Sigra Pty. Ltd.

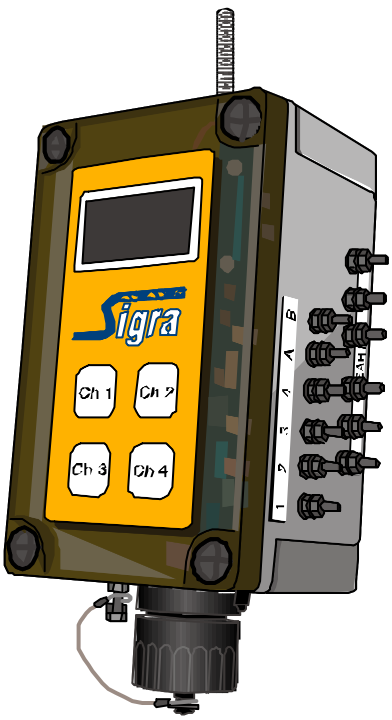
Drilling, Mining & Civil Engineering
Research, Development & Consulting

ABN: 68 061 279 427

The

Sigra Logger User Manual

Revision 3.1.0, August 2007



21 Lombank St, Acacia Ridge, Brisbane, Queensland 4110, Australia
Tel: (+61) (7) 3216 6344   Fax: (+61) (7) 3216 6988
http://www.sigra.com.au/

Table of Contents

List of Figures

List of Tables

Glossary

4th-order polynomial. A general-purpose calibration function applicable to many transducers. See also *calibration function*.

Alarm. A warning message that is generated when the value of a measured transducer signals satisfies a set of user-specified conditions.

Calibration constants. The constants for each term in the calibration function. The calibration constants are transducer-dependent and are usually supplied by the transducer manufacturer.

Calibration function. A mathematical function used to model the relationship between the measured raw data values (*e.g.*, frequency and resistance) and the values of real-world properties (*e.g.*, pressure and temperature).

Channel. A logger input to which a transducer can be connected and then measured. The logger provides 8 channels.

Coefficient file. A file containing a time-stamped history of the channel configuration and calibration information for a logger which is used to determine how raw data measurements are interpreted in order to obtain the calculated values of real-world properties.

Coefficient record. A record within a coefficient file that describes the channel configuration and calibration information for a logger at a given date.

CRC (cyclic redundancy check). A small, 16-bit digital signature of the contents of a copy of logger settings that can be used to reliably determine if two different copies of logger settings are identical.

CSV (comma separated values). A file format in which the data values on each line are separated by commas rather than spaces or columns. Many spreadsheets such as Excel support importing CSV-formatted data files.

Data checkpoint. The logger records the time of the last data record that was successfully downloaded onto a PC. This allows data to be downloaded from the logger using different PCs without having to re-download previously downloaded data.

Firmware. The on-board software that controls the operation of the logger's microcontroller. It is separate from the PC software that is used to interact with the logger.

Logger clock. An on-board clock on the logger which keeps track of the current time. The clock's value is lost each time the batteries are disconnected or the logger is reset. The clock must be set before logging will commence.

Logger group. A group of related loggers. Each logger group has a unique name and data directory in which data and settings are stored. This allows data from different projects to be segregated. The software will only search for loggers associated with the current logger group using RF at start up and connect.

Logger network. A group of one or more loggers interconnected by RF communication.

Raw data value. See *data sample.*

Recording mode. A settings parameter that defines under what conditions a measured data sample is stored in the logger's non-volatile memory.

RF. Radio frequency.

Sample interval. A settings parameter that defines how often (in seconds) each of the transducers connected to the logger is measured (but not necessarily recorded).

Sampling. The act of measuring an analogue electrical signal from a transducer and converting it into a 16-bit (0-65535) digital value (*raw data value*) using an analogue-to-digital converter (ADC). See also *calibration function*.

Serial number. A three-digit number which uniquely identifies the logger.

Settings. A set of parameters stored on the logger that controls its operational behaviour.

Settings history. A history of changes made to the logger's sensor settings are stored on-board the logger. The history can later be downloaded and used as a reference.

Steinhart-Hart log 3rd-order polynomial. A calibration function specifically designed for temperature measurements using thermistors. See also *calibration function*.

Sweep frequency range. The sweep frequency range defines the range of frequencies used to excite a vibrating wire transducer.

Thermistor. A transducer whose resistance varies with temperature.

Time-stamp. A value used to describe the date and time at which an event occurred. The value is stored as the number of seconds since 1970/01/01 00:00:00. Date/times before the year 1970 or after the year 2038 cannot be represented.

Transducer. A device for converting one form of state into another, *e.g.*, converting kinetic, mechanical or thermal state into electrical signals such as voltage, resistance or frequency.

Vibrating wire. A transducer whose output signal frequency varies with the tension of an internal vibrating wire.

1 Logger Operation Overview

This section aims to give a general overview of the main concepts involved in the operation of the logger.

1.1 Data measurement

Sigra Field Data Loggers are designed to allow the direct connection of a broad range of industry-standard transducers. Transducers are devices for converting one form of state into another. In the context of the Sigra loggers, transducers convert forms of state such as kinetic, mechanical and thermal state into electrical signals. The Sigra logger provides 8 channels that can be used to measure the following types of transducers:

- voltage;
- resistance;
- frequency;
- vibrating wire; and
- opened/closed switches (*e.g.*, reed switches).

Analogue electrical signals from transducers are measured and converted (sampled) to digital values using the logger’s onboard analogue to digital converter chip (ADC). The sampled data values (*raw data*) are stored as 16-bit (0-65535) values in the logger’s onboard non-volatile memory. Each raw data sample is also dated with the time at which the measurement was performed. The relationship between the units of a raw data sample and the actual measured electrical signal is shown in Table 1. Logger serial numbers less than 475 use first number, equal or greater use second number.

Transducer type	**1 raw data unit**
Voltage	0.50354×10^{-4} V or 0.76142x10-4
Resistance	1 Ω
Vibrating wire	0.1 Hz
Frequency	0.1 Hz
Switches	1 Ω

Table 1: Raw data units for each type of transducer.

A mathematical *calibration function* is used to model the relationship between the measured raw data values (*e.g.*, frequency and resistance) and the values of real-world properties (*e.g.*, pressure and temperature). An example of a calibration curve for a thermistor, designed to measure temperature, is shown in Figure 1.

A general-purpose calibration function applicable to many transducers is the 4^{th}-order polynomial function given by Equation 1.

$$f(x) = ax^4 + bx^3 + cx^2 + dx^1 + ex^0 \qquad (1)$$

where: x = the raw data sample value; and
a,b,c,d,e = calibration constants.

The calibration constants are transducer-dependent and are usually supplied by the transducer manufacturer. Calibration functions can be specified on a channel-by-channel basis, allowing transducers to be individually calibrated.

