocks (1-10)
                          7   The number of minutes per block (1- 60)
Outputs: 1   Average wind direction
                          2   Immediate data (most recent sample)
                          3   Standard deviation of data over sample interval
                          E1 Process Error Code

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[323] Refer to Category #2, Process #1.
[324] Ibid.
[325] Refer to Category #1, Process #3.
[326] Refer to Category #2, Process #1.
[327] Refer to Category #1, Process #3.
[328] Ibid.

Assumptions: This process assumes that the wind direction will not change by more
                          than 180 degrees between sampling

This process operates similarly to the Block Average Process[329], but it is intended for wind direction
averaging. Unlike the Wind Vector Average Process[330] and Running Wind Vector Average Process[331],
this process computes a *scalar average* of the wind direction rather than a vector average.

> **Coastal Environmental Systems favors the use of the Wind Vector Average
> Process or Running Wind Vector Average Process over the Block Average
> Direction Process because vector averaging of wind direction is more
> accurate.**

2.4.   True Wind Vector Average Process

Inputs:	4	Wind speed
	5	Wind direction
	6	Compass Input
	7	Vehicle Speed Over Ground
	8	Vehicle Course Over Ground
Outputs:	1	Vector Average True Wind Speed
	2	Vector Average True Independent Wind Direction
	3	Vector Average True Component Wind Direction
	4	Most Recent True Wind Speed
	5	Most Recent True Independent Wind Direction
	6	Most Recent True Component Wind Direction
	7	Average U vector
	8	Average V vector
	E1	Process Error Code
Assumptions:		This process assumes that you have compass data, the vehicle speed over ground and course over ground

This process is used to calculate the true wind speed and direction from an anemometer installed on a
moving vehicle. While the vehicle is moving, the vehicle's course over ground and speed over ground
must be known to convert the measured wind speed and wind direction into true values. If no compass is
present, the orientation of the anemometer with respect to the vehicle must be known. If a compass is
available, the orientation of the anemometer with respect to the vehicle is unimportant.

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[329] Refer to Category #1, Process #4.
[330] Refer to Category #2, Process #1.
[331] Refer to Category #2, Process #2.

> **When the vehicle is stationary, the True Wind Vector Average Process can only provide true wind speed and true wind direction data if a compass is installed.**

The vehicle's course over ground and speed over ground can be obtained from a GPS receiver.[332] If no compass is present, the orientation of the anemometer must be provided as a constant input for Line Item #6, the Compass Input. The orientation is specified so that the measured wind direction will be zero degrees when the anemometer is pointing toward the front (or bow) of the vehicle.

The process uses the following calculations to determine true wind speed (S_{true}), true component wind direction (DC_{true}) and true independent wind direction (DI_{true}) from the measured wind speed (S_{meas}), measured wind direction (D_{meas}), compass (C), speed over ground (S_{gnd}) and course over ground (D_{gnd}):

$$u_i = S_{meas}\sin(D_{true} + C), \quad v_i = S_{meas}\cos(D_{true} + C)$$

$$u_{vehicle} = S_{gnd}\sin(D_{gnd}), \qquad v_{vehicle} = S_{gnd}\cos(D_{gnd})$$

$$u_{true} = u_i - u_{vehicle}, \quad v_{true} = v_i - v_{vehicle}$$

$$S_{true} = \sqrt{u_{true}^2 + v_{true}^2}$$

$$DC_{true} = \arctan\frac{v_{true}}{u_{true}}$$

$$x_{true} = u_{true} \div S_{true}, \quad y_{true} = v_{true} \div S_{true}$$

$$DI_{true} = \arctan\frac{y_{true}}{x_{true}}$$

2.5.   Barometric Pressure Process

Inputs:	4	Barometric pressure sensor or process input
Outputs:	1	Average sea level Barometric pressure
	2	Most recent sea level Barometric pressure calculation
	E1	Process Error Code
Assumptions:		Data input to this function should be scaled to millibars

This process calculates immediate barometric pressure (P_{imm}) and average barometric pressure that are corrected to sea level by using the Barometer Elevation (H_{baro}) parameter located in the System Functions Menu.[333] The measured barometric pressure (P_{meas}) is corrected by a factor of one millibar for every 8 meters that the barometric pressure sensor is above sea level using the following equation:

$$P_{imm} = P_{meas} + \frac{H_{baro}}{8}$$

The average barometric pressure is calculated across the Sample Interval from the corrected immediate barometric pressure using equations similar to the Averaging Process.[334]

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[332] Refer to Section 10.3.4.
[333] Refer to Section 5.8.
[334] Refer to Category #1, Process #2.

2.6.   **Rainfall Process**

Inputs:	4	Rain Data
	5	Rain accumulation interval, 0 to 24 hours
	6	Rain accumulation offset, 0 to 24 hours
	7	Rain Sensor Type
		1 Tipping bucket
		2 R.M. Young sensor
		3 Optical rain rate
	8	Rain End Reset Delay
Outputs:	1	Rain accumulation over accumulation interval
	2	Average hourly rain rate in accumulation per hour
	3	Rain accumulation over the sample interval
	4	Rain Indication (0 = not raining, 1 = raining)
	L1	Rain Start Time (seconds after midnight, 1/1/1970)
	L2	Rain End Time (seconds after midnight, 1/1/1970)
	E1	Process Error Code
Assumptions:		The accumulation interval and offset should be defined in hours.
		The rain data input must be a sensor, not a process, and the sensor must be configured with its Maximum Sensor Readings value set to 0 (the default).

This process first determines the input sensor type, defined in Line Item #7, to properly interpret the measured rain sensor data from Line Item #4:

- Tipping bucket sensors yield discrete quantities of rain.

- R.M. Young rain sensors show a current accumulation from 0 to 50 mm.

- Optical rain sensors show the current rain rate in mm/hr.

ZENOSOFT® converts the measured rain sensor data from the R.M. Young or optical rain sensor into a quantity of rainfall that is similar to that reported by a tipping bucket sensor.

The measured quantity of rain is added to two independent accumulation values:

- A long-term rain accumulation interval, data output #1, that is user-defined and independent of the Sample Interval.

- A rain accumulation interval, whose length of time is equivalent to the Sample Interval, data output #3.

The long-term rain accumulation interval is defined by Line Items #5 and #6. The Rain Accumulation Offset parameter in Line Item #6 defines the offset from midnight that the Rain Accumulation Interval from Line Item #5 begins. The long-term rain accumulation value is reset to zero at the beginning of each Rain Accumulation Interval. As an example, a Rain Accumulation Interval of 24 hours with a Rain Accumulation Offset of 9 hours would mean that every morning at 9:00 a.m. the long-term rain accumulation value is reset.

A running rain accumulation value can be calculated if the following steps are used:

- Divide the desired time interval for the running rain accumulation value by the Sample Interval Time[335] to obtain the number of required running intervals.

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[335] Refer to Section 3.1.3.

- Divide the number of required running intervals by 7 and round it up to the nearest whole number.

- Create as many Process Records as calculated from the previous step following the Process Record containing the Rain Process.

- Configure each new Process Record to be a Previous Sample Value Process.[336]

- Set the input data value, Line Item #4, of the first Previous Sample Value Process to the data output #3, the Sample Interval rain accumulation, of the Rain Process. Set the input value for any successive Previous Sample Value Processes to the oldest data from the previous Process Record that defines a Previous Sample Value Process.

- Create as many new Process Records as were done to hold the Previous Sample Value Processes.

- Configure each new Process Record to be an Add Multiple Data Values Process.[337]

- Set the data input of each Add Multiple Data Value Process to the last 7 outputs of each Previous Sample Data Process. Only use the first data output from the first Previous Sample Data Process in one Add Multiple Data Value Process.[338]

- The running rain accumulation will be obtained by adding the outputs of each Add Multiple Data Value Process into a single value. You will need to create at least one more Process Record to do this, and configure it to be an Add Multiple Data Value Process.

The hourly rain rate value, data output #2, is calculated by dividing the Sample Interval rain accumulation value (the value reported by data output #3) by the time elapsed since the beginning of the Sample Interval.

The rain indication output, data output #4, is an indication that the rain sensor is currently detecting rain; i.e., 0 means no current rainfall, 1 means it is currently raining. The Rain Process will continue to report that rain is falling, even if the data inputted into Line Item #4 is zero for as long as the user specified in the Rain End Reset Delay, Line Item #8. If no rain is reported to the process for a time period exceeding the Rain End Reset Delay, the Rain Process will assume that rainfall has ended and will set the rain indication output to 0. Once rain is reported to the Rain Process and current rain indication is zero, the process will set the rain indication high and set the rain start time (data output #L1) to the current time. The rain end time (data output #L2) is set to the current clock value when the Rain Reset Delay Time runs out.

2.7.   Dewpoint Process

Inputs:	4	Temperature in °C
	5	Humidity as a Percentage
	6	Barometric Pressure in mbar[339]
Outputs:	1	Average calculated Dewpoint temperature in °C
	2	Most recent calculated Dewpoint temperature in °C
	3	Virtual Temperature in °C
	4	Wet-bulb Temperature in °C
	E1	Process Error Code
Assumptions:		Metric input and output data

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[336] Refer to Category #1, Process #12.

[337] Refer to Category #5, Process #11.

[338] Since you are linking multiple Previous Sample Data Processes together, the oldest value in each Previous Sample Period Process will be the same as the current (or newest) value in the next Previous Sample Data Process.

[339] If this input is not specified, the process uses a default value of 1013 mbar for barometric pressure.

The algorithm is that in "Principles of Meteorological Analysis", by W.J. Saucier. It is assumed that if the temperature is below freezing then the surface layer is ice, and that if it is above freezing the surface layer is water. This gives the following choice:

$$\alpha_c = \begin{cases} 21.875, & T \le 0; \\ 17.2694, & T > 0; \end{cases}$$

$$\beta_c = \begin{cases} 265.5, & T \le 0; \\ 237.3, & T > 0. \end{cases}$$

The saturation vapor pressure e_S is given by:

$$e_s = 6.11 \exp\left[\frac{\alpha_c T}{\beta_c + T}\right].$$

The saturation mixing ratio w_s is given by:

$$w_s = \varepsilon \frac{e_s}{p - e_s}, \quad \varepsilon = 0.622.$$

The actual mixing ratio w is given by:

$$w = \frac{r}{100} w_s.$$

The actual vapor pressure e is given by:

$$e = p \frac{w}{w + \varepsilon}.$$

Finally, the dewpoint D is found as:

$$D = \frac{\beta_c \log_e\left[\frac{e}{6.11}\right]}{\alpha_c - \log_e\left[\frac{e}{6.11}\right]}.$$

The virtual temperature (T_V) is calculated using the following equation:

$$T_V = T\left\{\frac{1 + \dfrac{w}{\varepsilon}}{1 + w}\right\}$$

Calculating the wet-bulb temperature (T_W) begins with the following equations. All temperatures are calculated in Kelvin.

Next, an initial guess of the wet-bulb temperature is made using the following equation:

$$e_W = 26.66082 - 0.0091379024 T_W - \frac{6106.396}{T_W}$$

$$e_s = 26.66082 - 0.0091379024 T - \frac{6106.396}{T}$$

$$e_d = 26.66082 - 0.0091379024 D - \frac{6106.396}{D}$$

$$s = \frac{e_s - e_d}{T - D} \quad T_W = \frac{fT + Ds}{f + s}$$
$$f = 0.0006355 p$$

Next, the wet-bulb partial pressure is calculated using the following equation:

Two difference equations are then used to calculate to improve the calculation for the wet-bulb temperature:

A better value for the wet-bulb temperature is calculated using the next equation:

$$d_1 = f(T - T_W) - (e_W - e_d)$$

$$d_2 = e_W \left(0.0091379024 - \frac{6106.396}{T_W^2} \right) - f$$

$$T_{W-NEW} = T_W - \frac{d_1}{d_2}$$

If the difference between T_{W-NEW} and T_W is significant, a new e_W is calculated along with new d_1 and d_2 values until the difference is nearly zero. The resulting wet-bulb temperature is reported in degrees Celsius.

2.8.   Evapotranspiration Process

Inputs:
4   Wind speed in m/s
5   Air temperature in °C
6   Relative humidity, as a percentage
7   Solar or net radiation, in W/m^2
8   Site altitude, in meters above sea level
9   Height of wind speed measurements above the ground, in m
10   Vegetation canopy height, in meters
11   Site latitude, in degrees, southern values negative
12   Site longitude, in degrees, western values negative

	13	Longitude of the standard time zone meridian
	14	Radiation sensor code: 0 for net radiometer, 1 for solar

Outputs: 1   Average potential evapotranspiration rate in mm/hr
                   2   Most recent potential evapotranspiration rate in mm/hr
                   E1 Process Error Code

Assumptions: The ZENO must be set to the standard time period -- not to daylight saving time.
Typical values of the vegetation height are 0.1 m for grass, 0.3 m for alfalfa. The vegetation canopy height must be greater than 0.05 m, and less than the wind measurement height.
If a solar radiation sensor is specified, the model estimates the cloud cover, and hence the net radiation, using that value. If the ZENO starts up at night, it cannot estimate the cloud cover until sunrise the next day. In the interim, the ZENO will output a null value of -1000.0.

The Penman-Monteith equation is used in the following form:

$$\lambda E = \frac{\Delta[R_n - G] + \rho c_p [e_s(T) - e]/r_H}{\Delta + \gamma *} \tag{1}$$

where the symbols indicate:

E potential evapotranspiration rate, to be determined
λ latent heat of evaporation of water
Δ rate of change of saturation vapor pressure of water with temperature
R_n net radiative transfer of heat into the ground
G rate of loss of heat into the ground through conduction
ρ density of air
c_p specific heat capacity of air at constant pressure
$e_s(T)$ saturation vapor pressure at temperature T
e measured vapor pressure
r_H resistance of radiative and convective transfer of heat in air
$\gamma*$ modified psychrometer constant

The calculation requires that the ZENO time clock not be set to daylight saving time, unless a net radiation measurement is available.

