



SDI-12 Protocol

AUG 2016 Conference

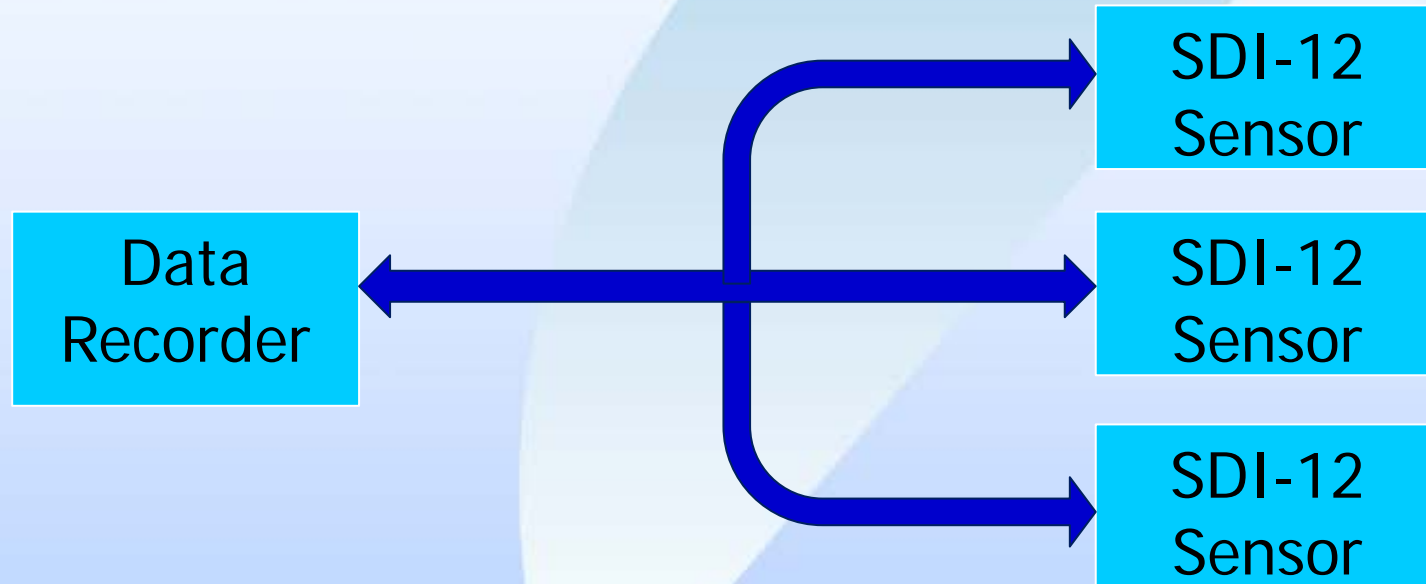
Carrie Lery
High Sierra Electronics, Inc.

SDI-12 Discussion Topics

- Overview
- Advantages
- Communications
- Basic Command/Response Set
- Typical Measurement Sequence
- Measurement Example
- ALERT vs. ALERT2
- Transparent Mode
- Demo

SDI-12 Overview

SDI-12: Serial-Digital Interface at 1200 baud.



SDI-12 is a standard for interfacing data recorders with microprocessor-based sensors.