The logger also features an offset function that allows the dynamic compensation of transducer readings on one channel using the computed results of measurements from another channel. For example, a vibrating wire transducer that also houses a thermistor can be used to display pressure (in kPa) that is corrected for temperature variations of the transducer.

Recorded data may be previewed on a logger's LCD screen or downloaded onto a PC for full analysis. Because recorded data is stored in raw units on the logger, calibration changes can be retrospectively made to data after the transducer measurements have been logged.

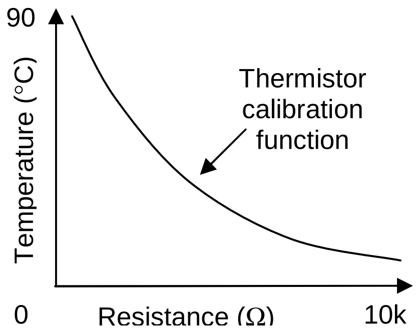


Figure 1: Example temperature calibration curve for a thermistor.

1.2 Settings

The behaviour of the logger is controlled by a set of parameters referred to as *logger settings*. The logger settings control several classes of operation including:

- general functions such as the power mode of the logger;
- logging functions such as what types of transducers are connected to each channel and how often data should be recorded; and
- communication functions such as how it communicates with other loggers and devices.

Before the logger can be put into operation, all the settings parameters must be properly configured. The settings are stored in non-volatile memory on the logger and will not be lost if the battery is disconnected.

The supplied PC software enables the settings to be easily configured. Since radio communication may be slow, it is impractical to download the settings from the logger each time they are to be modified and, therefore, a copy of the logger settings is stored on the PC's hard drive. A third copy of the logger settings is made in the PC's memory as the user edits them. Thus, in normal operation, up to three individual copies of the logger settings can exist:

- the logger settings physically stored in the logger's memory;
- a cached copy of the logger settings stored on the PC's hard drive; and
- a copy of the logger settings which are currently being modified by the user stored in the PC's memory.

Multiple PCs can be used to access the logger (though not simultaneously). To ensure that the settings stored on the logger are identical to those stored on the PC, each time the logger is accessed the PC software verifies that the settings stored on the PC are the same as those on the logger by requesting the CRC[1] of the settings from the logger and ensuring that the returned CRC matches the CRC of the settings stored on the PC. If the settings are missing from the PC or the settings are different from those stored on the logger then the PC software provides the user with a choice of either:

- downloading the settings stored on the logger onto the PC;
- uploading the settings stored on the PC onto the logger; or
- creating a new set of logger settings from scratch.

Additionally, each time the settings are updated on the logger, a copy of the changes is stored in logger's onboard memory. This settings changes history can later be downloaded and examined to establish the logger settings at a particular date.

1.3 Recording data

Data recorded by the logger is stored in the logger's memory until it can be downloaded to a PC. The logger can store between 18000 – 45000 data samples, depending on the number of channels being recorded. Once the memory is full, the oldest data in the memory will be overwritten by new data. Therefore, data should be downloaded regularly in order to avoid data loss. How often the sensors are sampled and what data samples are recorded in the logger's memory are controlled the logger settings. The logger supports two types of recording modes:

- *Record Every Sample*. Every data sample is recorded in the logger's memory; and
- *Record On Value Change*. The data sample is only recorded if one of the following conditions is met:
  - a calculated data value has varied from the last recorded value by more than a specified amount for one or more of the sampled sensors; or
  - no data samples have been recorded for a specified period of time.

The latter recording mode is useful for reducing the size of recorded data for relatively stable transducers signals.

1.4 Downloading Data

The PC software supports three types of data downloads:

- downloading data which is dated after the most recent data record present on the PC;
- downloading data from within a date range specified by the user; and
- downloading data from the date of the last data record previously downloaded from the logger.

In order to implement the 3rd download type, the logger maintains a *data checkpoint date*. The data checkpoint date is the timestamp of the last data record that was previously downloaded from the logger and it is updated each time the data is successfully downloaded from the logger. This enables different PCs to be used to download only the data that has not been previously downloaded from the logger.

Downloading data from the logger does not permanently erase it from the logger's memory and hence it is possible to download old (previously downloaded) data from the logger (assuming it has not been overwritten by new data).

1.5 Alarms

The logger can be configured to generate warning notifications when the transducers that are being monitored by the logger exceed user-defined thresholds. The thresholds can be

[1] A CRC (Cyclic Redundancy Check) is a small, 16-bit digital signature of the contents of a copy of logger settings that can be used to reliably determine if two different copies of the logger settings are identical.

configured on a channel-by-channel basis and are specified as absolute minimums/maximums or as rate of changes. The logger can be configured to automatically dial-up to send the warning notification using a connected mobile phone or it may be configured to relay the warning notification through another nearby data logger using radio communication.

1.6 Logger Groups

Groups of loggers can be defined. Logger groups are useful for managing many loggers that may be associated with different projects. Each logger group has its own data directory in which settings/data are written/read and its own list of known loggers which the software will attempt to connect to using RF when the group is selected. Groups are identified by a user-specified group name. Changing logger groups effectively changes the data directory that settings and data files for all loggers are written to/read from. Logger groups offer the following advantages:

- descriptive names (*e.g.*, locations) can be associated with loggers;
- data from different loggers can be segregated; and
- detection of loggers at start up is quicker.

1.7 Communication

The logger supports three modes of communication:

- RS232 communication;
- modem communication; and
- radio communication.

Multiple modes of communication can be used in combination to access loggers.

RS232 communication

The Sigra Logger has an inbuilt RS232 communication interface that enables it to communicate with a PC's serial using the supplied RS232 cable. Alternatively, a USB-to-serial converter can be used to connect the RS232 cable to a PC's USB port.

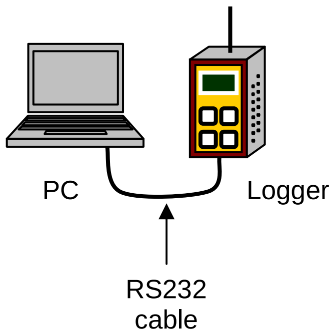


Figure 2: Connecting a PC to a logger using a RS232 cable.

Modem communication

The Sigra Logger's RS232 interface can also be used to connect to a data modem, *e.g.*, a GSM/CDMA data modem or a PC modem (see Figure 3). This allows the logger to be remotely accessed from a PC dialing-up the logger or for the logger to dial up a PC to send warning alarms.

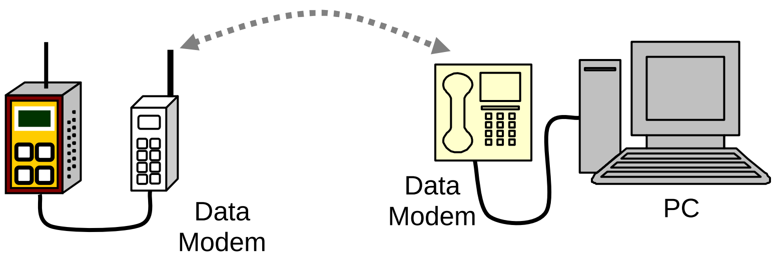


Figure 3: Connecting a PC to a logger using data modems.