Net Radiation

If a net radiometer is available, it measures the net radiation R_n directly. If only solar radiation is measured, the net radiation is calculated as described in this section.

The ground conduction G is parameterized as $0.1R_n$ when R_n is positive, and $0.5R_n$ when R_n is negative.

If the solar radiation S_t is measured, the net radiation is calculated in the following way. The quoted hourly accuracy of this fit (developed and tested in coastal, desert, mountain and interior valley regions in California) is 10% for solar angle $\theta > 10°$. The fit, based upon well-watered grass, was:

$$R_n = 0.89 \{[1 - \alpha]S_t + \varepsilon_a[1 - c]\sigma T^4 + [c - \varepsilon_s]\sigma T^4\} \tag{2}$$

where the new symbols are:

α short-wave surface albedo

ε_a long-wave emissivity of the atmosphere
ε_s long-wave surface emissivity, taken equal to 0.98
c cloud cover fraction
σ Stefan-Boltzmann constant (5.67×10^{-8} W m^{-2} K^{-4})

The fits to the short-wave surface albedo and the cloud cover fraction both depend on the solar altitude θ, this quantity is used both directly, and to evaluate the estimated radiation flux in the absence of cloud cover. The calculation of θ is given in the following equations, where t is the time in hours (not using daylight saving), and D is the day of the year, found from the internal ZENO clock:

$$\eta = \frac{360° D}{365};$$
$$d = 23.27° \cdot \sin\left[\eta - 80.1°\right];$$
$$E_t = 0.1227\sin\left[\eta - 4.3°\right] + 0.1654\sin\left[2\eta + 18.4°\right] + 0.0058\sin\left[3\eta + 15.3°\right];$$ \hfill (3)
$$t_{12} = 12 + \frac{L_s - \ell}{15°} + E_t;$$
$$\sin\theta = \sin d \sin\varphi + \cos d \cos\varphi \cos\left[15(t - t_{12})\right].$$

In these equations, all angles are in degrees and all times are in hours. The locally calculated quantities are as follows:

η the angle corresponding to the day of the year
d solar declination
E_t equation of time (the difference between mean solar time, or clock time, and true solar time, or sundial time)
t_{12} the clock time corresponding to mean solar time

and the inputs, additional to the day and hour of the measurement, are:

L_s the longitude of the standard meridian for the time zone of the site
ℓ the actual site longitude
φ site latitude
σ Stefan-Boltzmann constant (5.67×10^{-8} W m^{-2} K^{-1})

Given the value of the solar altitude θ, measured in degrees, the quantities in equation (2), and hence the net short-wave radiation, are calculated as follows. The cloud cover is estimated from the downward solar radiation when $\theta \geq 10°$:

$$S_p = \left[0.79 - \frac{3.75°}{\theta}\right]S_0 \sin\theta;$$
$$c = \min\left\{1, \left[1.33 - 1.33\frac{S_t}{S_p}\right]^{0.294}\right\};$$ \hfill (4)

Cloud cover when $\theta < 10°$ (overnight) is taken equal to the last measured value of c before sunset. If the ZENO has started up since sunset when the net radiation calculation is carried out, the ZENO returns an error code.

The albedo α is estimated to be 0.26.

The long-wave emissivity ε_a of the atmosphere is calculated as:

$$\varepsilon_a = 1.08\left\{1 - \exp\left[-\left(\frac{e}{100\text{Pa}}\right)^{T/2016}\right]\right\},\tag{5}$$

where the air temperature T is measured in K, and the vapor pressure e is (as suggested in equation (6)) measured in Pa. The ratio $[e(T)/100\text{Pa}]$ is equal to the vapor pressure measured in millibars.

Modified Psychrometer Constant And Resistances

The resistances to transfer of sensible heat and water vapor appear in the calculation of the modified psychrometer constant $\gamma*$, in addition to the direct appearance of the resistance to heat transfer r_H. The modified psychrometer constant is given by:

$$\gamma* = \gamma\frac{r_V + r_c}{r_H} = \frac{c_p p}{\lambda\varepsilon}\cdot\frac{r_V + r_c}{r_H},\tag{6}$$

where the newly introduced symbols are:

γ the psychrometer constant, defined in equation (7)
r_V air resistance to transfer of water vapor
r_c canopy resistance to transfer of water vapor
r_H air resistance to transfer of sensible heat
c_p specific heat capacity of air at constant pressure
p air pressure
λ latent heat of vaporization of water
ε ratio of the molecular weights of air and water

This section discusses only the various resistances. The evaluation of the various terms making up the psychrometer constant γ is defined in the next section.

In practice, the resistances of the air to transfer of water vapor and sensible heat are sufficiently similar that they can be replaced by a single quantity, the air resistance:

$$r_a = r_V \approx r_C.\tag{7}$$

This is found from the measured wind speed at height z, $u(z)$, and the height of the plant canopy, h_c. for calculations of potential evapotranspiration, a reference crop height of $h_c = 12$ cm is assumed. The air resistance is:

$$r_a = \ln\left[\frac{z-d}{z_{0m}}\right]\ln\left[\frac{z-d}{z_{0h}}\right]\frac{1}{k^2 u(z)},\tag{8}$$

with the roughness scales for momentum and heat transfer, z_{0m} and z_{0h}, and the zero plane displacement d, given by:

$$z_{0m} = 0.123h_c;$$
$$z_{0h} = 0.0123h_c;\tag{9}$$
$$d = 0.67h_c.$$

The von Karman constant k is equal to 0.41.

The canopy resistance is set to 70 sm⁻¹. During the night, the canopy resistance is increased by a factor of 10 to allow for stomatal closing.

Water Vapor Pressure *e*

This is equal to the product of the saturation vapor pressure $e_s(T)$ and the relative humidity h_r.

Saturation Vapor Pressure $e_s(T)$

This is related to the saturation vapor pressure $e_s(T^*)$ at temperature $T^* = 273.15$K through the expression:

$$e_s(T) = e_s(T^*)\exp\left[\frac{a_1(T - T^*) + a_2(T - T^*)^2}{T}\right];$$

$$e_s(T^*) = 611\,\text{Pa};$$

$$a_1 = 19.82;$$

$$a_2 = -0.00814\,\text{K}^{-1};$$

(10)

where all temperatures are given in Kelvin.

Air Pressure *p*

This is related to the site altitude *A* and the pressure p_0 at sea level through:

$$p(A) = p_0\,\exp\left[\frac{-A}{a_3}\right];$$

$$p_0 = 1.012 \times 10^5\,\text{Pa};$$

$$a_3 = 8500\,\text{m}.$$

(11)

The altitude A is given in meters.

Rate of Change of Saturation Vapor Pressure *Δ*

This is given by the derivative of equation (10):

$$\Delta = e_s(T) \cdot \left[\frac{a_1 T^* + a_2\left(T^2 - T^{*2}\right)}{T^2}\right],$$

(12)

where the constants a_1 and a_2 take the same values as in equation (10).

Latent Heat of Vaporization of Water *λ*

This is fit to a linear form:

$$\lambda(T) = \lambda(T^*) - a_4(T - T^*);$$
$$\lambda(T^*) = 2.501 \times 10^6 \text{ Jkg}^{-1};$$
$$a_4 = 2.37 \times 10^3 \text{ Jkg}^{-1}\text{K}^{-1};$$

(13)

where the temperatures are given in Kelvin and the value is related to the value at $T^* = 273.15$K.

Air Density ρ

This is related to the air density ρ_0 at 273.15 K and sea level through:

$$\rho(A,T) = \rho_0(T^*) \cdot \frac{T^*}{T} \cdot \exp\left[-\frac{A}{a_3}\right];$$
$$\rho_0(T^*) = 1.291 \text{ kgm}^{-3};$$

(14)

where a_3 takes the same value (8500m) as in equation (11).

2.9.   Free Running Wind Vector Average

Inputs:	4	Wind speed sensor, process or constant output
	5	Wind direction sensor, process or constant output
	6	Compass sensor, process or constant output (optional)
	7	Gust sample window (1 to 5 seconds)
	8	Processing interval (minutes)
	9	Processing offset (minutes)
Outputs:	1	Vector average wind speed
	2	Vector average independent wind direction
	3	Average wind speed
	4	Most recent wind speed
	5	Most recent wind direction
	6	Sigma-theta
	7	Maximum wind gust
	8	Average U-vector
	9	Average V-vector
	10	Most recent compass
	11	Wind gust direction
	12	Vector average component wind direction
	13	Process completion flag
	L1	Time of maximum gust
	L2	Process completion time
	E1	Process error code
Assumptions:		Compass input may be from a sensor, or left as a NULL input. If a compass is defined, the compass input is used only if the field Add Compass To Vane—in the System Functions Menu of the User Interface—is set to YES. In this case, each wind direction value is adjusted with the latest compass reading. Note that wind direction is the direction from which the wind is blowing.

                        If a NULL compass is defined, the value of Add Compass To Vane has no effect.

This process performs the same calculations as the Wind Vector Average Process[340], except that it runs independently of the Sample Interval like the Free Running Average Process[341].

The period of time that this process performs its calculations is defined by Line Items #8 and #9, the processing interval and the processing offset respectively. These two Line Items are the same as Line Items #5 and #6 of the Free Running Average Process.[342]

2.10. Altimeter Setting Process

Inputs:	4	Lowest Valid Pressure (inHg).
	5	Average Ambient Temperature (C).
	6	Field Elevation (Feet)
	7	Sensor Elevation
	8	Field Pressure Exponent
	9	Altimeter Setting Exponent
	10	Inverse Altimeter Setting Exponent
	11	Height Constant
	12	Pressure Constant (inHg)
Outputs:	1	Immediate Altimeter Setting
	2	Average Altimeter Setting
	E1	Process error code
Assumptions:		Neither the Pressure Constant nor the Altimeter Setting Exponent can equal 0. and the Average Ambient Temperature cannot equal -273.15°K.

This process calculates the altimeter setting in English Units. The variables used for the calculations are listed in the following table:

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[340] Refer to Category #2, Process #1.
[341] Refer to Category #1, Process #8.
[342] Ibid.

Variable	Definition
A_S	Altimeter Setting
P_V	Lowest Valid Pressure
T_A	Ambient Temperature
H_F	Field Elevation
H_S	Sensor Elevation
σFP	Field Pressure Exponent
σAS	Altimeter Setting Exponent
σIAS	Inverse Altimeter Setting Exponent
KH	Height Constant
KP	Pressure Constant
σ	Working Exponent
P_F	Field Pressure
H_{EF}	Effective Field Height

The following calculations are made:

$$\sigma = \begin{cases} \sigma_{IAS} & ,\sigma_{IAS} > 0 \\ 1/\sigma_{AS} & ,\sigma_{IAS} \leq 0 \end{cases}$$

$$t = \sigma_{FP}\left(\frac{H_S - H_F}{T_A + 273.15}\right)$$

$$P_F = \begin{cases} P_V & ,\left|H_F - H_S\right| < 90 \\ P_V e^t & ,\left|H_F - H_S\right| \geq 90 \end{cases}$$

$$H_{EF} = \begin{cases} H_S & ,\left|H_F - H_S\right| < 90 \\ H_F & ,\left|H_F - H_S\right| \geq 90 \end{cases}$$

$$A_S = K_P\left\{\left(\frac{P_F}{K_P}\right)^{\sigma_{AS}} + K_H H_{EF}\right\}^{\sigma}$$

2.11. FAA SAWS Wind Gust Process

Inputs:	4	Average Wind Speed
	5	Current Wind Speed.
Outputs:	1	Gust for Display (Knots)
	2	10-Minute Maximum Wind Speed (Knots)
	3	10-Minute Minimum Wind Speed (Knots)
	4	Array Size
	5	Array Count
	E1	Process error code
Assumptions:		This process creates a 10-minute running array to store current wind speed data.

The following variables are used by this process:

Variable	Description
WS_{avg}	Average Wind Speed
WS_{cur}	Current Wind Speed
WS_{max}	Maximum 10-Minute Wind Speed
WS_{min}	Minimum 10-Minute Wind Speed
G_{prev}	Previous Wind Gust
G_{cur}	Current Wind Gust

Current wind speed is fed into the 10-minute running array of current wind speeds. WS_{max} and WS_{min} are determined from the 10-minute running array of current wind speeds.

Then the following calculations are performed to determine the wind gust. First, determine whether a new wind gust is available:

$$
if \begin{pmatrix} WS_{avg} \geq 9 \\ and \\ (WS_{max} - WS_{min}) \geq 10 \\ and \\ (WS_{max} - WS_{avg}) \geq 5 \end{pmatrix}
$$

then

$$G_{cur} = WS_{max}$$

If no new current gust is available, then determine whether a sustained gust is available:

$$
if \begin{pmatrix} (WS_{max} - WS_{avg}) \geq 3 \\ and \\ G_{prev} > 0 \end{pmatrix}
$$

then

$$G_{cur} = WS_{max}$$

If no new gust can be determined at all, then the current gust is zero.

2.12. NWS Running Average Wind Speed Process

Inputs:
4 Current Wind Speed (Knots)
5 Upper Wind Speed Limit (Knots)
6 Lower Wind Speed Limit (Knots)
7 Percent Valid Data
8 Bit Flag Number (1 - 31)
9 Input Out of Range Flag (1 - 31)

Outputs:
1 2-Minute Running Avg. Wind Speed
2 10-Minute Running Wind Gust
3 2-Minute Running Peak Wind Speed
4 Wind Gust Alert Flag

                              5   Peak Wind Speed Alert Flag
                              6   Data Invalid Flag
                              E1   Process Error Code
             Assumptions: This process creates 10-minute running array to store current wind speed
                                  data.

The process stores the current wind speed in the 10-minute running array if the wind speed is not a bad
sensor value and is between the specified upper & lower limits. The 2-Minute Running Average Wind
Speed is a scalar wind speed average and is calculated from data stored in the 10-minute array. The 2-
Minute Peak Wind Speed is the maximum wind speed for the past 2 minutes. The 10-Minute Running
Wind Gust is calculated using the same algorithm as the FAA SAWS Wind Gust Process[343].