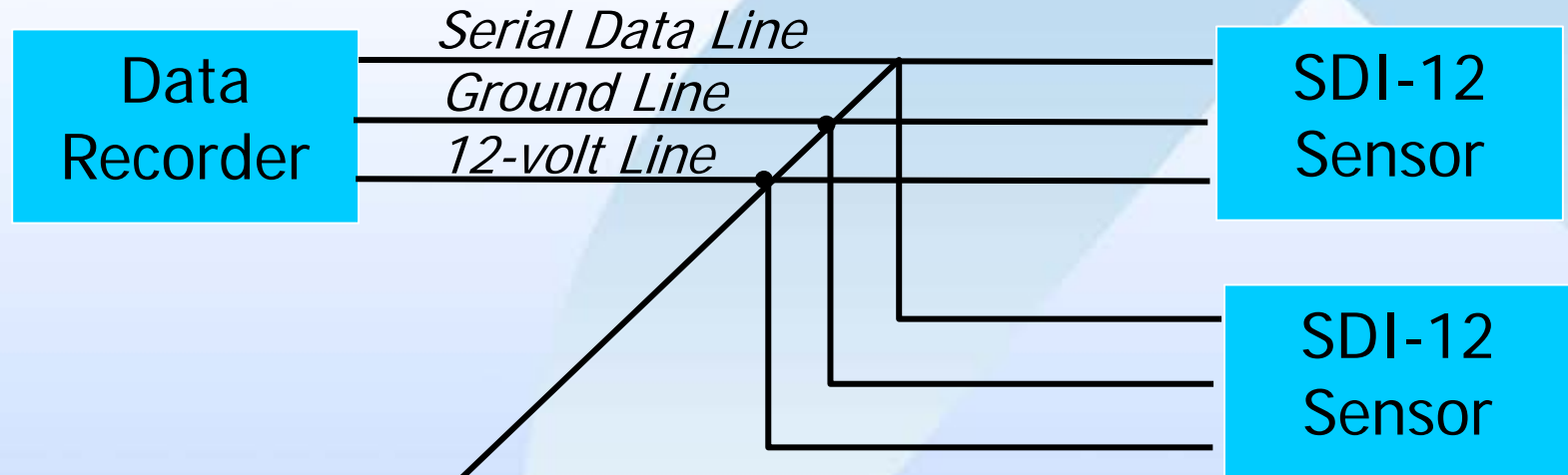
SDI-12 Overview

SDI-12 supports systems requiring

- Low Power (i.e. Battery powered)
- Low system cost
- One data recorder, multiple sensors, one cable

SDI-12 Overview

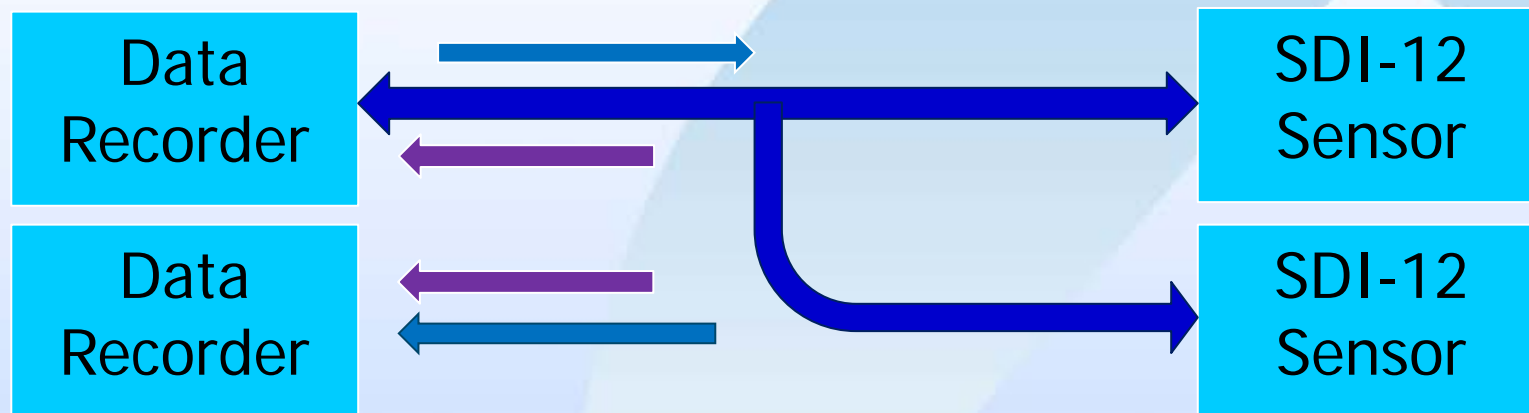
SDI-12 Bus



The SDI-12 bus is capable of having at least 10 sensors connected to it, each with 200 feet of cable. With fewer sensors, longer cable lengths are possible.

SDI-12 Overview

Data Recorder Listen-only Mode



Only one data recorder may poll SDI-12 sensors.

An additional recorder must be placed in Listen-only "Evesdropping" mode to avoid contention.

Listen-only recorders retrieve samples at the sampling rate of the polling recorder.