Radio communication
The Sigra Logger has an inbuilt short-range data radio frequency (RF) transceiver that supports RF communication between loggers, with clear line-of-sight, over a distance of up to 500 m (and frequently beyond) using the standard whip aerial. For greater RF range, an external directional antenna (*e.g.*, Yagi antenna) or high-powered RF transceiver can be attached to the logger.

Loggers can be connected using RF communication to form a logger network. Users can access individual loggers in the network by using one logger to relay messages to and from another logger (see Figure 4).

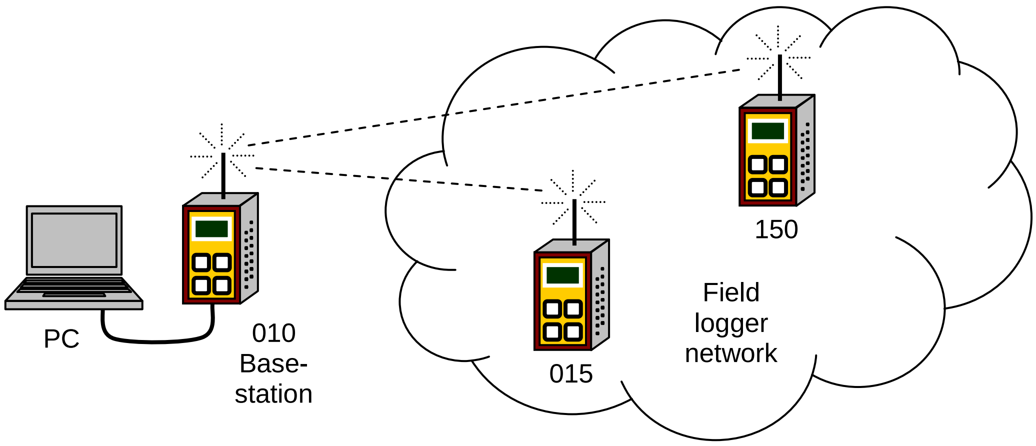


Figure 4: Connecting a PC to a logger using radio communication.

2 Hardware

2.1 Supported transducers

Sigra Data Loggers are designed to measure and record transducer readings from four different types of transducer:

- voltage;
- resistance;
- frequency;
- vibrating wire; and
- opened/closed switches.

Other types of transducers will require additional electronic circuitry to interface them with the logger (please contact Sigra for further consultation/information).

Transducers can be individually calibrated using one of the following calibration functions:

- 4th-order (or lower) polynomial
- Steinhart-Hart 3rd-order log polynomial (for thermistors measuring temperature only).

The logger measures the analogue electrical signals from the transducer and converts them into raw data samples. The correspondences between the units of a raw data sample and the actual measured electrical signal for each transducer type are shown in Table 2. For voltage, Logger serial numbers less than 475 use first number, equal or greater use second number.

Transducer type	1 raw data unit
Voltage	0.50354×10^{-4} V or 0.76142x10-4
Resistance	1 Ω
Vibrating wire	0.1 Hz
Frequency	0.1 Hz
Switch	1 Ω

Table 2: Raw data units for each type of transducer.

Voltage transducers
The loggers will measure a maximum voltage directly in a range from 0 to +3.3V (serial numbers less than 475) or 5V (serial numbers equal or greater than 475). If it is necessary to measure voltages outside of this range, then the input voltage must be scaled to the maximum voltage or less using a resistive divider network or other means. For logger serial numbers less than 475, all voltage measurements, a resistor of at least 1000Ω should be connected in series between the voltage source being measured and the logger terminal.

Resistance transducers
The logger will measure resistance in the range of 0 to 65 KΩ.

Frequency transducers
The logger will measure frequency in the range of 0.5 to 5.0 kHz with 0.1Hz resolution.

Vibrating wire transducers

Vibrating wire transducers are frequency devices but differ in operation to other frequency transducers in that they require the transducer to first be excited by an electrical signal from the logger before they produce a measurable output. The excitation signal causes the internal wire in the transducer to vibrate and the resulting frequency at which the wire vibrates is measured. The logger supports up to four vibrating wire transducers (channels 1-4 only).

Switches

The logger will measure the opened/closed state of a switch between the terminals of the current channel. To achieve this, the logger measures the resistance of switch (low Ω = closed, high Ω = open). Using the resistance measurements, a count of the number of times the switch has opened and closed can also be obtained (firmware>0.73 only).

2.2 External Layout

Sigra Field Data Loggers are housed in a durable, waterproof case. They have been designed to withstand exposure to harsh environments. The front and side views of the Sigra logger are shown in Figure 5.