The Peak Wind Speed Alert Flag is set if the 2-minute peak wind speed is greater than 25 knots.

The Wind Gust Alert Flag is set if the 2-Minute Average Running Wind Speed is greater than 20 knots
and the current wind speed is 15 knots greater than the previous current wind speed.

If the percent of data received by the process is bad and is less than the acceptable Percent Good Data, the
Data Invalid Flag is set. If a BIT Flag Number is between 1 and 31, the specified bit will also be set in
the BIT.[344]

If the current wind speed is outside the specified upper & lower limits and the Input Out of Range Flag is
set to a value between 1 and 31, the specified bit will be set in the BIT.[345]

2.13. NWS Running Vector Average Wind Direction Process

             Inputs: 4   Wind Direction
                              5   Average Wind Speed (Knots)
                              6   Minimum Wind Speed for Variability
                              7   Minimum Wind Direction for Variability
                              8   Percent Valid Data
                              9   Bit Flag Number (1 - 31)
             Outputs: 1   2-Minute Running Avg. Vector Wind Direction
                              2   Variable Wind Direction Flag
                              3   Wind Difference
                              4   Data Invalid Flag
                              E1   Process Error Code
             Assumptions: This process creates 2-minute running array to store current wind
                                  direction data.

The 2-Minute Running Average Vector Wind Direction is calculated the same as in the Running Vector
Average Wind Process[346].

The Variable Wind Direction Flag is calculated in the following manner:

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[343] Refer to Category #2, Process #11.
[344] Viewable from the BIT Process, refer to Category #3, Process #1.
[345] Ibid.
[346] Refer to Category #2, Process #2.

1. Two running averages are calculated--all the winds to the "left" and "right" of the current 2-Minute Running Average Vector Wind Direction are averaged.

2. The Wind Difference is the difference between the "left" and "right" wind direction averages.

3. If the Wind Difference is greater than the Minimum Wind Direction for Variability and the Current Average Wind Speed is greater than the Minimum Wind Speed for Variability, then the Variable Wind Direction Flag is set to one. Otherwise, it is set to zero.

2.14. FAA Running Wind Average Process

Inputs:	4	Wind Speed
	5	Wind Direction
	6	Switch Closure
	7	Percent Valid Data
Outputs:	1	Running Average Scalar Wind Speed
	2	Running Average Vector Independent Wind Direction
	3	Data Invalid Flag
	4	Data Index 1
	5	Data Index 2
	6	Data Index 3
	7	Data Index 4
	E1	Process error code
Assumptions:		This process creates 2-minute running array to store current wind direction data.

This process calculates four separate running wind averages simultaneously. Depending upon the value of the third input (Switch Closure), one of the four running wind averages is supplied:

Switch Closure	Outputted Running Wind Average (Seconds)
0	15
1	30
2	60
3	120

The calculation of the running wind average data is similar to the Running Wind Vector Average Process[347]. However, only the running average scalar wind speed and no other values are calculated other than running average independent wind direction.

3. ALARM PROCESSES CATEGORY

All alarm processes have at least one process output to indicate the status of the alarm. The process output will have a value of 1 when an alarm has been triggered or a value of 0 when no alarm condition exists. Some alarm processes can also change the electronic state of a digital output, depending upon the status of the alarm. The digital output will be high when an alarm condition exists, or it will be low when no alarm condition exists.

---

[347] Refer to Category #2, Process #1.

Unless otherwise stated, digital outputs are set high or low only when the inputs to the process toggle the alarm state. for example, if the data range process is triggered and the digital output goes high, it will remain high until the alarm state is untriggered. Further, the digital output will only go high again when the alarm state is triggered again. The process output that indicates the alarm status will be set to 1 when the inputs to the process trigger an alarm state. The process output will remain at 1 until the end of the sample interval time. Generally, if the alarm is set and reset within the same sample interval, the following events will occur:

- The process output will be 0 (zero) until the alarm is set

- The process output will be 1 (one) when the alarm is triggered, and it will remain so until the end of the sample interval time

- The process output will remain 1 (one) into the next sample interval if the alarm condition still exists

- Only when the inputs to the process untrigger the alarm condition will the process output go to 0 (zero)

This means that if the alarm is set and reset within a sample interval time, the process output will be 0 until the alarm is first set, 1 from that point until the end of the sample interval, and 0 from the start of the next sample interval.; 1 from that point until the end of the sample interval; and 0 from the start of the next sample interval. The reason for this is that the output message will always notify the user that an alarm has occurred within the sample interval.

3.1.   Built-In-Test (BIT) Process

    Inputs: None
    Outputs: L1 32-bit value of the
               E1 Process Error Code

Various internal system functions or user-defined processes are used to set individual bits in the global BIT value. Up to 31 bits can be assigned in the global BIT value (the 32nd bit is used internally by the ZENO®-3200, and is not accessible to the user). The process clears the global BIT value after it has been read at the end of the Sample Duration.

The following list of bit flags are pre-assigned for system wide operation

1. System reset

2. Real-time clock suspect

3. Data logging memory initialized

4. Serial device communication failure

5. EEPROM suspect

6. 18-bit analog to digital converter suspect

7. 12-bit analog to digital converter suspect

8. Clock adjustment made due to temperature compensation

These flags may be OR-ed with other warnings, and flags 8 to 31 set, by user processes Data Range, Alarm and Data Time-out.

3.2.   Data Range Process

Inputs:	4	Any sensor or process output
	5	Upper limit (User Value)
	6	Lower limit (User Value)
	7	User parameter BIT bit number (1 to 31, 0 = disabled)
	8	Valid Range (0 = between, 1 = beyond)
	9	Limits (0 = inclusive, 1 = exclusive)
Outputs:	1	Status
	0	data in range
	1	data outside the specified range.
	E1	Process Error Code
		Also sets a bit flag in the global BIT value.
Assumptions:	None	

This process reads the input data from referenced by Line Item #4 and compares it to the range limits as specified in Line Items #5, #6, #8 and #9. This is summarized in the following table:

Valid Range (Line Item #8)	Limits (Line Item #9)	Action Performed by Process
0 = between	0 = inclusive	If the input data is between the Upper Limit and Lower Limit or equal to either limit, the data is valid; otherwise, it's invalid.
	1 = exclusive	If the input data is between the Upper Limit and Lower Limit but not equal to either limit, the data is valid; otherwise, it's invalid.
1 = beyond	0 = inclusive	If the input data is greater than the Upper Limit or less than the Lower Limit or equal to either limit, the data is valid; otherwise, it's invalid.
	1 = exclusive	If the input data is greater than the Upper Limit or less than the Lower Limit and not equal to either limit, the data is valid; otherwise, it's invalid.

If the data is valid, the data output #1 is set to zero. If the data is invalid, the data output #1 is set to one and the bit flag as specified in Line Item #7 is set in the global BIT value if Line Item #7 is greater than zero.

3.3.   Alarm Process

Inputs:	4	Any sensor or process output
	5	Alarm set-point
	6	Alarm Reset
	7	BIT bit number (1 to 31, 0 = disabled)
	8	Digital I/O port number (18 to 23)
	9	Second digital I/O port number (18 to 23)
	10	Switched Voltage
Outputs:	1	Status
	0	no alarm condition
	1	alarm condition
	E1	Process Error Code
		Sets a bit flag in the global BIT value
		Activates a digital output (5 VDC) if there is an active alarm condition or a switched voltage

Assumptions: If the Alarm Reset value is less than the Alarm Set-point value then the alarm is activated when the data value becomes greater than the Alarm Set-point, and deactivated when it goes below the Alarm Reset
If the Alarm Reset value is greater than the Alarm Set-point value then the alarm is activated when the data value drops below the Alarm Set-point, and deactivated when it returns above the Alarm Reset value

This process reads the data input, compares it to the Alarm Set-point and Alarm Reset values, and activates or deactivates the alarm status accordingly.

If the alarm is set, the corresponding bit in the global BIT value will be set.[348] Any digital output specified by Line Items #8 or #9 will be set HIGH. Any switched voltage specified by Line Item #10 will be turned on.

3.4.   Data Time-out Process

Inputs: 4   Any sensor or process output
                     5   Time-out Interval (seconds)
                     6   Minimum Delta Change
                     7   BIT bit number (1 to 31, 0 = disabled)
Outputs: 1   Status
                          0   data has changed within the time interval
                          1   data has not changed
                     E1   Process Error Code
Assumptions: None

The Data Time-out Process is an excellent tool to check for faulty sensors or malfunctioning system components because the process observes how much the input data changes over time:

- The input data is read and compared to a baseline reading.

- If the difference between the two values is greater than the Minimum Delta Change value, then a new baseline level is established as the current data reading, and the time elapsed counter is reset.

- Otherwise, if the difference is less than the Minimum Delta Change, then the time elapsed counter is compared to the Time-out Interval. If the time elapsed is greater than the Time-out Interval then the output status is set to 1 and a bit flag may be set in the global BIT value[349].

This process is similar to the Static Alarm Process.[350]

3.5.   Alarm Reset Process

Inputs: 4   Digital I/O port number (18 to 23)
                     5   Second digital I/O port number (18 to 23)
Outputs: E1   Process Error Code
Assumptions: A reset button provides a switch closure input to channel 24, the IRQ4 channel; this cannot coexist with a tipping bucket sensor which requires the same input channel

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[348] Refer to Category #3, Process #1.
[349] Refer to Category #3, Process #1.
[350] Refer to Category #3, Process #15.

This process is used to acknowledge (set to low) an alarm set by either the Alarm Process[351] or the Two-Range Alarm processes[352]. An alarm can be acknowledged at any time, independent of the Sample Interval. Once acknowledged, the alarm will not be re-enabled until a new alarm condition exists.

3.6.   Two-Range Alarm Process

Inputs:	4	Any sensor or process output representing a high/low threshold
	5	Any sensor or process output upon which the alarm is triggered
	6	Two-Range Alarm Constants Process Record Number
	7	BIT bit number (1 to 31, 0=disabled)
	9	Digital I/O port number (18 to 23)
	10	Digital I/O port number (18 to 23)
Outputs:	1	Status
		0 no alarm condition
		1 alarm condition
	E1	Process Error Code
		Sets a bit flag in the global BIT value
		Activates a digital output (5 VDC) if there is an active alarm condition
Assumptions:		The process number specified as input number 4 must be of the type Two-Range Alarm Constants

This process is described in more detail under the Two-Range Alarm Constants Process.[353]

3.7.   Two-Range Alarm Constants Process

Inputs:	4	Threshold select decision point
	5	First upper limit
	6	First lower limit
	7	Second upper limit
	8	Second lower limit
Outputs:	E1	Process Error Code

This process, in conjunction with a Two-Range Alarm Process[354], is used to set an alarm in cases where there are two distinct alarm thresholds.

The Two-Range Alarm Process and the Two-Range Alarms Constants process are separated to allow more than one Two-Range Alarm Process to access the same constants.

Line Item #4 of this process defines the threshold that selects which set of limits to use: the first set upper and lower limits or the second set of upper and lower limits. The following table summarizes how the constants defined in this process apply to a Two-Range Alarm Process[355].

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[351] Refer to Category #3, Process #3.
[352] Refer to Category #3, Process #6.
[353] Refer to Category #3, Process #7.
[354] Refer to Category #3, Process #6.
[355] Ibid.

Value Referenced in Line Item #4 of Two-Range Alarm	Value Referenced in Line Item #5 of Two-Range Alarm Process
Below the Threshold defined in Line Item #4 of the Two-Range Alarm Constants Process	Compared to first set of limits (Line Items #5 and #6) of the Two-Range Alarm Constants Process
Above the Threshold defined in Line Item #4 of the Two-Range Alarm Constants Process	Compared to second set of limits (Line Items #7 and #8) of the Two-Range Alarm Constants Process

If the value referenced by Line Item #5 of the Two-Range Alarm Process[356] goes beyond the selected limits, then the alarm condition will be set in the Two-Range Alarm Process.

Consider an example in which a system used to monitor wind loading on power lines. Damage to the power lines may be caused by high wind speeds, as well as relatively low wind speeds if the temperature is below freezing and the power lines are covered in ice. In this example, the ZENO®-3200 would be configured as follows:

- A temperature sensor would be defined as the input for Line Item #4 of the Two-Range Alarm Process.

- The threshold select decision point, the Line Item #4 of the Two-Level Alarm Constants Process, would be set to 32ºF.

- A wind speed sensor would be defined as the input for Line Item #5 of the Two-Range Alarm Process.

- The First Upper Limit, Line Item #5 of the Two-Level Alarm Constants Process, would define the maximum allowable wind speed for below-freezing temperatures.

- The First Lower Limit, Line Item #6 of the Two-Level Alarm Constants Process, would be set to a negative number since no wind would not cause a problem.

- The Second Upper Limit, Line Item #7 of the Two-Level Alarm Constants Process, would define the maximum allowable wind speed for above-freezing temperatures.

- The Second Lower Limit, Line Item #8 of the Two-Level Alarm Constants Process, would be set to a negative number since low winds would not cause a problem with above-freezing temperatures.

3.8.   Missing Sensor Data Process

Inputs:	4	Sensor process from an SDI-12 sensor
	5	Default data value
	6	Digital I/O port number (18 to 23)
Outputs:	1	Status
		0 no alarm condition
		1 alarm condition
	2	Sensor data value
	E1	Process Error Code
Assumptions:		Input number 1 is from an SDI-12 sensor
		Activates a digital output (5 VDC) if there is an active alarm condition.

When the ZENO®-3200 is unable to collect data from a Sensor Record, then all data outputs for that Sensor Record are set to Bad Sensor Values (BSVs)[357]. for floating point values, the BSV is the number -1,000,000.

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[356] Ibid.
[357] Refer to Section 10.4.5.