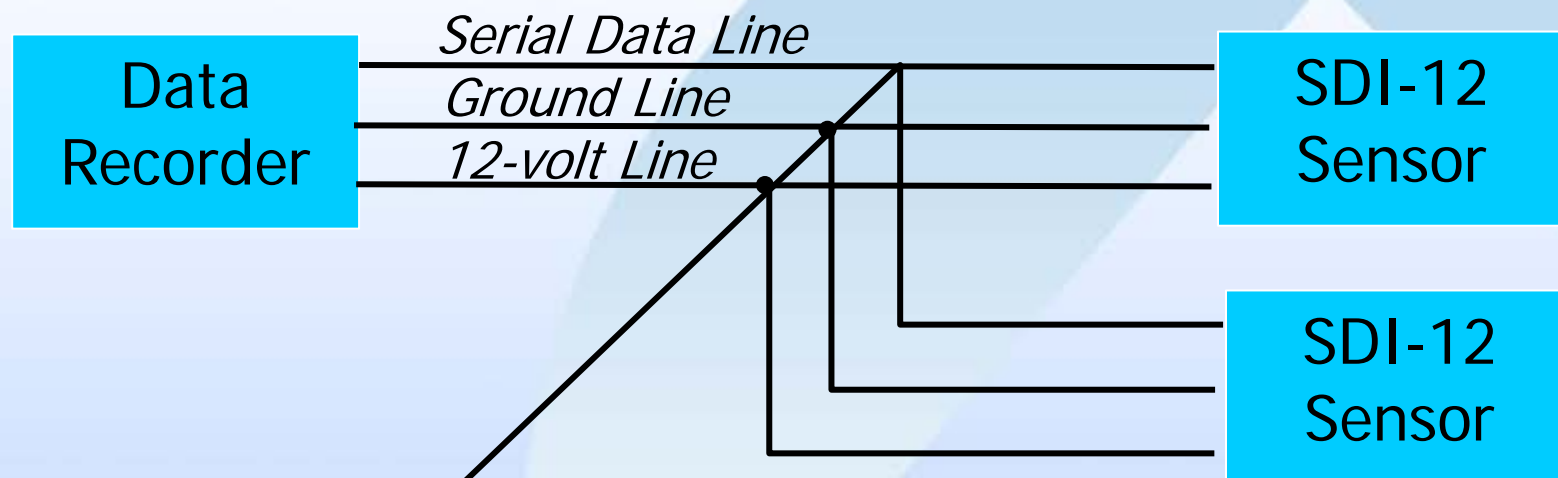


SDI-12 Advantages

- Self Calibration and Storage
- Sensor Interchangeability
- Design Simplification
- Design Independence
- Minimized Learning Curve

SDI-12 COMMUNICATIONS

Byte Frame Format



Serial byte frame format: 1200, 7, E, 1

Commands/Responses: Printable ASCII characters.



SDI-12 COMMUNICATIONS

Recorder Command

The data recorder starts by sending a break to wake up the sensors on the data line.

* A break is continuous spacing on the data line for at least 12 milliseconds.

The data recorder then sends a command.

SDI-12 COMMUNICATIONS

Recorder Command

Commands begin with a unique sensor address that specifies the sensor the recorder wants to communicate with.

a <Command>!

Other sensors on the SDI-12 bus ignore the command and return to low-power standby mode.

All commands are terminated with a '!'.

SDI-12 COMMUNICATIONS

Sensor Response

a <Response> <CR> <LF>

Sensors only respond if they have been sent a command.

The first character of a response is the address of the responding sensor.

All responses are terminated with a <CR><LF>.