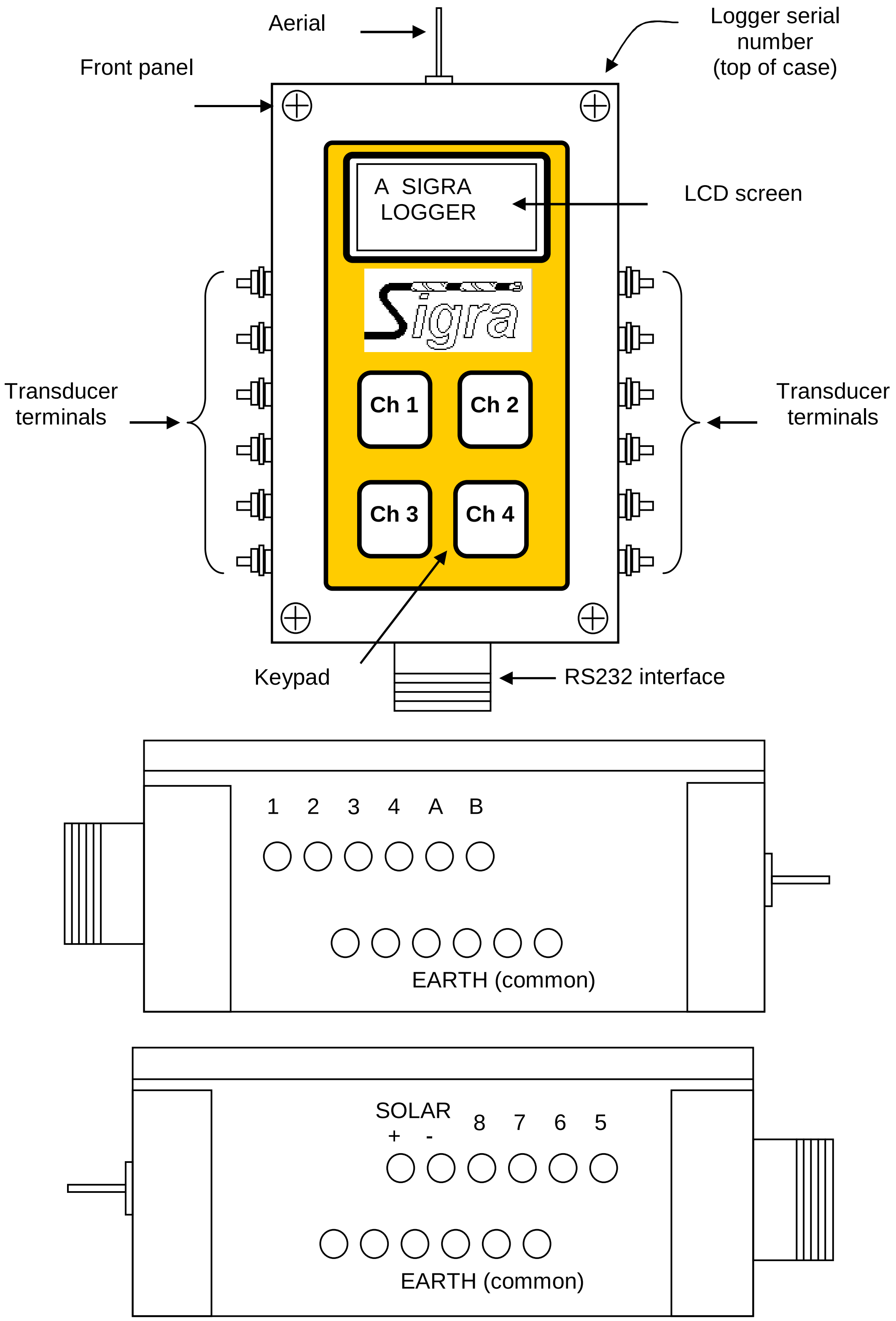


Figure 5: Front and side views of the Sigra Field Data Logger.

The main components of the Sigra logger are as follows:

Aerial

A standard whip aerial is supplied with every Sigra Logger, supporting RF communication over a range beyond 500 m.

LCD Screen
Messages are displayed on the LCD screen (8 character x 2 lines).

Keypad
The 4-button keypad can be used to interact directly with the logger.

RS232 interface
The RS232 interface is a 7-pin waterproof connector (Amphenol C 16-1 series T31060000) located on the bottom side of logger that allows connection to a PC or modem. The cap should be screwed on to the connector when there is no cable connected.

Terminals
Transducers are connected via stainless steel terminals labelled 1 – 8 on both sides of the logger case. Channels 1 - 4 support direct connection to vibrating wire transducers. Terminals labelled A,B,SOLAR+,SOLAR- are not connected internally to the logger but have been included to provide connection points for additional equipment (*e.g.*, external power supplies). The bottom row of terminals is a common earth rail. Transducer wires should be connected between a numbered terminal and any of the common earth terminals.

The terminals have been waterproofed using Loctite 290. The seals will withstand reasonable tightening but may be broken by over-tightening the screws. It is recommended that the nuts be tightened using a socket driver held in the fingers.

Shielded cable should be used where cable lengths are excessive or electrical interference is experienced (erratic measurements are obtained).

Logger's Serial Number
Each logger has a three-digit serial number which uniquely identifies the logger. The serial number is located on the top side of the case (near the aerial connector). The serial number of the logger can also be displayed on the logger's LCD screen by pressing the keypad buttons CH1+CH2 simultaneously (see Section 0 for more details).

2.3 Internal layout

Disassembling the logger

The logger can be disassembled by unscrewing the four front screws and gently removing the front panel. The internal view of the logger is shown in Figure 6 and **Error! Reference source not found.**. The main printed circuit board (PCB) is attached to the rear of the front panel. Cables run from the connectors on the PCB to various points in the box (terminals, aerial, and RS232 connector). Cable connectors are polarised so that it is not possible to incorrectly connect cables. Care should be taken when reassembling the front panel to ensure no cables or other materials compromise the seal. Over-tightening the front screws may cause the front panel to crack.

Adjusting the LCD display contrast
The contrast of the LCD display can be adjusted for optimum viewing by using a small screwdriver to rotate the screw on the trim pot on the PCB (see Figure 6 **Error! Reference source not found.**). Increasing the contrast will consume more power when the LCD display is in use.

Replacing the batteries
In the centre of the box is a battery pack (4 x AA Alkaline cells or rechargeable battery pack) that is secured to the box. The AA Alkaline batteries can be replaced by disconnecting the battery connector from the PCB, unscrewing the strap screws, replacing the batteries, replacing the battery pack and strap and reconnecting the battery connector to the PCB.

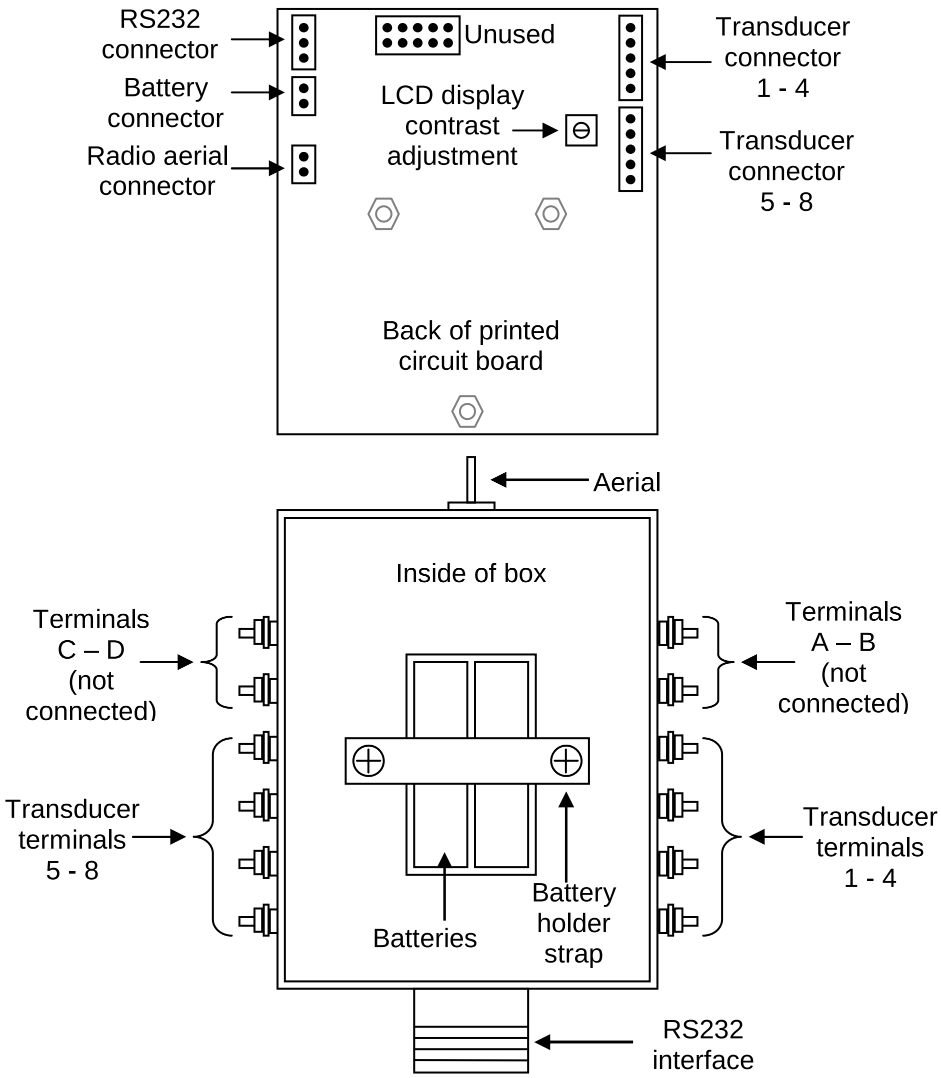


Figure 6: Internal view of logger with AA batteries.