The Missing Sensor Data Process allows the setting of an alarm condition when the inputted data value is set to a BSV and allows replacement of a BSV with a substitute value.   The first data output from this process is the alarm condition, which is set to one if the inputted data value is a BSV; otherwise, it is set to zero. The second data output is the inputted data value (Line Item #4) when it is NOT a BSV; otherwise, it is the substitute, default value specified by Line Item #5.

3.9.   Multiple Alarm Process

Inputs:	4-11	Data inputs, preferably from other alarm processes (D)	
	12	Number of input alarms required for output alarm (U)	
	13	Digital I/O port number, 18 to 23 (U)	
	14	Digital I/O port number, 18 to 23 (U)	
	15	Output Message Number, 1 to 4 (U)	
	16	Log Alarm Message, 0 = no or 1 = yes (U)	
Outputs:	1	Status	
		0	no alarm condition
		1	alarm condition
	E1	Process Error Code	
Assumptions:		Input numbers 1 through 8 are alarm inputs	
		Activates a digital output (5 VDC), and initiates modem dial-out, on certain combinations of alarm conditions (see below)	

The Multiple Alarm Process allows the user to define an alarm condition that is the result of a combination of conditions. Up to eight individual input values can be referenced by Line Items #4 through #11. Each of the input values is interpreted in a Boolean fashion: 1) no condition exists if the input value is zero or 2) the condition does exist when the input value is non-zero. Line Item #12 defines how many (*N*) existing conditions from Line Items #4 through #11 constitute an alarm condition.

Here is an example of four separate conditions:

- Let Line Item #4 reference an alarm process triggered when the temperature goes below freezing

- Let Line Item #5 reference an alarm process triggered when the wind speed exceeds 25 knots

- Let Line Item #6 reference an alarm process triggered when the air temperature drops below the dewpoint

- Let Line Item #7 reference an alarm process triggered when the barometric pressure drops below 30 inches of mercury

To continue the example, an alarm condition does not need to be reported when only one or two of the listed conditions exists; but an alarm condition does need to be reported if at least three conditions exist simultaneously. Therefore, Line Item #12 would be set to 3 and the Multiple Alarm Process will be triggered when at least three of the four conditions is present.

When the Multiple Alarm Process determines that an alarm condition exists, data output #1 will be set to one; otherwise, it is set to zero.

The digital outputs, switched voltage and logging an alarm message[358] are set slightly differently from data output #1. If less than *N* of the input values is non-zero, then the digital outputs (if defined) and switched voltage (if defined) are set low. The first time that *N* or more input alarms are non-zero, if

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[358] Refer to Section 11.3.

defined, the digital outputs and switched voltage are set high and an alarm message will be transmitted and/or logged. This is repeated if an input alarm is set to non-zero that was previously set to zero and *N* or more of the input values are non-zero.

If this process instructs ZENOSOFT® to transmit an alarm message, it will follow the same procedure that is used in the Dial-out Alarm Process.[359]

3.10. Dial-out Alarm Process

Inputs:	4	Data Input (D)
	5	Alarm threshold (U)
	6	Message number, 0=disabled or 1-4 (U)
	7	Log Alarm Message, 0=no or 1=yes (U)
Outputs:	1	Status
		0 no alarm condition
		1 alarm condition
	E1	Process Error Code
Assumptions:		Initiates a modem dial-out when the input first exceeds its threshold (see below)

When the referenced input data value in Line Item #4 moves from below to above the defined threshold level defined in Line Item #5, ZENOSOFT® will transmit the specified output message defined in Line Item #6. If no output message number is defined in Line Item #6, no output message will be transmitted. If Line Item #7 is set to 1 and an output message is defined in Line Item #6, ZENOSOFT® will also log the output message defined in Line Item #6.

If the output message number is specified on a communications port that is configured to connect to a modem, ZENOSOFT® will initiate a dial-out on the modem prior to transmitting the output message.[360] Hence the name, Dial-out Alarm Process.

If the output message number is specified on a communications port that is a direct terminal connection, the ZENOSOFT® will transmit the message directly to the communications port with no dial-out.[361]

If the output message number is specified on a communications port that is connected to a GOES transmitter, the output message will be sent to the GOES transmitter as a random message.[362]

3.11. Incremental Change Alarm Process

Inputs:	4	Any sensor or process input
	5	Incremental change alarm threshold
	6	Decrease Baseline flag (0=no, 1=yes)
Outputs:	1	Immediate alarm state (0=off, 1=on)
	2	Alarm occurred in this interval? (0=off, 1=on)
	3	Increment since last alarm
	E1	Process Error Code

---

[359] Refer to Category #3, Process #10.
[360] Refer to Section 11.3.2.
[361] Refer to Section 11.3.
[362] Refer to Section 11.3.3.

Assumptions: May be used for a weighed bucket rain sensor

The Incremental Change Alarm Process triggers indicates an alarm condition when the inputted data value (x_i), referenced in Line Item #4, changes by an amount that exceeds the change threshold value ($dx_{threshold}$) referenced in Line Item #5.

The process does this by initially storing the first data value (x_0) as a baseline value (x_{base}) when ZENOSOFT® begins data collection. The difference (dx) between each successive new data value and the baseline value is compared with the change threshold value:

$$dx = x_i - x_{base}$$

$$alarm = \begin{cases} 1, & dx \geq dx_{threshold} \\ 0, & dx < dx_{threshold} \end{cases}$$

$$x_{base} = \begin{cases} x_i, & alarm \equiv 1 \\ unchanged, & alarm \equiv 0 \end{cases}$$

The original baseline value is replaced by the current inputted value when an alarm is triggered.

Data output #1 will remain set to one only if successive inputted data values continue to exceed the new baseline threshold difference. Data output #2 will remain set to one throughout the Sample Interval that the alarm was triggered. Data output #3 reports the difference dx.

If Line Item #6 is set to one and the current inputted value referenced by Line Item #4 is below the stored baseline value, ZENOSOFT® will set the baseline value to the current inputted value. If Line Item #6 is set to zero, this does not occur.

As an example, a weighed-bucket rain sensor can lose contents due to evaporation after a period of rain. If Line Item #6 is set to one, the process will immediately detect new rainfall; otherwise, rainfall will only be detected when the weight of water exceeds the amount lost due to evaporation from the previous rain cycle.

3.12. Error Checking Alarm Process

Inputs:	4	BIT flag number (1 – 31)
Outputs:	1	Number of processes reporting errors
	2-6	First 4 process record numbers of processes reporting errors
	L1-L4	First 4 process error codes of processes reporting errors
	E1	Process error code
Assumptions:	None.	

Called by ZENOSOFT® only at the end of the Sample Duration, the Error Checking Alarm Process checks the status of each configured Process Record's error code (data output E1).[363] It counts and reports the number of configured Process Records that indicate error codes and lists up to four Process Records that are reporting errors as well as their error codes.

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[363] Refer to Section 10.4.5.

The Error Checking Alarm Process is an excellent tool for discovering problems with data collection and issues with timing.[364] Often, this process is used only during the development of a complex configuration to work out errors within the configuration.

3.13. Timed Event Process

Inputs:	4	Digital output channel (0 or 18 – 23)
	5	Timed event on interval (xxx:xx:xx)
	6	Timed event on duration (xxx:xx:xx)
	7	Start of first event (xx/xx/xx xx:xx:xx)
Outputs:	1	Boolean state (0 = off, 1 = on)
	E1	Process error code
Assumptions:		Inputs 2 through 4 are entered and displayed as time values or as date & time, but are stored internally and in configuration files as seconds after midnight, 1/1/1970

The Timed Event Process is used to control the state of a data output and optional digital output on a regularly timed basis. It operates similarly to the digital output that is controlled from the Digital Control Menu,[365] but can be used to directly affect other Process Records by using its data output as an input to other Process Records.

Line Items #5, #6, and #7 operate in essentially the same manner as Line Items #1, #2, and #3 of the Digital Control Menu.[366] The beginning of the first Event-on Interval, defined by Line Item #5, is set by Line Item #7, the Start of the first event. The duration of the Event-on Interval is set by Line Item #6. During the Event-on Interval, data output #1 is set to one and the digital output channel specified in Line Item #4 will be turned on if one is specified. Otherwise, data output #1 is set to zero and the digital output channel is kept off if one is specified.

More than one Timed Event Process can be created in a single configuration and each one can control a different digital output channel.

> **Coastal Environmental Systems does NOT recommend configuring more than one Process Record to control the same digital output channel.**

3.14. One-shot Daily Timed Event Process

Inputs:	4	When Timed Even Occurs (seconds after midnight)
	5	Timed event on duration (seconds)
	6	Digital Output Channel
Outputs:	1	Boolean state (0 = off, 1 = on)
	E1	Process error code
Assumptions:		Inputs 1 and 2 are entered as data inputs. Constants can be used. Their values are in seconds after midnight of the same day

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[364] Refer to Section 12.1.
[365] Refer to Section 6.6.4.
[366] Ibid.

The One-shot Daily Timed Event Process is similar to the Timed Event Process[367], except that it is designed to operate only once every 24 hours

Data output #1 will be set to one when the current time is past the start of the first event, as defined in Line Item #4, and will remain so for as long as specified by Line Item #5. Otherwise, the date output is set to zero. The on-event only occurs only once in a 24-hour period as defined by the ZENO®-3200's internal clock.

If the digital output channel, Line Item #6, is set to a value between 18 and 23, then the specified digital output channel will be set high when the output of the process is high. Otherwise, it will be set low.

3.15.   Static Alarm Process

Inputs:		4	Data
		5	Threshold
		6	Timeout for Threshold
		7	BIT Flag Number (1 - 31)
Outputs:		1	Immediate Alarm State (0 = off, 1 = on)
		2	Interval Alarm State (0 = off, 1 = on)
		3	Baseline Value
		4	Seconds Remaining Before Timeout
		E1	Process error code

The Static Alarm Process monitors the data referenced by Line Item #4. It verifies that the data is changing by an amount greater than the threshold defined by Line Item #5 and within the time period as defined by Line Item #6. The alarm is set to one if the data input value does not change by an amount greater than the specified threshold and within the given time period.

This process operates similarly to the Data Time-out Process[368], but it provides extra information with data outputs #2, #3 and #4.

4.   SPECIAL SENSOR PROCESSES CATEGORY

4.1.   NTC Thermistor Process

Inputs:		4	Any sensor or process value (read below)
		5	A-coefficient for Steinhart-Hart equation
		6	B-coefficient for Steinhart-Hart equation
		7	C-coefficient for Steinhart-Hart equation
		8	Resistance value for R2
		9	Upper Limit
		10	Lower Limit
		11	BIT flag number (1 - 31)
Outputs:		1	The average temperature value
		2	The most recent temperature value

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[367] Refer to Category #3, Process #13.
[368] Refer to Category #3, Process #4.

<blockquote>

E1 Process Error Code

Assumptions: Sensor data is scaled to show a voltage ratio of V-measured divided by V-excitation. The linear scale factor in the sensor input (line item 14) should be set equal to 1 / V-excitation

</blockquote>

The data value inputted into Line Item #4 must represent the voltage ratio produced by a voltage divider circuit where R1 is a thermistor. The sensor scale coefficient should multiply the sensor reading by the inverse of the excitation value.

This process converts the non-linear sensor voltage ratio into a resistance value for the NTC thermistor and applies the Steinhart-Hart thermistor equation to the resistance value to derive a temperature value:

$$\frac{1}{T} = A + B \ln R + C(\ln R)^3 .$$

Coefficients A, B, C and R in the Steinhart-Hart thermistor equation correspond to Line Items #5 through #8 respectively. Values for these coefficients for the YSI 44034 Thermistor are described in Appendix C.

The process further calculates an average temperate across the Sample Duration after applying the Steinhart-Hart thermistor equation. Data output #1 contains the average temperature as calculated across the Sample Duration. Data output #1 contains the immediate temperature for the most recent data referenced by Line Item #4.

Line Items #9 through #11 are used in the event that a valid temperature range needs to be checked without having to add an additional alarm process. If the average temperature calculated by this process exceeds the upper and lower limits as specified in Line Items #9 and #10 respectively, ZENOSOFT® will set the bit in the Global BIT[369] as specified in Line Item #11.

4.2. Paroscientific Barometer Process

Inputs:
4   Temperature period in micro-seconds
5   Pressure period in micro-seconds
6   U0 (Paroscientific equation coefficients from calibration sheet)
7   Y1
8   Y2
9   C1
10 C2
11 C3
12 D1
13 T1
14 T2
15 T3

Outputs:
1   Average pressure value in mbar
2   Average temperature value in degrees Celsius
3   Immediate pressure value (last value read)
4   Immediate temperature value (last value read)
E1 Process Error Code

---

[369] Refer to Category #3, Process #1.

Assumptions: This process is intended for the Paroscientific barometer model 216B-101

This process takes the pressure (**T**) and temperature (**U**) period measurements, applies this data to the Paroscientific third order logarithmic equation to derive the immediate temperature (**Temp**) and pressure

$$U_1 = U - U_0$$

$$C = C_3 U_1^2 + C_2 U_1 + C_1$$

$$D = 1 - D_1$$

$$T_4 = 1 - \left(\frac{T_3 U_1^2 + T_2 U_1 + T_1}{T} \right)^2$$

$$P = 68.965517 \cdot CDT_4^2$$

$$Temp = Y_1 U_1 + Y_2 U_1^2$$

(**P**) values. The coefficients listed in Line Items #6 through #15 are used as follows:

The average temperature and average pressure values are calculated from their respective immediate values across the Sample Duration.

4.3.   Thermocouple Process

Inputs: 4   Thermocouple voltage from any sensor, process or constant output.
                     5   Thermocouple type code (0 = J, 1 = K, 2 = T)
Outputs: 1   Average temperature in ºC
                     2   Most recent temperature in ºC
                     E1   Process error code
Assumptions: The data inputted into Line Item #4 MUST BE in volts from a thermocouple. The process converts the value in volts to a value in microvolts (μV)

The Thermocouple Process converts the extremely nonlinear voltage supplied by a thermocouple into an equivalent temperature. The three most common types of thermocouples are supported by this process: Type-J, Type-K, and Type-T.

$$T \approx a_9 V^9 + a_8 V^8 + a_7 V^7 + a_6 V^6 + a_5 V^5 + a_4 V^4 + a_3 V^3 + a_2 V^2 + a_1 V + a_0$$

To convert the nonlinear thermocouple voltage into temperature, a ninth-order polynomial is used:

The above polynomial approximation is only good over a limited range of voltages. Further, for different voltage ranges, different values are used for the polynomial coefficients. The following table describes the valid range of voltages in microvolts. Different coefficients are used for the polynomial equation for different voltage ranges.