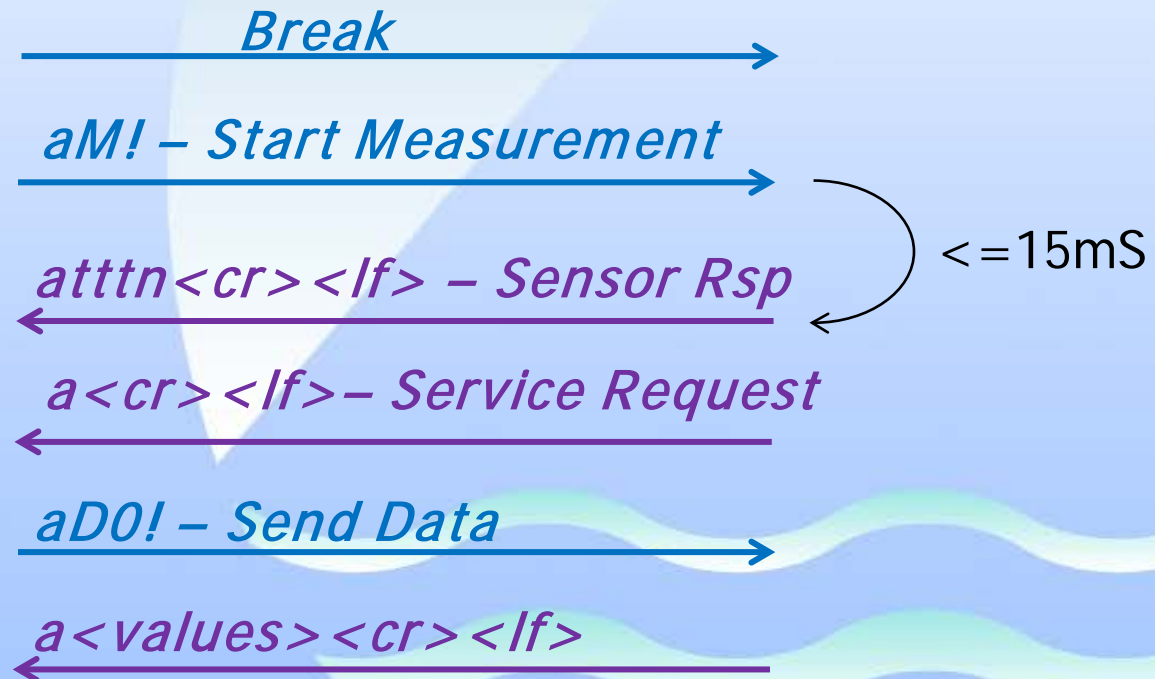
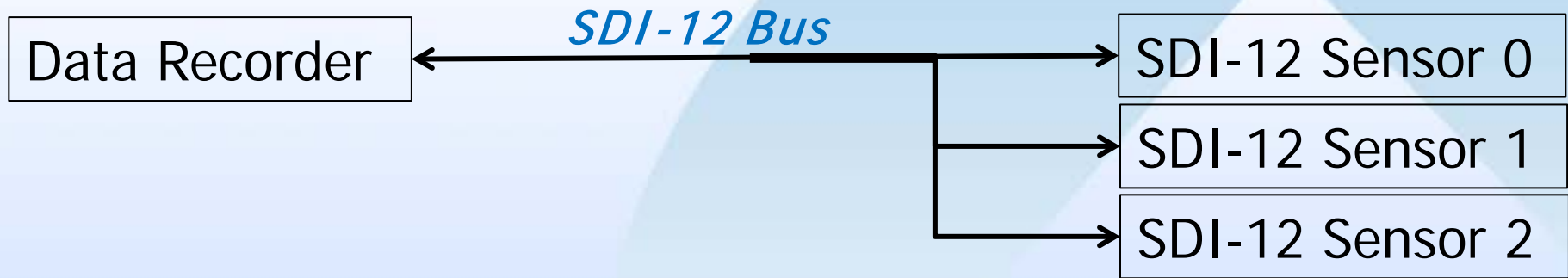
Basic SDI-12 Command/Response Set

Command Name	Command	Response
Acknowledge Active	a!	a<CR><LF>
Send Identification	al!	alccccccmmmmmmvvvxxx...xx<CR><LF>
Change Address	aAb!	b<CR><LF>
Address Query	?!	a<CR><LF>
Start Measurement*	aM!	atttn<CR><LF>
Start Measurement and Request CRC*	aMC!	atttn<CR><LF>>
Send Data	aD0! Thru aD9!	a<values><CR><LF> OR a<values><CRC><CR><LF>
Additional Measurements*	aM1! Thru aM9!	atttn<CR><LF>
Additional Measurements, Request CRC*	aMC1!...aMC9!	atttn<CR><LF>
Start Verification*	aV!	atttn<CR><LF>
Start Concurrent Measurement	aC!	atttnn<CR><LF>
Additional Concurrent Measurement	aCC!	atttnn<CR><LF>
Additional Concurrent Measurements	aC1!...aC9!	atttnn<CR><LF>
Additional Concurrent Measurements, Request CRC	aCC1!...aCC9!	atttnn<CR><LF>
Continuous Measurements	aR0!...aR9!	a<values><CR><LF>
Continuous Measurements, Request CRC*	aRC0!...aRC9!	a<values><CR><LF>

*This command may result in a service request **a<CR><LF>** from the sensor.