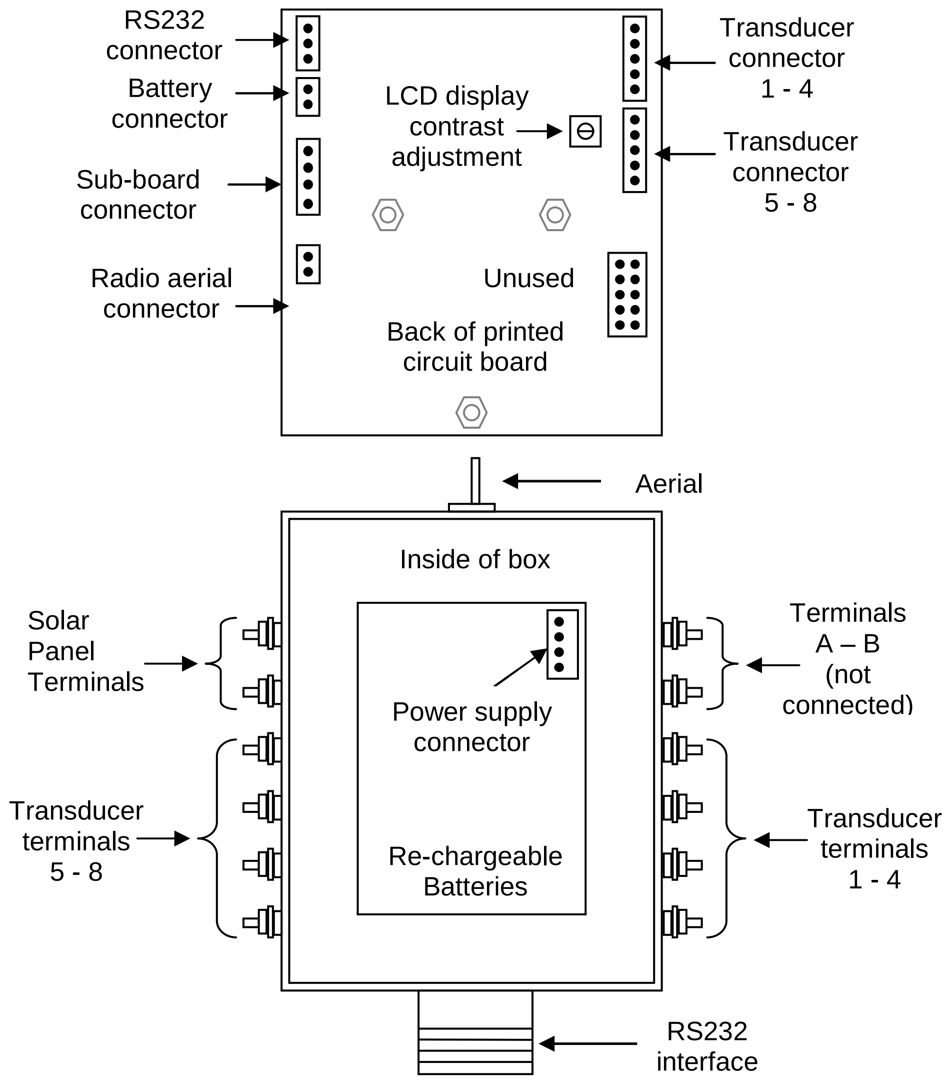


Figure 7: Internal view of logger (serial number > 474) with rechargeable battery pack.

LCD screen messages
When the logger is first powered up ‘SIGRA LOGGER’ will momentarily appear on the LCD screen. If nothing is displayed on the screen the batteries should be checked.

If the logger’s clock is not set, the message ‘SET CLOCK’ will appear on the LCD screen. The logger will not record any data until the logger’s clock is set. This can be done by using the keypad (see Section 0) or using the PC software (see Section 3.5.9).

If there are no valid settings stored on the logger, the message ‘NO SETTINGS’ will appear on the LCD screen. Use the PC software to correctly configure the logger (see Section 3.5).

Other messages that may appear on the screen are listed in

Message	Meaning
OFFLINE	The logger has been configured for modem use and a modem has been detected connected to the logger.
ONLINE	The logger has been configured for modem use and has answered an incoming modem call.
PC	The logger is communicating with a PC using the RS232 cable.
RF	RF transmissions have been detected.
RX	A valid RF message has been received. Logger serial numbers greater than 474 will also display RF level strength.
TX	An RF message is being transmitted.
RESET	The logger is being reset.
PENDING	The requested operation is waiting, pending the completion of another task.

Table 3: LCD screen messages.

Keypad operation

The keypad on the front panel of the logger can be used to directly interact with the logger. It provides five main functions:

- Displaying information about the logger.
- Checking and setting the logger’s clock time.
- Reading battery voltage level.
- Sampling channels.
- Resetting the logger.
- Viewing previously recorded data.

Check that the batteries are connected if no display appears on LCD screen when using the keypad.

Displaying information about the logger
Pressing the CH1 + CH2 buttons simultaneously displays information about the logger. The information contains the serial number and firmware version of the logger (see Figure 8).

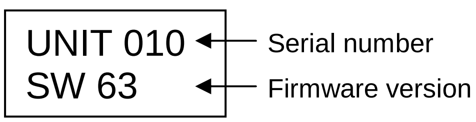


Figure 8: Logger information display.

Checking and setting the logger's clock time

The logger's clock time can be checked by pressing the CH1 + CH3 buttons simultaneously. If the logger's clock has not been set, the time will be displayed as (19)70/01/01 00:00:00.

Pressing the CH1 + CH4 buttons on logger serial number less than 475, or CH2 + CH3 on logger numbers greater than 474 simultaneously will cause the logger to enter set clock mode. In this mode, the time (initially the date of the last recorded data sample) is displayed on the LCD screen in YY/MM/DD HH:MM:SS format. Use the CH2 or CH4 button to increase or decrease a date component value. Pressing CH1 moves to the next date component. Pressing CH3 sets the logger's clock to the currently displayed time. Pressing CH1 + CH3 simultaneously, or pressing no buttons for 30 seconds, will leave the set clock mode without making any changes to the clock.