Thermocouple Type	Lowest Valid Voltage (µV)	First Midrange Voltage (µV)	Second Midrange Voltage (µV)	Highest Valid Voltage (µV)
J	-8095	0	42919	69553
K	-5891	0	20644	54886
T	-5603	0	N/A	20872

> **For any inputted voltage that is beyond the valid voltage range, the Thermocouple Process will report the immediate temperature as a BSV.[370]**

The coefficients that are used in the polynomial equation for the thermocouple type and voltage range are listed in the following table:

Type	Range	Coefficients									
		A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
J	1	0	-8.3823321e-29	-2.3963370e-24	-2.8131513e-20	-1.7256713e-16	-5.9086933e-13	-1.0752178e-9	-1.2286185e-6	1.9528268e-2	0
	2	0	0	5.099890e-31	-5.344285e-26	3.585153e-21	-2.549687e-16	1.036969e-11	-2.001204e-7	1.978425e-2	0
	3	0	0	0	0	4.73886084e-21	-1.43033468e-15	1.70276630e-10	-9.94773230e-6	0.3.005436 84	-3113.5818 7
L	1	0	-5.1920577e-28	-1.0450598e-23	-8.6632643e-20	-3.7342377e-16	-8.9773540e-13	-1.0833638e-9	-1.1662878e-6	2.5173462e-2	0
	2	-1.052755e-35	1.057734e-30	-4.413030e-26	9.804036e-22	-1.228034e-17	8.315270e-14	-2.503131e-10	7.860106e-8	2.508355e-2	0
	3	0	0	0	-3.110810e-26	8.802193e-21	-9.650715e-16	5.464731e-11	-1.646031e-6	4.830222e-2	-131.8058
T	1	0	0	1.2668171e-24	2.0241446e-20	1.3304473e-16	4.2527777e-13	7.9018692e-10	-2.1316967e-7	2.5949192e-2	0
	2	0	0	0	-7.293422e-25	6.048144e-20	-2.165394e-15	4.637791e-11	-7.602961e-7	2.592800e-2	0

---

[370] Refer to Section 10.4.5.

All immediate temperatures calculated by this process are averaged to provide an average temperature across the Sample Duration. Any immediate temperature that is a BSV[371] due to an out-of-range voltage is not included in the average calculations.

4.4.   Raw GPS to Real Number Process

Inputs:	4	Latitude from GPS sensor (any sensor, process or constant input)
	5	Longitude from GPS sensor (any sensor, process or constant input)
Outputs:	1	Latitude as a real number
	2	Longitude as real number
	E1	Process error code
Assumptions:		It is assumed that the inputs to the process are taken directly from the latitude & longitude outputs from a GPS sensor

This process converts raw GPS latitude and longitude data from a GPS sensor into real-number values. Both the raw latitudinal and longitudinal values from a GPS sensor have the format "DDDMM.mmmm" where "D" is degrees, "M" is minutes and "m" is decimal minutes.[372]

The outputs from this process are both of the form "DDD.dddd" where "D" is in degrees and "d" is decimal degrees.

4.5.   UV Biometer Process

Inputs:	4	UV biometer temperature in ºC (D)
	5	UV biometer radiation in MED/hr (D)
Outputs:	1	Average temperature corrected radiation in MED/hr
	2	Most recent temperature corrected radiation in MED/hr
	E1	Process Error Code
Assumptions:		None

This process calculates the temperature-corrected radiation for an Ultraviolet (UV) Biometer using the following equation:

$$R_c = \frac{R}{1 + 0.01\,(T - 25)}$$

R_C is the temperature-corrected radiation, R is the inputted UV Biometer radiation and T is the UV Biometer temperature.

4.6.   PIR Temperature Correction Process

Inputs:	4	Dome temperature in ºC (any sensor, process or constant output)
	5	Case temperature in ºC (any sensor, process or constant output)

---

[371] Refer to Section 10.4.5.
[372] Refer to Section 10.3.4.

	6	Thermopile output (any sensor, process or constant output)
	7	Thermopile surface emissivity
	8	Constant K
Outputs:	1	Average corrected PIR
	2	Most recent PIR
	E1	Process error code
Assumptions:	None.	

$$PIR \; = \; E \; + \; \sigma \left(\varepsilon T_C^{\,4} \; - \; K \left(T_D^{\,4} \; - \; T_C^{\,4} \right) \right)$$

This process calculates the temperature-corrected PIR using the following equations:

PIR is the temperature-corrected PIR, E is the thermopile output, σ is the Stefan-Boltzmann constant[373], *K* is the thermopile surface emissivity, T_C is the case temperature and T_D is the dome temperature.

4.7.   Four-Pole Switch Process

Inputs:	4	Switch Pole 1
	5	Switch Pole 2
	6	Switch Pole 3
	7	Switch Pole 4
	8	Data1
	9	Data2
	10	Data3
	11	Data4
Outputs:	1	Selected Data
	2	Closed Switch (1 to 4)
	E1	Process error code
Assumptions:	Only one switch pole can be closed at one time. Fewer than 4 can be specified for this process, but must have matching data for each pole specified. An open switch has an input of zero, a closed switch has a non-zero input value.	

This process acts like a multiplexer by outputting the corresponding data (from Line Items #8 through #11) for the corresponding closed switch (from Line Items #4 through #7) as well as the switch number (1 to 4).

5.   ARITHMETIC PROCESSES CATEGORY

5.1.   U-V Vectors To Magnitude-Direction Process

Inputs:	4	U-vector (D)
	5	V-vector (D)
Outputs:	1	Vector magnitude
	2	Vector direction

---

[373] Refer to Appendix A.

E1 Process Error Code
Assumptions: None

This process takes the square root of the squares of the two input values to produce the vector magnitude (M), and takes the arc-tangent of (V/U) to produce the vector direction (D):

$$M = \sqrt{U^2 + V^2}$$

$$D = \arctan\left(\frac{V}{U}\right)$$

5.2.   Add Data & Constant Process

Inputs: 4 Augend (D)
                    5 Constant Addend (U)
Outputs: 1 The sum of the augend and addend
                    E1 Process Error Code

5.3.   Add Two Data Values Process

Inputs: 4 Augend (D)
                    5 Addend (D)
Outputs: 1 The sum of the augend and addend
                    E1 Process Error Code

5.4.   Subtract Data Values Process

Inputs: 4 Minuend (Any sensor or process output)
                    5 Subtrahend (Any sensor or process output)
Outputs: 1 The difference between minuend and subtrahend
                    E1 Process Error Code

5.5.   Multiply Data & Constant Process

Inputs: 4 Multiplicand (D)
                    5 Constant Multiplier (U)
Outputs: 1 The product of multiplying the multiplicand with the constant
                       multiplier.
                    E1 Process Error Code

5.6.   Multiply Two Data Values Process

Inputs: 4 Multiplicand (D)
                    5 Multiplier (D)
Outputs: 1 The product of multiplying the multiplicand with the constant
                       multiplier
                    E1 Process Error Code

5.7.   Divide Two Data Values Process

Inputs: 4   Dividend (D)
                     5   Divisor (D)
Outputs: 1   The quotient of dividing the dividend by the divisor
                     E1 Process Error Code

5.8.   Quadratic Process

Inputs: 4   Data X (D)
                     5   Quadratic coefficient A (U)
                     6   Quadratic coefficient B (U)
                     7   Quadratic coefficient C (U)
Outputs: 1   The result y calculated from quadratic equation $y = Ax^2 + Bx + C$
                     E1 Process Error Code

5.9.   Invert Data Value Process

Inputs: 4   Data X   (D)
Outputs: 1   The result from inverting the input data value (1/X)
Assumptions: If Data X is 0, the result will be set to a Bad Sensor Value.
                     E1 Process Error Code

5.10.   Raise Data To Power Process

Inputs: 4   Data X   (D)
                     5   Constant Exponent Value Y (U)
Outputs: 1   The results from raising the Data X to the exponential value, X^Y
                     E1 Process Error Code

5.11.   Add Multiple Data Values   Process

Inputs: 4-11   Data1 through Data8 (All D)
Outputs: 1   The numerical sum of all 8 inputs
                     E1 Process Error Code

5.12.   Sixth-order Polynomial Process

Inputs: 4   Data X (D)
                     5   Coefficient a_6 (U)
                     6   Coefficient a_5 (U)
                     7   Coefficient a_4 (U)
                     8   Coefficient a_3 (U)
                     9   Coefficient a_2 (U)
                     10   Coefficient a_1 (U)
                     11   Coefficient a_0 (U)
Outputs: 1   The value of the sixth-order polynomial applied to x
                     E1 Process Error Code

This process calculates the sixth-order polynomial $a_6x^6 + a_5x^5 + a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0$.

5.13. Conditional Select Process

Inputs:	4	Control Data C (D)
	5	Data X→Output if Control=0 (D)
	6	Data Y→Output if Control<0 (D)
	7	Data Z→Output if Control>0 (D)
Outputs:	1	Data X if C=0, or Data Y if C<0; or Data Z if C>0.
	E1	Process Error Code

This process can be used as a logical IF statement. It allows you to choose between 2 or 3 calculated data values. for example, if the control input is the temperature in ºC, you can use this process to calculate a meteorological quantity differently for positive and negative inputs.

5.14. Boolean Combine Data & Constant Process

Inputs:	4	Data (D)
	5	Constant (32-bit User Input in hexadecimal)
Outputs:	L1	AND of both inputs
	L2	OR of both inputs
	L3	XOR of both inputs
	L4	NAND of both inputs
	L5	NOR of both inputs
	L6	XNOR of both inputs
	E1	Process error code
Assumptions:	None	

5.15. Boolean Combine Data Process

Inputs:	4	Data1 (D)
	5	Data2 (D)
Outputs:	L1	AND of both inputs
	L2	OR of both inputs
	L3	XOR of both inputs
	L4	NAND of both inputs
	L5	NOR of both inputs
	L6	XNOR of both inputs
	E1	Process error code
Assumptions:	None	

5.16. Data Rounding Process

Inputs:	4	Data
	5	Decimal Places
	6	Rounding Factor
Outputs:	1	Rounded Data
	E1	Process error code
Assumptions:	None.	

The data is rounded to the specified number of decimal places and specified rounding factor. A rounding factor of 1 is standard rounding.

6. OUTPUT AND CONTROL PROCESSES CATEGORY

6.1. DAC Analog Output Process

Inputs	4	Any sensor or process output
	5	Maximum data limit, corresponding to 5 V output
	6	Minimum data limit, corresponding to 0 V output
	7	DAC number (1 - 36)
	8	DAC update code 0 - 1
		0 Output voltage changes at the end of the sample period
		1 Output voltage changes whenever the input value changes
Outputs	1	Number of DAC counts
	E1	Process Error Code
Assumptions		The optional Digital to Analog expansion board must be present.

The output voltage will be scaled so that the minimum and maximum data limits correspond to 0 and 5 V respectively.

The minimum configuration is for four DACs on a single board. DACs 1 through 8 will be on the first expansion board, 9 - 16 on the second, and so on. If you program a DAC that is not present, you will be warned when you exit from the Zeno Program Menu or save the configuration to EEPROM. The following set of channels represents the maximum configuration:

- DAC channels 1 through 8 on board 1

- DAC channels 10 through 17 on board 2

- DAC channels 19 through 26 on board 3

- DAC channels 28 through 35 on board 4

Channels 9, 18, 27 and 36 are reserved for the AC excitation, which is a separate option that must be factory-configured.

E. CONFIGURATION FILE CONTENTS

Coastal Environmental Systems

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1. CONFIGURATION FILE DEFINITION

The configuration file is a text-based file generated by the ZENO®-3200. It is designed to be readable by itself or by other ZENO®-3200s. It contains all the information necessary to configure a ZENO®-3200.

Each line of the configuration file begins with an Identifier (ID) code. The IDs are summarized in the following table.

ID	Description	
*	Remark. (The line containing the ZENOSOFT version number that generated the configuration file is used for downward compatibility.[374])	
PARAM*n*	List of up to 10 run-time parameters beginning with parameter number "*n* * 10".	
CONSTANT*n*	List of up to 10 constants beginning with constant number "*n* * 10".	
REPEAT*n*	List of up to 10 repeater remote addresses beginning with remote address number "*n* * 10".	
GSI	A Command Line from a General Serial Script Record definition. These are listed sequentially according to Command Line number and Script Record number.	
SENSOR	A Sensor Record definition.	These are listed sequentially according to Record Number. Order of values corresponds to their Line Item number position in the User Interface menus.
PROCESS	A Process Record definition.	
DATA	A Data Output Record definition.	
EOF	End of file.	

> **In general, Coastal Environmental Systems does not recommend that you edit any configuration file directly, but there may be times when this is necessary.**

---

[374] Refer to Section 9.4.

---

2.   CONTENTS OF RUN-TIME PARAMETER LINES

For interested users, the following is a brief line-by-line description of the run-time parameters contained in the "PARAM" lines of a configuration file.

> **Coastal Environmental Systems strongly recommends not modifying any run-time parameters that are italicized below because they are not generally accessible and they are not intended to be changed by the user.**

- Lines beginning with an asterisk * are treated as comments.