SDI-12 COMMUNICATIONS

Typical Measurement Sequence



SDI-12 Measure Command Response

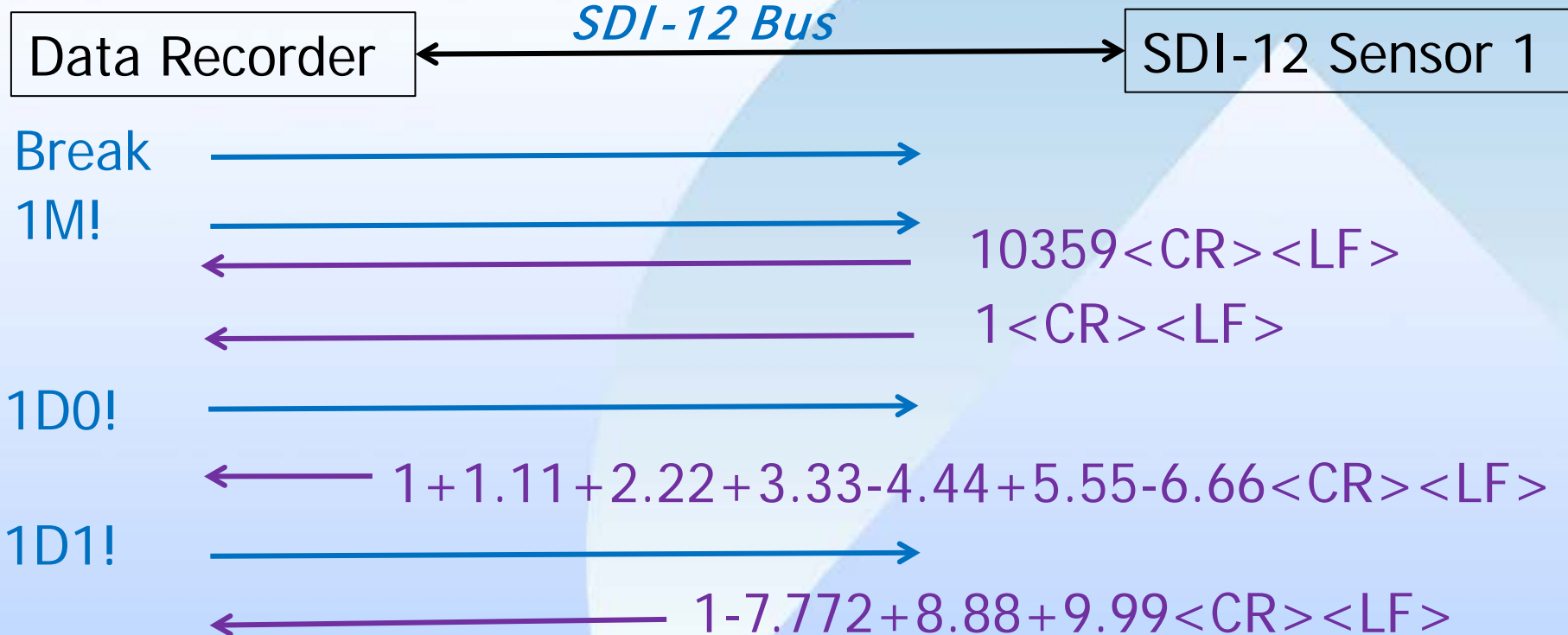
attn<CR><LF>

a - the sensor address

ttt - the specified time, in seconds, until the sensor will have the measurement(s) ready

n - the number of measurement values the sensor will make and return in one or more subsequent D commands; n is a single digit integer with a valid range of 1 to 9

SDI-12 Measurement Example



If measured data exceeds 35 bytes, multiple data buffers are needed to retrieve all parameters.

Legacy ALERT Constraints

The ALERT value range is 0 – 2047.