The logger's clock must be set before it will not record data. The clock will need to be re-set each time the logger's batteries are disconnected on logger numbers less than 475.

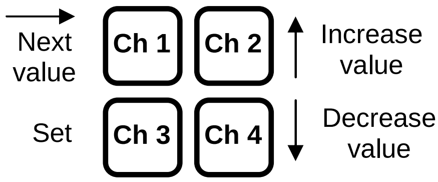


Figure 9: Set clock mode buttons.

Viewing battery voltage

Pressing the CH1 + CH3 buttons will display the current battery voltage.

Sampling channels

Channel transducers can be instantaneously sampled and the real-world value displayed on the LCD display. To sample any of channels 1-4, press and release the corresponding channel number on the keypad. To sample any of channels 5-8, press and hold the corresponding button shown in Figure 10 for 2 seconds. For all channels, the reading will only be displayed on the screen once the button is released. Both the value and units for the channel reading are displayed for 5 seconds.

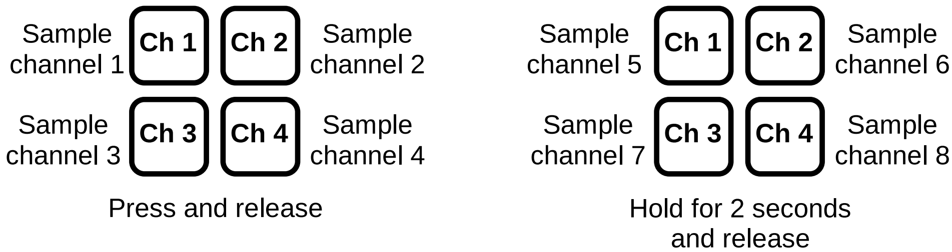


Figure 10: Channel reading buttons.

Resetting the logger

Pressing the CH1 + CH3 + CH4 buttons simultaneously resets the logger. This function is equivalent to disconnecting and then reconnecting the batteries. Resetting the logger causes the logger to do a self-test and then resume operation. Data and settings stored on the logger will not be lost. However, the logger's clock time will need to be set again before logging will commence.

Viewing previously recorded data on loggers before 475

Previously recorded data on the logger can be viewed using the keypad. Holding any button for at least 5 seconds will cause the logger to enter history mode. In history mode, a date

(initially the date of the last recorded data sample) is displayed on the LCD screen. Continuing to hold the button will case the date to gradually count backwards. Release the button at the desired data date and then select the channel to be displayed using one of the buttons shown in Figure 10. Multiple channels can be displayed while in history mode. The logger will leave history mode if no buttons are pressed for 3 seconds.
This feature has been **removed on newer loggers**.

2.4 Power/Batteries

The logger is designed to be a low power device. The battery pack supplied with the logger could be a non-rechargeable battery pack of four AA alkaline cells (6V) or rechargeable battery pack used with a solar panel. The alkaline batteries under normal operation, should last for many months. The actual battery life depends on a number of factors including the sampling rate, the type of transducer used, and the radio settings (see the following section for more details). Vibrating wire transducers, in particular, consume more power than other transducer types because an excitation signal is required before each sample to cause the internal wire to vibrate.

If the terminal voltage of the battery drops below a set level a low battery alarm is generated (see Sections 3.5.14 and 3.8). The logger will continue to operate after the alarm is raised, but replacement of the alkaline batteries, or recharging the rechargeable battery pack should be considered in order to avoid data loss. See Section 2.3 for details on replacing the batteries.

Logger serial number -	Less than 475	475 and greater.
Low voltage level alarm set.	4.8 Volts	5.3 Volts
Reset low voltage alarm.	none	5.5 Volts

Table 4: Low battery level alarm settings

For applications having greater power requirements (*e.g.*, modems), other power supply options such as an external solar power cell and rechargeable battery combination or direct mains power supply can be arranged where necessary. Please contact Sigra for more information.

Battery life considerations

Battery capacity is normally quoted in Ampere-hours (Ah) for larger batteries and milliampere-hours (mAh) for smaller batteries. Typical consumption values are listed in mAh for various modes of operation in Table 5

Mode of Operation	**Consumption per day (mAh)**
Standby (low power mode)	1.32
Check for incoming RF transmissions every second	12.0
Check for incoming RF transmissions every 5 seconds	2.40
Check for incoming RF transmissions every 10 seconds	1.20
Sample every 10 minutes with 1 thermistor	0.03
Sample every 10 minutes with 8 thermistors	0.21
Sample every 10 minutes with 1 vibrating wire and 1 thermistor	0.24
Sample every 10 minutes with 4 vibrating wires and 4 thermistors	0.92
Download one day's records using RF	0.33

Table 5: Power consumption for different modes of operation.

From **Error! Reference source not found.**, it is evident that the interval at which the logger checks for incoming RF transmissions (see Section 3.5.11) has a significant influence on battery life. The trade-off is between longer battery life and shorter initial access time when communicating with a logger using RF.

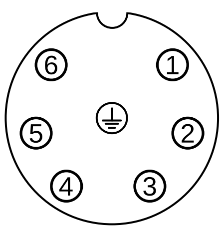
Assuming that a set of alkaline AA cells for our type of usage is rated at 1500mAh, the number of days of operation available from a set of batteries for various logger configurations is listed in Table 6.

Configuration Details	Battery Life (days)
1 thermistor Sampled every 10 minutes (record every sample) Check for incoming RF transmissions every 10 seconds Download once per day (144 records) using RF	555
1 thermistor Sampled every 60 seconds (record every sample) Check for incoming RF transmissions every 10 seconds Download once per day (1440 records) using RF	258
4 vibrating wire transducers and 4 thermistors Sampled every 10 minutes (record every sample) Check for incoming RF transmissions every 10 seconds Download once per day (144 records) using RF	397
4 vibrating wire transducers and 4 thermistors Sampled every 10 minutes (record every sample) Check for incoming RF transmissions every 1 second Download once per day (144 records) using RF	102

Table 6 AA battery life in days.

2.5 RS232 interface

The logger can be connected to either a PC or a modem using a RS232 cable. Different cables are required for connecting to a PC or modem since they are wired differently (see Figure 11). Both cables use an Amphenol C16-1 series T3105 001 plug to connect to the logger's RS232 interface. The PC cable uses a standard female DB-9 plug to connect to the PC. The type of plug required to a modem varies in size and wiring depending on the modem type – consult your modem manufacturer's data sheet.



(a) Logger RS232 interface pinout

Logger Pin	Modem Signal
⏚	DTR
1	DSR
2	RTS
3	CTS
4	GND
5	RXD
6	TXD

(b) Logger-modem cable wiring

Logger Pin	PC Pin
⏚	6 DSR
1	4 DTR
2	8 CTS
3	7 RTS
4	5 GND
5	2 RXD
6	3 TXD

(c) Logger-PC cable wiring

Figure 11: Logger cable wiring.