> **The only exception to this is the second line, containing the firmware version: this version number is read and used by the ZENO®-3200 for downward compatibility.[375]**

- The line beginning PARAM1 contains the following information:
  - Sample interval time, in seconds
  - Sample time offset, in seconds
  - Sample duration time, in seconds
  - Sensor timing loop #2 in half-seconds
  - Sensor timing loop #3 in half-seconds
  - Sensor timing loop #4 in half-seconds
  - Primary unit ID
  - Secondary unit ID
  - COM1 baud rate
  - COM2 baud rate
- The line beginning PARAM2 contains the following information:
  - COM3 baud rate
  - COM1 port type (0=RS232, 2=RADIO, 3=TWO-WAY RADIO, 5=RS232H)
  - COM2 port type (0=RS232, 1=RS485, 4=GOES, 5=RS232H, 6=CGOES)
  - COM3 port type (0=RS232, 1=RS485, 5=RS232H)
  - *COM3 CCSAIL exclusive? (0=NO, 1=YES; generally set to 0)*
  - Data dump format (1=space delimited, 2=comma delimited, 3=match real-time message)
  - Real time message format (0=none, 1=comma delimited ASCII, 2=fixed width ASCII)
  - Add compass to vane? (0=NO, 1=YES)
  - Compass offset in degrees
  - Barometer elevation in meters
- The line beginning PARAM3 contains the following information:
  - *Clock processor speed (generally set to 16777)*
  - *System read/write parameter (generally set to 1)*
  - *ADC noise rejection frequency (50/60 Hz; jumper required to set this option)*
  - *ADC significant bits (18/13; jumper required to set this option)*
  - Output message #1 period in half-seconds (e.g., 1s given as 2) (0 = after data sampling)
  - Output message #2 period in half-seconds (0 = not transmitted)
  - Output message #3 period in half-seconds (0 = not transmitted)
  - Output message #4 period in half-seconds (0=not transmitted)
  - Output message #1 COM port (0=COM1; 1=COM2; 2=COM3)

[375] Refer to Section 9.4.

- - Output message #2 COM port
- The line beginning PARAM4 contains the following information:
  - - Output message #3 COM port
  - - Output message #4 COM port
  - - Modem present? (0=NO, 1=YES)
  - - *ADC values output in volts or counts? (0=VOLTS, 1=COUNTS)*
  - - *Time crystal calibration offset (generally 0)*
  - - *Time crystal calibration base frequency*
  - - *ADC quiet mode (generally 0)*
  - - Modem COM port (-1=NONE, 0, 1 or 2 for COM1, COM2 or COM3)
  - - Modem retry period in seconds
  - - Modem hang-up delay in seconds
- The line beginning PARAM5 contains the following information:
  - - User interface on COM2/3 only? (0=NO, 1=YES)
  - - Switched voltage code for radios on COM1
  - - *Not used*
  - - *Not used*
  - - COM1 PTT setup time in ms
  - - Switched voltage code for radios on COM2
  - - *Not used*
  - - *Not used*
  - - Switched voltage code for radios on COM3
  - - *Not used*
- The line beginning PARAM6 contains the following information:
  - - *Not used*
  - - Digital power on interval in seconds
  - - Digital power on duration in seconds
  - - Time of first power on -- seconds since 12:00:00AM, December 31, 1969
  - - GOES DCP address (decimal representation of a hex address)
  - - GOES self-timed channel number (decimal)
  - - GOES self-timed transmission interval code
  - - GOES self-timed transmission offset
  - - GOES transmission window length in minutes
  - - GOES preamble (0=SHORT; 1=LONG)
- The line beginning PARAM7 contains the following information:
  - - GOES random transmission channel number
  - - GOES random transmission interval
  - - GOES random transmission active time
  - - Control channel for digital power control
  - - *12-bit ADC correction factor (×10,000)*
  - - Network Source Address (0 to 9998)
  - - Alternate Source Address (0 to 9998)
  - - Repeater transmit delay
  - - ARGOS push-to-talk delay
  - - ARGOS repeat count
- The line beginning PARAM8 contains the following information:
  - - ARGOS repeat interval
  - - ARGOS push-to-talk digital port
  - - ARGOS timestamp flag

- ARGOS checksum flag
- Response delay time
- *Daylight savings time flag*
- Modem switched voltage
- Modem ring channel
- *Local time offset*
- *Zero-offset check period*

- The line beginning PARAM9 contains the following information:
  - Speech installed
  - Speech activity channel
  - Speech tone detect channel
  - Speech switched voltage
  - *Road pin pulse channel*
  - *Road plate pulse channel*
  - *Flash board SPI channels*
  - COM1 GSI memory size
  - COM2 GSI memory size
  - COM3 GSI memory size

- The line beginning PARAM10 contains the following information:
  - *Low-frequency sensor timeout*
  - Record counter start
  - Record counter reset
  - *Capacitor ground TPU channel*
  - GOES bit rate
  - GOES interleaver
  - Passthrough mode escape character

- The line beginning PARAM11 contains the following information:
  - *Local packet modem name*
  - *Destination packet modem name*
  - First telephone dial-out number
  - Second telephone dial-out number
  - Third telephone dial-out number
  - Fourth telephone dial-out number
  - User level password
  - Administrator level password
  - *Leads password*
  - Modem initialization string

- The line beginning PARAM12 contains the following information:
  - Bad sensor value replacement
  - BIT name #1
  - BIT name #2
  - BIT name #3
  - BIT name #4
  - BIT name #5
  - BIT name #6
  - BIT name #7
  - BIT name #8
  - BIT name #9

- The line beginning PARAM13 contains the following information:

- BIT name #10
- BIT name #11
- BIT name #12
- BIT name #13
- BIT name #14
- BIT name #15
- BIT name #16
- BIT name #17
- BIT name #18
- BIT name #19

- The line beginning PARAM14 contains the following information:
  - BIT name #20
  - BIT name #21
  - BIT name #22
  - BIT name #23
  - BIT name #24
  - BIT name #25
  - BIT name #26
  - BIT name #27
  - BIT name #28
  - BIT name #29

- The line beginning PARAM15 contains the following information:
  - BIT name #30
  - BIT name #31
  - BIT name #32

F.   LIBRARY OF CCSAIL COMMANDS

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The ZENO®-3200 data logger supports both a user menu command line protocol and a machine interface known as CCSAIL. CCSAIL is a simple ASCII based bi-directional command-acknowledgment protocol used to set parameters or request data from a ZENO®-3200 system.

For a description of the CCSAIL Message Protocol, refer to Section 4.6 in the main section of this User Manual.

In this appendix, the base station terminal initiating the CCSAIL commands will be referred to as the HOST, and the ZENO®-3200 data logger will be referred to as the REMOTE.

1.   BASIC CCSAIL COMMAND INFORMATION

The ZENO®-3200 requires certain conditions to be met in order to operate some CCSAIL commands. These conditions are summarized in the following table.

CCSAIL Command	Active CTS	Requires Halted Data Col.	Active Data Col.	Repeatable	CCSAIL Command	Active CTS	Requires Halted Data Col.	Active Data Col.	Repeatable
TM[376]			✓	✓	GETASCII				✓
D@	✓		✓	✓	RESETREPEAT				✓
DB	✓		✓		SETREPEAT				✓
DA	✓		✓	✓	GETREPEAT				✓
DD			✓	✓	ENDSAMPLE				✓
OK				✓	STARTSAMPLE				✓
NAK				✓	ADDGSI		✓		✓
OPEN			✓		DELGSI		✓		✓
ERROR				✓	INSGSI		✓		✓
D*	✓		✓		REMGSI		✓		✓
DX*	✓		✓		SETGSI		✓		✓
DX@	✓		✓		GETGSI				✓
DN			✓	✓	ADDSENSOR		✓		✓
DL	✓		✓	✓	ADDPROCESS		✓		✓
DXL	✓		✓		ADDDATA		✓		✓
PTSDI			✓		SETSENSOR		✓		✓
LXT	✓		✓		SETPROCESS		✓		✓
LXR	✓		✓		SETDATA		✓		✓
DCHS				✓	GETSENSOR				✓
SDO			✓	✓	GETPROCESS				✓
PT			✓		GETDATA				✓
ER				✓	DELSENSOR		✓		✓
REBOOT				✓	DELPROCESS		✓		✓
LXB	✓		✓		DELDATA		✓		✓
LXA	✓		✓		ERASECONSTANTS				✓
SETPARAM				✓	SETCONSTANT				✓
GETPARAM				✓	GETCONSTANT				✓
SETASCII				✓	DEFAULTCONFIG		✓		✓

2. RESPONSES

OK

This command is returned from either the HOST or the REMOTE to acknowledge the receipt of a CCSAIL command other than the several data request commands or any system-wide global command.

EXAMPLE: **#00010134OK47(ETX)**

To ID 0001 from 0134, acknowledge receipt of command.

NAK

---

[376] Applies to both global TM and addressed TM commands.

This command is returned from either HOST or the REMOTE to indicate a negative acknowledgment for a recently received CCSAIL message with an unknown command or with an invalid parameter.

EXAMPLE: **#01340001NAK11(ETX)**

To ID 0134 from 0001, negative acknowledgement of received command.

ERRORnnn,

When ZENOSOFT® receives an invalid parameter for a particular configuration command, it will respond with a CCSAIL error message indicating the type of error encountered, represented by **nnn**. An example of an error response from ZENOSOFT® would be as follows:

#00010134<CR><LF>ERROR8,89^C

The typical error codes that will be reported are as follows:

Code	Meaning	Code	Meaning
6	Invalid Item Number	88	Invalid Value in GSI Line
7	Invalid Item Value	89	Invalid GSI Script Line Syntax
8	Cannot Change Item	90	Specifier Doesn't Match Format Field in GSI Line
12	Invalid Menu Option	91	Invalid GSI Format Field
14	Invalid Scan List Records	92	Invalid GSI Backslash Code
16	Invalid Record Number	93	Invalid GSI Specifier
60	Cannot Create Another Record	94	GSI Specifier Out of Range
61	Invalid Item in Record	95	GSI Command Already Defined
82	Insufficient Mem for GSI Script	96	Invalid GSI Checksum Code
83	Max Num of GSI Scripts	97	Invalid GSI Checksum
84	Max Num of Lines in GSI Script	98	GSI Command Not in Use
85	Invalid GSI Script Number	99	GSI Restricted Field
86	Invalid Line Number in GSI Script	100	Number of Invalid GSI Checksum Codes
87	Invalid GSI Script Command	101	Invalid GSI Address Identifier

3. TIME COMMANDS

TMyymmddhhmmss

Global or addressed time set command. No message is returned from the REMOTE in response to a global TM command, but it will respond with an OK to an addressed TM command. Time is in 24 hour format. This command is useful for synchronizing multiple ZENO®-3200 units.

EXAMPLE of Global Command: **#TM94100212000056(ETX)**

Set Date and Time to October 2, 1994, 12:00:00 PM. (ETX) represents 0x03 character.

EXAMPLE of Addressed Command:

HOST: **#01340001TM**95101009050060 **(ETX)**

REMOTE: **#00010134**
                        OK,14(ETX)

The HOST addresses a command to the REMOTE, setting the station date and time to October 10, 1995, 9:05 a.m. The REMOTE acknowledges the command.

4.   DATA RETRIEVAL COMMANDS

D*

Request all data sets residing in the REMOTE's data logging memory. This command behaves similarly to option * in the Data Retrieval Menu.[377] Caution should be considered before using this command as it may require several minutes of data transfer time if there are numerous data sets stored in the REMOTE's logging memory.

EXAMPLE: **#01340001D*03(ETX)**

To ID 0134 from 0001, send all data sets in logging memory.

D@nn,

Request **nn** unmarked or oldest data sets. This command behaves similarly to options **@** and **M** in the Data Retrieval Menu.[378] These are data sets which have not been acknowledged by the HOST as having been received. The value of **nn** can be any positive integer from 1 to 9999, or the asterisk character. The **nn** parameter must be comma delimited to separate it from the checksum. If the requested number of data sets is larger than the actual number of sets in logging memory, the REMOTE will send all data sets in logging memory followed by an **EOF** string. The HOST station should acknowledge the receipt of valid data set messages with a CCSAIL OK message. This indicates to the REMOTE to mark the previously transmitted data sets as having been sent. The REMOTE will then respond to the next **D@nn** command by sending data sets logged after the last marked set. If the received message from the REMOTE fails the proper format check, then the requesting station ignores the received message, and sends the request command again.

EXAMPLE: **#01340001D@*,11(ETX)**

---

[377] Refer to Section 4.1.4.
[378] Refer to Section 4.1.3.

To ID 0134 from 0001, send all data collected since last **D@nn** or **DX@nn** command.

EXAMPLE: **#01340001D@5,22(ETX)**

To ID 0134 from 0001, send 5 data records collected since the last **D@nn** or **DX@nn** command.

DD

This command deletes all existing data sets inside the REMOTE's data logging memory. This command behaves similarly to option **D** in the Data Retrieval Menu.[379] The REMOTE will return an OK message in response to this command.

EXAMPLE: **#01340001DD29(ETX)**

To ID 0134 from 0001, delete all data sets in logging memory.

DByymmddhhmmssyymmddhhmmss (start date-time , stop date-time)

DXByymmddhhmmssyymmddhhmmss (start date-time , stop date-time)

Request all data sets which were logged between the indicated start and stop date-time strings. This command behaves similarly to option **B** in the Data Retrieval Menu.[380] If there are no data sets within the time specification, the REMOTE returns an EOF message. This is a fixed-field format message so there is no need to comma delimit the date-time parameters.

EXAMPLE: **#01340001DB941001000000941031235959 45(ETX)**

To ID 0134 from 0001, send all data sets logged during the month of October 1994.

DAyymmddhhmmssnn,

DXAyymmddhhmmssnn,

Request **nn** data sets logged on or after the indicated start date-time value. This command behaves similarly to option **A** in the Data Retrieval Menu.[381] The value of **nn** may range from 1 to 9999 inclusive, and must be comma delimited to separate it from the checksum. If the value of **nn** is greater than the actual number of logged data sets found, the REMOTE sends all data sets logged after the specified time, followed by an **EOF** string.

EXAMPLE: **#01340001DA94100100000011,59(ETX)**

To ID 0134 from 0001, send the first 11 data sets logged in October 1994.