Decimal points are not included in the transmitted value.

A value greater than 2047 will be based on a multiple of 2048.

In all cases, if there is a rollover in the data calculation, the remainder value will be sent.

Legacy ALERT Constraints

Including Precision in ALERT
Example of Positive Range

SDI-12 Sensor Value	Precision	ALERT value	Base Station Multiplier
18.530	0	18	1
18.530	1	185	0.1
18.530	2	1853	0.01
185.30	0	185	1
185.30	1	1853	0.1
185.30	2	98	0.01

ALERT2 vs ALERT?

ALERT2 can transmit values as float, integer or signed integer.

- 18.53 is transmitted as 18.53
- 185.3 is transmitted as 185.3
- -3000.5 is transmitted as -3000.5

SDI-12 Sensor – Setup / Diagnostics

SDI-12 Transparent Mode

User interface allowing users to send SDI-12 commands and read the response.

Allows users to submit extended commands that are custom to the sensor. i.e. Calibration or setup commands.

Allows users to verify an SDI-12 sensor is functioning properly.

All data recorders provide a transparent mode.

SDI-12 Sensor – Setup / Diagnostics



The screenshot shows the High Sierra Insight Software interface. The window title is "High Sierra Insight Software". The menu bar includes "File", "Transfer", and "Help". The main menu contains "RTU", "I/O", "Reporting", "Clock", "Realtime Data", "Logged Data", "SDI 12 Transparent Mode", "Repeater", and "ALERT Monitor Mode". A blue arrow points to the "SDI 12 Transparent Mode" menu item.

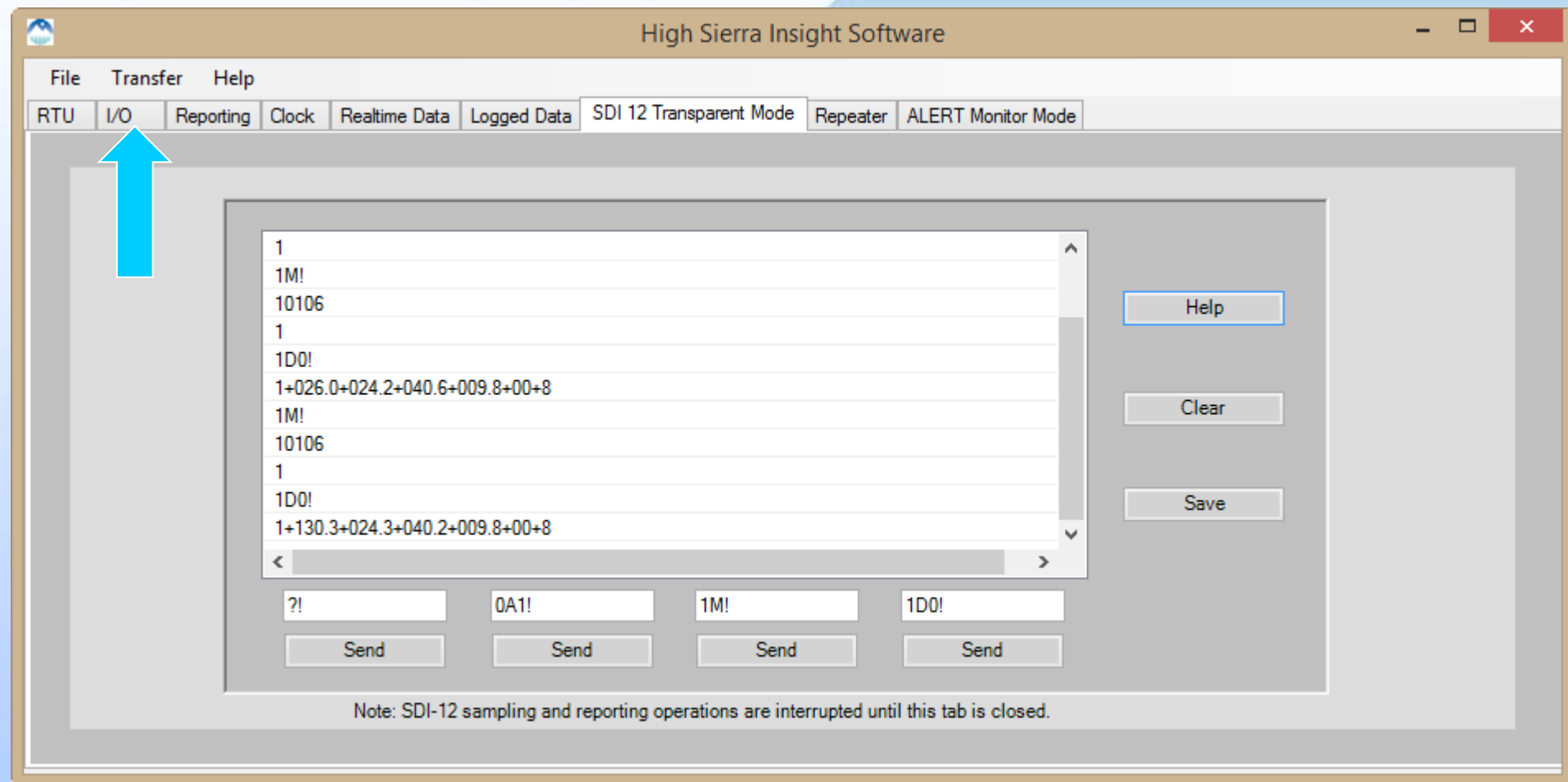
Below the menu, there is a checkbox for "ALERT2 (Pwr Cycle Req'd)".