2.6 RF interface

In order to access loggers from a PC using the RF communication, one logger which acts as a base-station must be directly connected to the PC. Messages to and from other loggers will be relayed through the logger acting as a base-station. Using RF communication to download data is slower than connecting directly to the logger using a RS232 cable.

RF communication between loggers requires the supplied aerials to be attached to the loggers. When used outdoors, RF transmission range is optimised when all aerials share the same orientation, preferably vertical. When used indoors, the orientation is not critical as the distances are generally much less and reflections provide multiple paths. Radio range is significantly affected by a number of factors including:

- environmental RF noise;
- RF transmitter power setting of the loggers;
- battery voltage of the loggers;
- type of aerial connected;
- differences in orientation of aerials;
- the surrounding terrain (*e.g.*, mountains); and
- presence of large metal objects in the vicinity (*e.g.*, fences).

The RF range of the loggers using the supplied whip aerial is up to 500+ m in good weather with clear line-of-sight contact between loggers. For greater ranges, an external antenna can be attached to the logger. Both directional antennas (e.g., Yagi antenna) and high-powered radio transceivers can be used. Sigra can supply directional Yagi aerials that increase the RF range by directing the majority of the power in a relatively narrow beam. The disadvantage of using a Yagi aerial is that transmitted power in directions other than the main beam is significantly reduced.

RF specifications

The RF transceiver used in loggers is low power device and does not require an operating license in most countries.

Operating Radio Frequency:	315.00MHz/433.92MHz (Country dependent).
Effective Radiated Power:	Less than 1mW on high power using standard whip aerial.

3 Software

3.1 Requirements

The PC software works with all Windows operating systems from Windows 95 onwards. The PC requires a free serial port to communicate with loggers directly connected to the PC. It is also possible to use a USB-to-RS232 converter if a USB port is available (not supported using Windows 95/NT4 - see Section 0 for more details).

The software is compatible with all loggers produced by Sigra Pty. Ltd., although some advanced features introduced in later logger firmware versions will be disabled in older loggers (loggers can be upgraded to the latest version by reprogramming the logger's firmware – see Section 3.5.5).

Old PC software (prior to version 2.5) is not compatible with newer loggers (firmware versions 0.54 onwards). The use of old PC software with newer loggers may result in erratic logger behaviour and settings corruption.

3.2 Installation

PC software for configuring and downloading data from the loggers is provided on the supplied CD. Research and development of the Sigra Logger is an ongoing process and periodically new software with improved functionality is released. The latest PC software, manual and logger firmware can be found at Sigra's web site, http://www.sigra.com.au/logger. Inserting the CD into the computer's CD-ROM will cause the installation software to be automatically executed. If Window's auto-play feature is not enabled for the CD-ROM, the software can be installed by executing setup.exe.

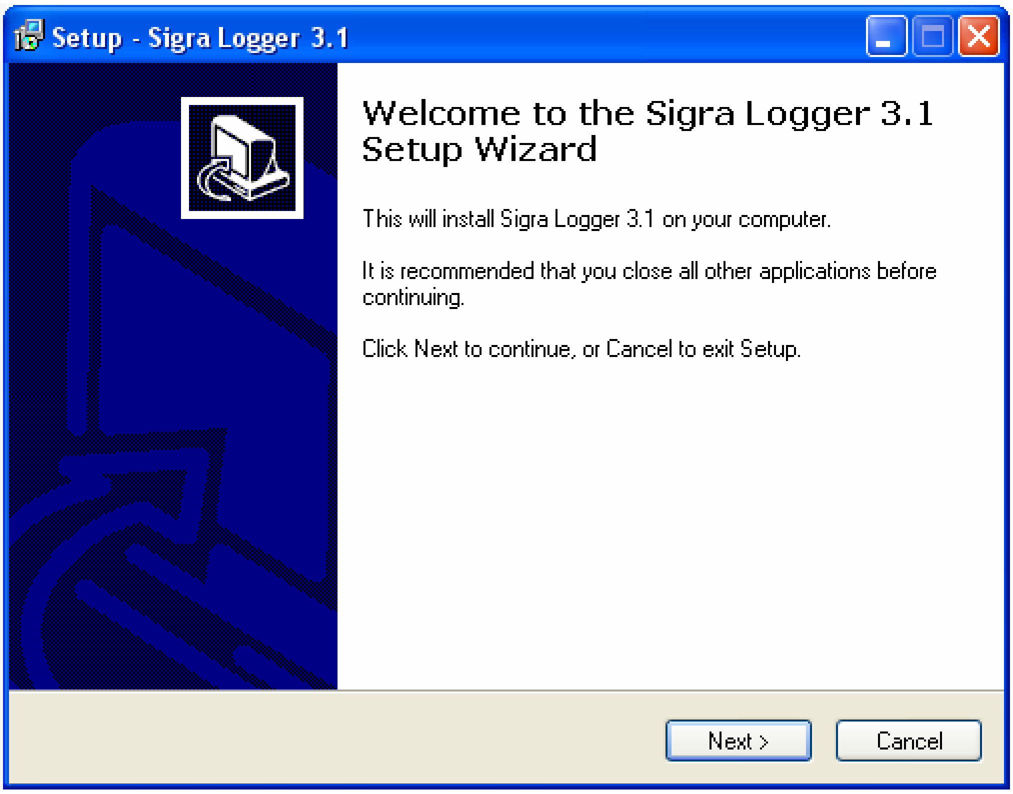


Figure 12: Setup wizard welcome page.