---

[379] Refer to Section 4.3.
[380] Refer to Section 4.1.5.
[381] Refer to Section 4.1.5.

DLnn,

DXLnn,

Request the latest, most recent **nn** data sets stored in data logging memory. This command behaves similarly to option **L** in the Data Retrieval Menu.[382] The value of **nn** may range from 1 to 9999 inclusive, and must be comma delimited to separate it from the checksum. If the value of **nn** is greater than the actual number of logged data sets found, the REMOTE sends all data sets logged after the specified time, followed by an **EOF** string.

EXAMPLE:

HOST: **#01340001DL10,78(ETX)**

REMOTE:

```
#00010134
95/10/10 09:13:26      25    15
95/10/10 09:13:28      25    14
95/10/10 09:13:30      25    14
95/10/10 09:13:32      25    14
95/10/10 09:13:34      25    14
95/10/10 09:13:36      25    14
95/10/10 09:13:38      25    14
95/10/10 09:13:40      25    14
95/10/10 09:13:42      25    14
95/10/10 09:13:44      25    14
35
```

To ID 0134 from 0001, send the latest 10 data sets stored in data logging memory.

DN

Request a count of the total data sets residing in the REMOTE's data logging memory. This command behaves similarly to option **N** in the Data Retrieval Menu.[383]

EXAMPLE: **#01340001DN39(ETX)**

To ID 0134 from 0001, inquire how many data sets are in logging memory.

An example response to the DN command would look like the following:

#00010134

122,09(ETX)

To ID 0001 from 0134, there are 122 data sets in logging memory

DX@nn,

---

[382] Refer to Section 4.1.2.
[383] Refer to Section 4.2.

Request **nn** unmarked data sets. This command behaves similarly to option **X@** in the Data Retrieval Menu.[384] This is effectively the same CCSAIL command as the **D@nn** sequence with one notable exception; this command initiates an X-Modem protocol file transfer of all unmarked data sets. Because the X-Modem protocol inherently contains its own form of data receipt acknowledgment, the data file returned from the REMOTE will not contain a CCSAIL checksum. The HOST station will acknowledge the receipt of the data file with a CCSAIL OK message. This indicates to the REMOTE that all data was properly received by the HOST, and should be marked as having been sent. If an OK message is not received, the data set will remain unmarked and will be sent again in response to the next **DX@nn** command.

EXAMPLE: **#01340001DX@99,71(ETX)**

To ID 0134 from 0001, request X-Modem file transfer of 99 records since the last **DX@nn** or **D@nn** command.

EXAMPLE: **#01340001DX@*,99(ETX)**

To ID 0134 from 0001, request X-Modem file transfer of all records since the last **DX@nn** or **D@nn** command.

DX*

Request all data sets residing in the REMOTE's data logging memory. This command behaves similarly to option **X*** in the Data Retrieval Menu.[385] This is effectively the same CCSAIL command as the **D*** command except that it specifies the use of the X-Modem protocol file transfer.

EXAMPLE: **#01340001DX*99(ETX)**

To ID 0134 from 0001, request X-Modem file transfer of all data records in logging memory.

5.   USER INTERFACE ACCESS

OPEN

Request the REMOTE to go to the normal User Menu communications. The REMOTE will cease using the CCSAIL protocol for communications, and will immediately jump into the regular user menu communication format. The user may enter any regular ZENO®-3200 menu command at this time. When the user enters **Q** for quit, or the menu system times-out due to inactivity, the REMOTE will resume the CCSAIL protocol.

EXAMPLE: **#01340001OPEN99(ETX)**

To ID 0134 from 0001, go to user menu command line operation.

---

[384] Refer to Sections 4.1.3 and 4.1.7.
[385] Refer to Sections 4.1.4 and 4.1.7.

6.   DIGITAL OUTPUT CONTROL COMMANDS

SDOxyy,

This command instructs the ZENO®-3200 to turn on or off ('n') the specified digital output ('yy'). Valid values for 'n' are 0 or 1 indicating off or on respectively. Valid values for 'yy' are between 18 and 23 respectively.

Upon success, ZENOSOFT® responds with a CCSAIL **OK**. Upon failure, ZENOSOFT® responds with a CCSAIL **NAK**.

7.   CONFIGURATION UPLOAD, DOWNLOAD, AND CHECKSUM COMMANDS

LXR or LXRn,

This command instructs the ZENO®-3200 to upload (receive) a new configuration file in an x-modem transfer.[386] The value 'n' indicates the size in bytes of the configuration file from which ZENOSOFT® calculates a time limit for the upload. If 'n' is not specified, a default time limit of 60 seconds is used.

Upon success, ZENOSOFT® responds with a CCSAIL **OK**; otherwise, it responds with a CCSAIL **NAK**. Also, upon failure, ZENOSOFT® will reload the configuration still stored in EEPROM.

LXT

This command instructs the ZENO®-3200 to download (transmit) the existing configuration file in an x-modem transfer.[387] ZENOSOFT® does not respond with a CCSAIL response at the end of the transfer.

DCHS

This CCSAIL command instructs the ZENO®-3200 to immediately output a checksum of the configuration stored in RAM and the checksum of the configuration stored in EEPROM. The output (for example) would look as follows:

#00010777<CR><LF>E3R184,32<ETX>

8.   SAVE AND REBOOT OR REBOOT ONLY

ER

This CCSAIL command instructs the ZENO®-3200 to immediately save the existing configuration into EEPROM. ZENOSOFT® generates a CCSAIL **OK** response upon success.

REBOOT

---

[386] Refer to Section 9.2.
[387] Refer to Section 9.1.

This CCSAIL command instructs the ZENO®-3200 to immediately reboot. This behaves the same as option **R** in the Zeno Program Menu.[388] Prior to reboot, ZENOSOFT® generates a CCSAIL **OK** response.

9. PASSTHROUGH MODE COMMANDS

PTtttnbbbbbpd,

This command instructs the ZENO®-3200 to go into passthrough mode over the specified COM port 'n', with type 'ttt', at baud rate 'bbbbb', with parity 'p' and data bits 'd'.[389]

Valid values for 'n' are 1, 2, 3, T or C for COM ports COM1, COM2, COM3, TTL-INTERFACE and COMPASS-INTERFACE respectively. Valid values for 'ttt' are 232 or 485 for either RS232 or RS485 communications. Valid values for 'bbbbb' are the following baud rates 00300, 00600, 01200, 02400, 04800, 09600 or 19200. Valid values for parity 'p' are N (no parity), E (even parity) or O (odd parity). Valid values for data bits 'd' are 6, 7 or 8.

Upon success, ZENOSOFT® will go into passthrough mode over the specified COM port. Upon failure, ZENOSOFT® responds with a CCSAIL **NAK**.

PTSDIn,

This command instructs the ZENO®-3200 to go into SDI-12 passthrough mode over the specified COM port 'n'. Valid values for 'n' are 2 or 3 for COM ports COM2 or COM3 respectively.[390]

Upon success, ZENOSOFT® will go into SDI-12 passthrough mode over the specified COM port. Upon failure, ZENOSOFT® responds with a CCSAIL **NAK**.

10. CONFIGURATION COMMANDS

The following set of new CCSAIL commands will be defined. The commands are based upon the format of the ZENO®-3200 configuration file.

With the exception of the checksum, which is always a two-digit value, the numeric values here can be of any length. The descriptions shown below should not be taken to imply fixed-length values.

10.1. Run-time Parameters

SETPARAMnnn,xxxxx,

Set parameter number nnn to the numeric value xxxxx. for example, the very first parameter defined is the sample interval time, in seconds; the nineteenth parameter is the compass offset. So to instruct

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[388] Refer to Section 10.8.
[389] Refer to Section 6.9.1.
[390] Refer to Section 6.9.2.

ZENO®-3200 number 134 to change the sample period to 30 seconds would require the following command:

#01340001SETPARAM1,30,34^C

To instruct the same ZENO®-3200 to change the compass offset to negative 16 degrees would require the following command:

#01340001SETPARAM19,-16,40^C

ZENOSOFT® will respond with a CCSAIL OK if the parameter can be changed successfully.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if run-time parameter **nnn** is not valid.

ZENOSOFT® will respond with a CCSAIL ERROR 7 if run-time parameter **nnn** is valid, but data value **xxxxx** is out of range.

ZENOSOFT® will respond with CCSAIL ERROR 8 if run-time parameter **nnn** cannot be changed. These include the following run-time parameters:

- 21 Clock processor speed (generally set to 16777)
- 22 System read/write parameter (generally set to 1)
- 24 ADC significant bits (18/13)
- 37 ADC quiet mode (generally set to 0)
- 43 Not used
- 44 Not used
- 47 Not used
- 48 Not used
- 50 Not used
- 51 Not used

Additionally, before setting any of the following parameters, the user must send the ENDSAMPLE command (see below). This command instructs the ZENO®-3200 to cease sampling.

- 4   Sensor timing loop #2 in half-seconds
- 5   Sensor timing loop #3 in half-seconds
- 6   Sensor timing loop #4 in half-seconds
- 23 ADC noise rejection frequency (50/60 Hz)
- 25 Output message #1 period in half-seconds (0 = directly after data sampling)
- 26 Output message #2 period in half-seconds (0 = not transmitted)
- 27 Output message #3 period in half-seconds (0 = not transmitted)
- 28 Output message #4 period in half-seconds (0 = not transmitted)
- 29 Output message #1 COM port (0=COM1; 1=COM2; 2=COM3)
- 30 Output message #2 COM port (0=COM1; 1=COM2; 2=COM3)
- 31 Output message #3 COM port (0=COM1; 1=COM2; 2=COM3)
- 32 Output message #4 COM port (0=COM1; 1=COM2; 2=COM3)
- 34 ADC values output in volts or counts? (0 = VOLTS, 1 = COUNTS)
- 35 Time crystal calibration offset (generally 0)
- 36 Time crystal calibration base frequency
- 65 12-bit ADC correction factor (×10,000)

If the user attempts to change any of these parameters while the ZENO®-3200 is sampling, ZENOSOFT® will return a CCSAIL ERROR 8.

GETPARAMnnn,

Retrieve the value of parameter number `nnn` from the remote ZENO®-3200.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if run-time parameter **nnn** is not valid.

If it is a valid run-time parameter number, ZENOSOFT® will respond with the string `PARAMnnn,xxxxx.` for example, if ZENO®-3200 number 134 is being polled for the current value of parameter number 2 (the sample time offset in seconds), and if the actual value is 15 seconds, the following communications will occur.

#01340001GETPARAM2,80^C

#00010134PARAM2,15,02^C

ASCII Run-time Parameters

SETASCIInnn,abcde,

Set the value of the ASCII parameter number `nnn` to the string `abcde.` for example, the third ASCII parameter is the first modem alarm dial-out phone number. To instruct ZENO®-3200 number 329 to change the first modem alarm dial-out phone number to 555-1212 would require the following command:

#03290001SETASCII3,555-1212,37^C

The ZENO®-3200 will respond with a CCSAIL `OK` if the parameter can be changed successfully.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if ASCII parameter **nnn** is not valid.

ZENOSOFT® will respond with a CCSAIL ERROR 7 if ASCII parameter **nnn** is valid, but data value **xxxxx** is out of range.

ZENOSOFT® will respond with CCSAIL ERROR 8 if ASCII parameter **nnn** cannot be changed.

The CCSAIL commands count the ASCII parameters starting from 1, rather than starting from the last numeric run-time parameter. (In the ZENO®-3200 configuration files, the ASCII parameter count starts from the last numeric run-time parameter). The reason for counting the ASCII parameters from 1, rather than from the last numeric run-time parameter, is for future compatibility. New numeric run-time parameters are defined often.

GETASCIInnn,

Retrieve the value of ASCII parameter number `nnn` from the remote ZENO®-3200.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if ASCII parameter **nnn** is not valid.

If it is a valid ASCII parameter number, ZENOSOFT® will respond with the string
`PARAMnnn,abcde.` for example, if ZENO®-3200 number 329 is being polled for the current value of
parameter number 8 (the administrator level password), and if the actual value is ZENO®-3200, the
following communications will occur.

#03290001GETASCII8,84^C

#00010329ASCII8,ZENO,20^C

10.2.   Constants[391]

GETCONSTANTnnn,

This CCSAIL command will retrieve the floating-point value of constant **nnn**.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if **nnn** is invalid.

An example of its usage is as follows:

#01340001GETCONSTANT5,45^C

#00010134

CONSTANT5,6.787,12^C

SETCONSTANTnnn,mmm,

This CCSAIL command will set the floating-point value of constant **nnn** to **mmm**.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if **nnn** is invalid.

An example of its usage is as follows:

#01340001SETCONSTANT5,8.783e-5,45^C

ZENOSOFT® will respond with a CCSAIL **OK** upon success.

ERASECONSTANTS

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[391] Refer to Section 10.5.

This CCSAIL command will set the floating-point value of all constants to 0.0.

An example of its usage is as follows:

#01340001ERASECONSTANTS52^C

ZENOSOFT® will respond with a CCSAIL **OK** upon success.

10.3.   Repeater Values[392]

<u>RESETREPEAT</u>

This CCSAIL command will reset all the repeater values (including the repeater run-time parameters) to their default values. It has the same effect as the "R" option in the Repeater Menu of the User Interface. The default values for the repeater are that all remote addresses are reset to -1; the Network Source Address and Alternate Source Address are both reset to -1; and the Repeater Transmit Delay parameter is reset to zero. An example of its use would be as follows:

#01340001RESETREPEAT29^C

ZENOSOFT® will respond with a CCSAIL "OK".

<u>SETREPEATnnn n1 n2 n3 n4 n5 n6 n7 n8,</u>

Set repeater line `nnn` to contain the specified 8 remote ZENO®-3200 addresses, `n1` through `n8`. (In the current ZENO®-3200 version, the repeater line number `nnn` must take the value 1; however, the repeater line number is provided for possible future upgrades that will permit more than 8 remote ZENO®-3200s in a single network).