The "Identification" section includes a text box for "Name" containing "Batt,SDI-12" and a "Filename" field containing "C:\Users\clery\Documents\InsightV4_09_02\Config\Ba". To the right of the "Name" field are buttons for "Open", "Save", "Save As", and "Delete".

On the right side of the interface, there are two buttons: "Retrieve RTU Parameters" and "Send RTU Parameters".

At the bottom right, there are fields for "Version: Undefined", "RF Warm Up (mSec): 180", and "Report Offset (Mins): 0". Below these is the text "Model Type: Unknown".

SDI-12 Sensor – Setup / Diagnostics



The screenshot displays the High Sierra Insight Software interface. The window title is "High Sierra Insight Software". The menu bar includes "File", "Transfer", and "Help". The main menu contains several tabs: "RTU", "I/O", "Reporting", "Clock", "Realtime Data", "Logged Data", "SDI 12 Transparent Mode", "Repeater", and "ALERT Monitor Mode". A blue arrow points to the "I/O" tab, which is currently selected. The main content area features a large text box with the following text:

```
1
1M!
10106
1
1D0!
1+026.0+024.2+040.6+009.8+00+8
1M!
10106
1
1D0!
1+130.3+024.3+040.2+009.8+00+8
```

Below the text box are four input fields with "Send" buttons:

?! <input type="text"/>	0A1! <input type="text"/>	1M! <input type="text"/>	1D0! <input type="text"/>
<input type="button" value="Send"/>	<input type="button" value="Send"/>	<input type="button" value="Send"/>	<input type="button" value="Send"/>

Additional buttons include "Help", "Clear", and "Save". A note at the bottom states: "Note: SDI-12 sampling and reporting operations are interrupted until this tab is closed."

SDI-12 Sensor – Setup / Diagnostics

High Sierra Insight Software

File Transfer Help

RTU I/O Reporting Clock Realtime Data Logged Data SDI 12 Transparent Mode Repeater ALERT Monitor Mode

Defined I/O Points

ID	Rel Addr	Type	Name	Add	Multi
0000	Yes	Counter 1	Rain_Gauge	0.0	1.0
0005	Yes	Battery	Battery	0.0	1.0
0007	Yes	SDI-12	SurfaceTemp	0.0	1.0

Configure I/O Points

Name: SurfaceTemp Type: SDI-12

ID / Offset: 7 Relative Addressing

Adder: 0 Multiplier: 1.0 Precision: 1

SDI-12 Address: 1 SDI-12 Parameter: 0 Listen Only

Update Sensor

Sensor 7 Read (10 second delay + sens...)

ID	Raw	Calibrated	ALERT
0007	0023.5000	0235.0000	0235
0007	0161.8000	1618.0000	1618
0007	0023.3999	0234.0000	0234

Add Sensor Delete Sensor

Retrieve RTU Parameters Send RTU Parameters Start Sensor Read

Questions