ZENOSOFT® will respond with a CCSAIL `OK` if all eight remote addresses can be changed successfully.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if REPEAT line **nnn** is not valid. (Currently, 1 is the only valid number.)

ZENOSOFT® will respond with a CCSAIL ERROR 7, if REPEAT line **nnn** is valid but one or more of the eight data values is not valid.

ZENOSOFT® will respond with a CCSAIL ERROR 8, if REPEAT line **nnn** is valid but one or more of the eight data values cannot be changed.

For example, to set the first three remote addresses to 1001, 1002, 1003, when communicating with ZENO®-3200 number 8001, the following command would be sent:

#80010001SETREPEAT1 1001 1002 1003 −1 −1 −1 −1 −1,79^C

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[392] Refer to Section 6.10.

GETREPEATnnn,

Retrieve the value of the **nnn**th eight remote addresses from the ZENO®-3200.

ZENOSOFT® will respond with a CCSAIL ERROR 6 if REPEAT line **nnn** is not valid. (Currently, 1 is the only valid number.)

If it is a valid REPEAT line number, ZENOSOFT® will respond with the string REPEATnnn, followed by a comma-separated list of remote addresses. for example, if ZENO®-3200 number 329 is being polled for the current repeater values, after they were set as described in the previous paragraph, the communications would be as follows:

#80010001GETREPEAT1,60^C

#00018001

REPEAT1 1001 1002 1003 -1 -1 -1 -1 -1,43^C

10.4.   Data Collection Control

ENDSAMPLE

This command instructs the remote ZENO®-3200 to cease sampling. This command is equivalent to entering the Zeno Program Menu through the standard User Interface, in that it allows the user to construct temporarily inconsistent configurations. (For example, if the user wishes to rewrite a General Serial Interface script, intermediate stages in the construction of the script may not make up a valid script file.)

The ZENO®-3200 will not start sampling again until the user sends the STARTSAMPLE command. There is one exception to this, which already occurs when the user enters the Zeno Program Menu through the standard User Interface. If the user is communicating with the ZENO®-3200 over a telephone modem, and the Carrier Detect line is dropped, then the ZENO®-3200 assumes that the connection has been lost. If the ZENO®-3200 has a valid configuration at this stage, then it quits the ZENO®-3200 Program Menu and starts sampling again.

If the user enters the User Interface while the ZENO®-3200 is not sampling—using either the U command or the CCSAIL OPEN command—the user will be presented with the Zeno Program Menu, rather than with the User Menu.

The ENDSAMPLE command must be used before any of the commands relating to GSI scripts, sensors, processes, or data output items can be used. Further, several run-time parameters can only be modified after the ENDSAMPLE command has been used; please refer to Appendix F, section 10.1.

For example, to instruct ZENO®-3200 number 1234 to cease sampling temporarily, the following command would be sent:

#12340001ENDSAMPLE60^C

The ZENO®-3200 would respond with:

#00011234OK,93^C

There may be a pause between when the ZENO®-3200 sends the ENDSAMPLE command and when the
CCSAIL OK response is sent. This pause allows the ZENO®-3200 to complete any current tasks.

STARTSAMPLE,x,

This command instructs the remote ZENO®-3200 to check that its configuration is internally consistent,
and if so then to start sampling. This command is equivalent to leaving the Zeno Program Menu through
the standard User Interface.

The parameter x takes one of the values Y (yes) or N (no).

The ZENO®-3200 will respond with a CCSAIL OK if the current ZENO®-3200 configuration is internally
consistent, and will immediately start sampling. This response is unaffected by the value of the parameter
(Y or N). If the ZENO®-3200 is already sampling (i.e., the ENDSAMPLE was not previously used), it
responds with a CCSAIL OK and continues sampling without pause.

If the current ZENOSOFT® configuration is not internally consistent, ZENOSOFT® returns with a
CCSAIL ERROR 14. If the value of the parameter was N (no), ZENOSOFT® simply returns a standard
CCSAIL ERROR 14. If the value of the parameter was Y (yes), ZENOSOFT® appends a set of warning
messages to the ERROR 14 (before the checksum). These are the same messages that appear if the user
attempts to quit the Zeno Program Menu with an inconsistent interface. In either case, the ZENO®-3200
does not re-start data sampling. The user must *either* correct the problems with the ZENO®-3200
configuration; *or* they must use the (pre-existing) CCSAIL REBOOT command to reboot and reload the
previously saved configuration.

Two examples, with an inconsistent configuration, are as follows. If the user does not request diagnostic
messages, the following conversation occurs.

#06290001STARTSAMPLE,N,72^C

#00010629ERROR14,64^C

If the user does request diagnostic messages, the following conversation occurs.

#06290001STARTSAMPLE,Y,83

Data output record #20 Item 4, Sensor reference S3.2 is invalid.

#00010629

ERROR14,29^C

10.5.   Create Default Configuration

DEFAULTCONFIG

This command causes ZENOSOFT® to go to the default configuration—completely deleting the existing configuration. The default configuration sets all run-time parameters to their default values, all constants to zero, deletes all sensors, processes, data outputs and GSI scripts. If successful, ZENOSOFT® returns a CCSAIL **OK**.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

10.6.   General Serial Interface (GSI) Commands[393]

ADDGSI,n,mmm,

Add a new GSI script before or after script **mmm**. **n** is either **A** for after or **B** for before. **mmm** is the existing GSI script number or **L** for last. If successful, ZENOSOFT® creates the new GSI script and returns a CCSAIL **OK**. This command can only be sent after the ENDSAMPLE command has been sent.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If **n** is neither an **A** or **B**, ZENOSOFT® will respond with a CCSAIL **ERROR** 12.

If script number **mmm** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 85.

If no more scripts can be added, ZENOSOFT® will respond with a CCSAIL **ERROR** 83.

DELGSInnn,

Delete GSI script number nnn. If successful, ZENOSOFT® deletes the desired GSI script and returns a CCSAIL **OK**. If **nnn** is set to 0, all scripts will be deleted.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

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[393] Refer to Section 12.2.

If script number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL ERROR 85.

INSGSInnn,mmm,

Insert line number mmm in script number nnn in the ZENO®-3200 configuration. This command can only be sent after the ENDSAMPLE command has been sent. If script number **nnn** exists and line number **mmm** is valid, ZENOSOFT® inserts the new line, sets the GSI command to NO_COMMAND in the new line and returns CCSAIL **OK**. This command can only be sent after the ENDSAMPLE command has been sent.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If script number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 85.

If script number **nnn** exists but line number **mmm** is invalid (either less than 1 or 2 more than the last line number), ZENOSOFT® will respond with a CCSAIL **ERROR** 86.

If script number **nnn** exists but no more lines can be inserted, ZENOSOFT® responds with CCSAIL ERROR 84.

REMGSInnn,mmm,

Remove line number mmm in script number nnn from the ZENO®-3200 configuration. If mmm takes the value 0, all script lines are removed. This command can only be sent after the ENDSAMPLE command has been sent.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If script number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 85.

If script number **nnn** exists but line number **mmm** is invalid (either less than 0 or more than the last line number), ZENOSOFT® will respond with a CCSAIL **ERROR** 86.

If line number mmm in script number nnn exists (or if mmm is equal to 0 and script number nnn exists), and the ZENO®-3200 has ceased sampling, then the ZENO®-3200 sends a CCSAIL OK command. The line(s) is removed.

If the user wishes to remove all script lines, then the script is not completely deleted. Instead, it has one line left—and that line contains the single command NO_COMMAND. This is consistent with what happens when the user deletes script number 1 through the user interface.

`SETGSInnn,mmm,abcde,`

Change line number mmm in script number nnn to contain the line abcde. If line number mmm does not exist, but line number mmm−1 exists, then insert line mmm as a new line and change it to abcde. Upon success, ZENOSOFT® returns a CCSAIL **OK**. This command—CCSAIL **ENDSAMPLE**—can only be sent after the ENDSAMPLE command has been sent.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If script number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 85.

If script number **nnn** exists but line number **mmm** is invalid (either less than 0 or more than the last line number + 1), ZENOSOFT® will respond with a CCSAIL **ERROR** 86.

If the specified line cannot be written due to an error with line **abcde**, ZENOSOFT® will respond with a CCSAIL ERROR message with an error code between 87 and 101 inclusive to indicate the problem with the line.

For example, suppose that the user wishes to send the following script, as script number 1, to the ZENO®-3200 with ID number 1287.

`FLOAT 3`

`SEND "DATA?\r"`

`RECEIVE 1000, "%f,%f,%f\r", F1, F2, F3`

The complete communication, including deleting the previous script file, would be as follows. The responses from the remote ZENO®-3200 are *italicized* below.

`#12670001ENDSAMPLE66^C`

`#00011267OK,99^C`

`#12670001REMGSI1,0,90^C`

`#00011267OK,99^C`

`#12670001SETGSI1,1,FLOAT 3,72^C`

`#00011267OK,99^C`

`#12670001SETGSI1,2,SEND "DATA?\r",65^C`

`#00011267OK,99^C`

`#12670001SETGSI1,3,RECEIVE 1000, "%f,%f,%f\r", F1, F2, F3,00^C`

`#00011267OK,99^C`

#12670001STARTSAMPLE49^C

#00011267OK,99^C

GETGSInnn,

This command instructs ZENOSOFT® to return the lines comprising script number `nnn`.   It is not necessary to first send the CCSAIL **ENDSAMPLE** command.

If script number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 85.

For example, if the user wishes to view lines installed in the previous example, the user would send the following CCSAIL command:

#12670001GETGSI1,41^C

The remote ZENO®-3200 (number 1267) would respond as follows.

#00011267

GSI1 1 FLOAT 3

GSI1 2 SEND "DATA?\r"

GSI1 3 RECEIVE 1000, "%f,%f,%f\r", F1, F2, F3,67^C

It is possible to use the GETGSI command without first using the ENDSAMPLE command.

10.7.   Sensor, Process and Data Output Commands[394]

ADDSENSOR,n,mmm,

ADDPROCESS,n,mmm,

ADDDATA,n,mmm,

These commands work in essentially the same way (and in a similar way to the **ADDGSI** command).

The command adds a new sensor, process or data output record after or before record number **mmm**. If record number **mmm** is **L**, the record number is the last configured record. If **n** is **A**, the new record is

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[394] Refer to Section 10.

placed after record number **mmm**. If **n** is **B**, the new record is placed before record number **mmm**. Upon success, another record will have been added in the desired location and ZENOSOFT® will return a CCSAIL **OK**.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If **n** is neither an **A** or **B**, ZENOSOFT® will respond with a CCSAIL **ERROR** 12.

If record number **mmm** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 16.

If no more records can be created, ZENOSOFT® will respond with a CCSAIL **ERROR** 60.

SETSENSORnnn,abcde,

SETPROCESSnnn,abcde,

SETDATAnnn,abcde,

These commands work essentially the same way (and in a similar way) to the SETGSI command.

The commands change sensor, process or data output record number nnn to take the value abcde. The value abcde is formatted just as the corresponding line would be formatted in a complete configuration file, except that the initial word SENSOR, PROCESS or DATA is omitted.

If record number nnn does not exist, but record number nnn-1 exists, the ZENO®-3200 creates record nnn and changes it to the new value abcde.

The ENDSAMPLE command must be used before any of these commands are used.

If the specified record can be written, the ZENO®-3200 writes that record and returns a CCSAIL OK message.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If record number **nnn−1** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 16.

If no more records can be created, ZENOSOFT® will respond with a CCSAIL **ERROR** 60.

If there is an error in the **abcde** string, ZENOSOFT® will respond with a CCSAIL **ERROR** 61.

For example, in the following conversation, the user first attempts to set up data output record number 14, referring to a nonexistent sensor output (the 11th output from sensor number 1: S1.11). The user then sets up the correct data output record, referring to the 11th output from process number 1: P1.11. The unit ID number of the ZENO®-3200 is 5310.

#53100001SETDATA14,9 1 "AWSPD" S1.11 1 5 7,53^C

#00015310ERROR61,56^C

#53100001SETDATA14,9 1 "AWSPD" P1.11 1 5 7,50^C

#00015310OK,92^C

GETSENSORnnn,

GETPROCESSnnn,

GETDATAnnn,

These commands work in essentially the same way (and in a similar way to the GETGSI command). The remote ZENO®-3200 returns the value of sensor record number nnn, process record number nnn, or data output record number nnn. These commands can be used while the remote ZENO®-3200 is still sampling – the ENDSAMPLE command does not need to be used first.

If the specified record exists, the remote ZENO®-3200 returns with SENSORnnn, PROCESSnnn, or DATAnnn, followed by the specified line. The initial word SENSOR, PROCESS or DATA is omitted.

If record number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 16.

For example, if the user wishes to double-check that data output record number 14 was correctly received by the remote ZENO®-3200 in the previous example, the following conversation would occur.

#53100001GETDATA1458^C

#00015310

DATA14,9 1 "AWSPD" P1.11 1 5 7,52^C

DELSENSORnnn,

DELPROCESSnnn,

DELDATAnnn,

These commands work in essentially the same way (and in a similar way to the DELGSI command). They instruct the remote ZENO®-3200 to delete the specified sensor, process or data output record. If nnn takes the value 0, then all sensors, processes, or data output records are deleted.

When the sensor, process or data output records are deleted, any subsequent records are updated (as is done when the user deletes a sensor, process or data output record through the standard User Interface). for example, if sensor record number 6 is deleted, then any references to sensor number 7 are replaced by sensor number 6.

The ENDSAMPLE command must be used before any of these commands are used.

If CCSAIL **ENDSAMPLE** has not been previously sent, ZENOSOFT® responds with a CCSAIL **ERROR** 8.

If record number **nnn** does not exist, ZENOSOFT® will respond with a CCSAIL **ERROR** 16.

As with the standard User Interface, if the user deletes all of the sensor, process or data output records, the first one is not actually deleted. Instead, it is replaced by the null record.

Upon success, ZENOSOFT® will return a CCSAIL **OK**.

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