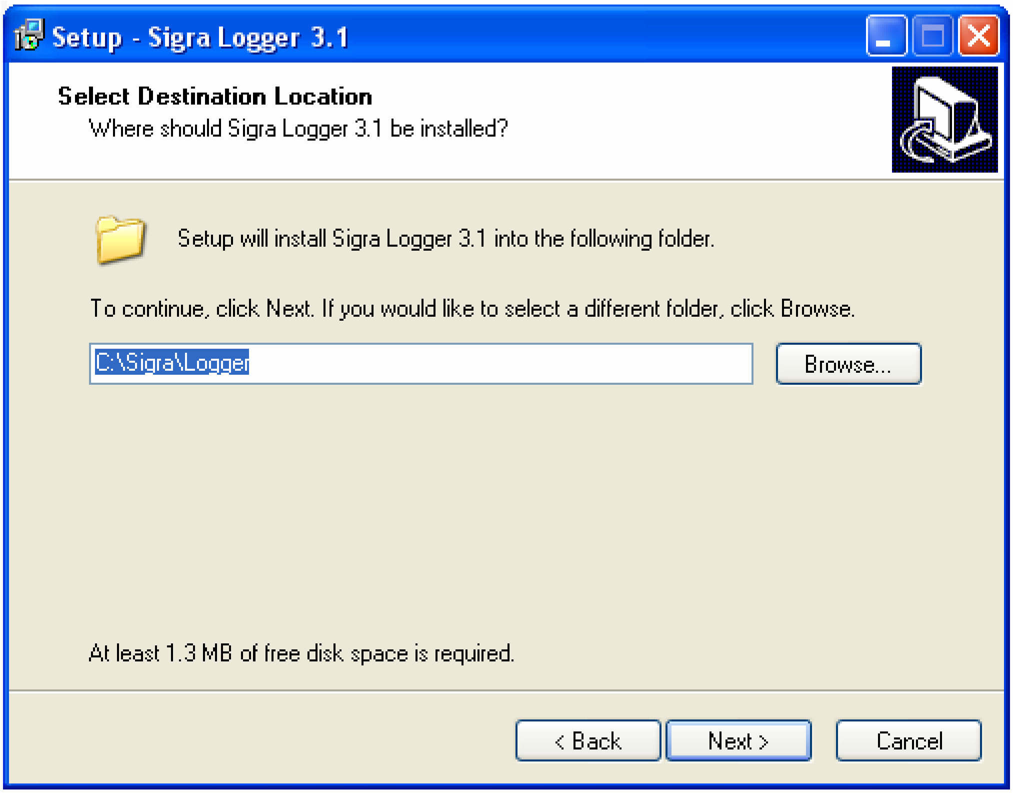


Figure 13: Select were to install the program.

The default installation directory is C:\Sigra\Logger this can be changed.

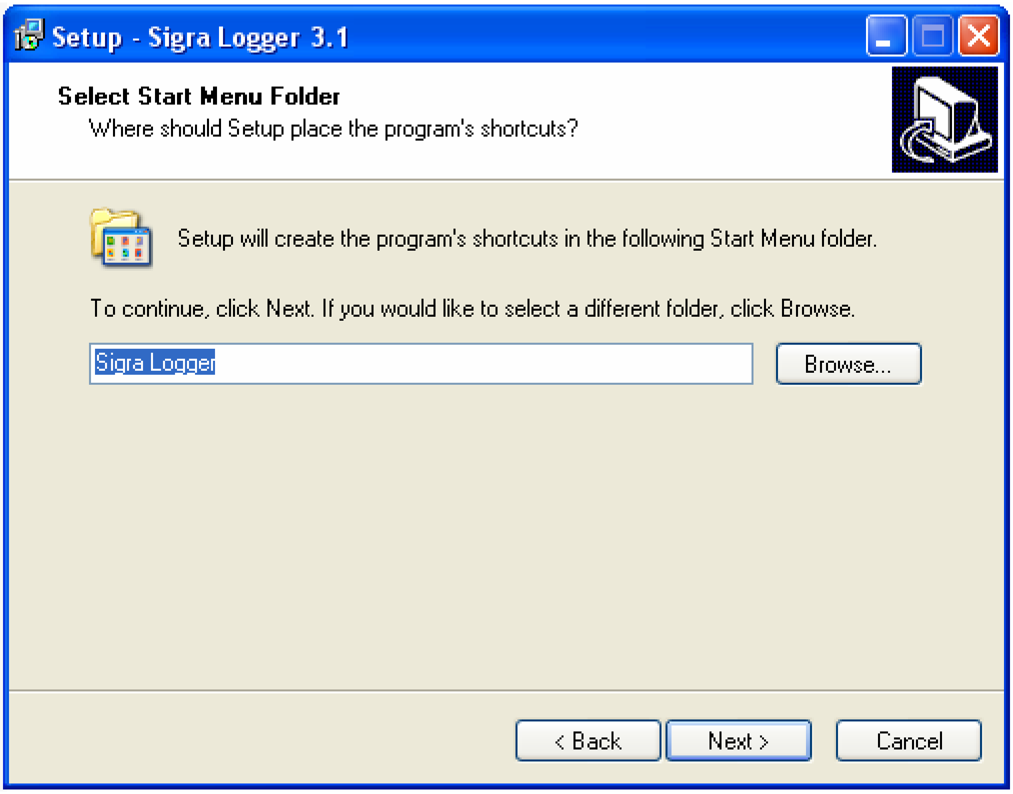


Figure 14: Selecting a Start Menu folder.

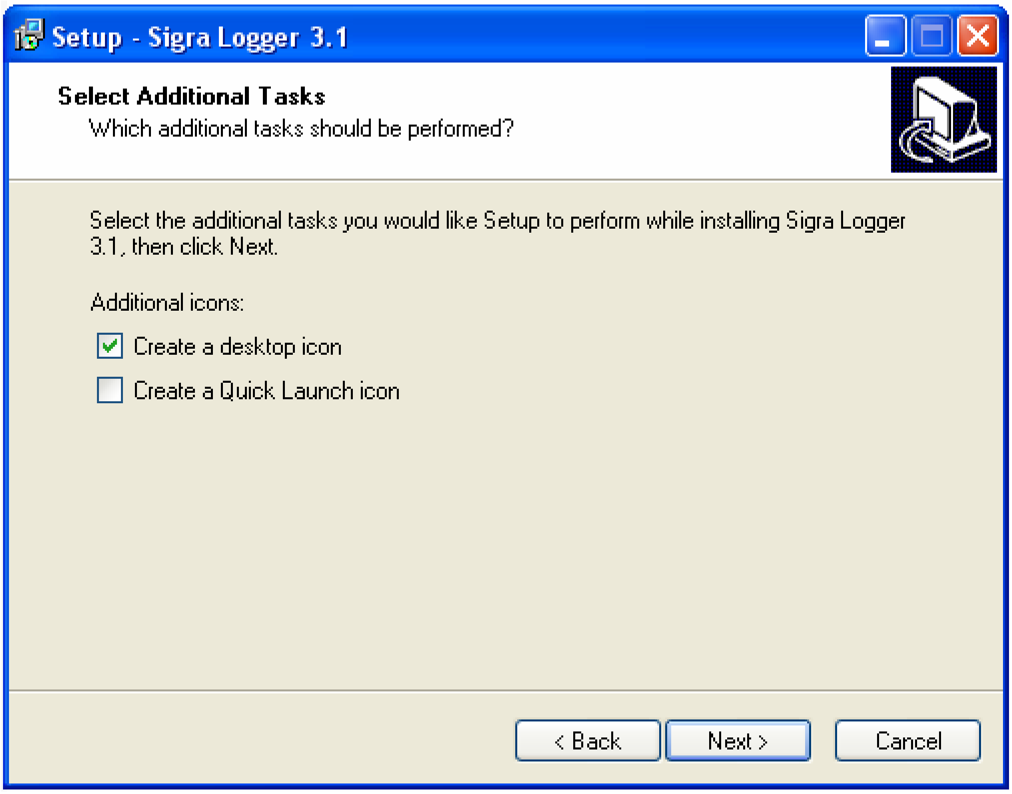


Figure 15: Desktop and Quick Launch icon options.

A summary of the selected installation options is then displayed, as shown in 15. The software will then be installed by pressing the Install button.

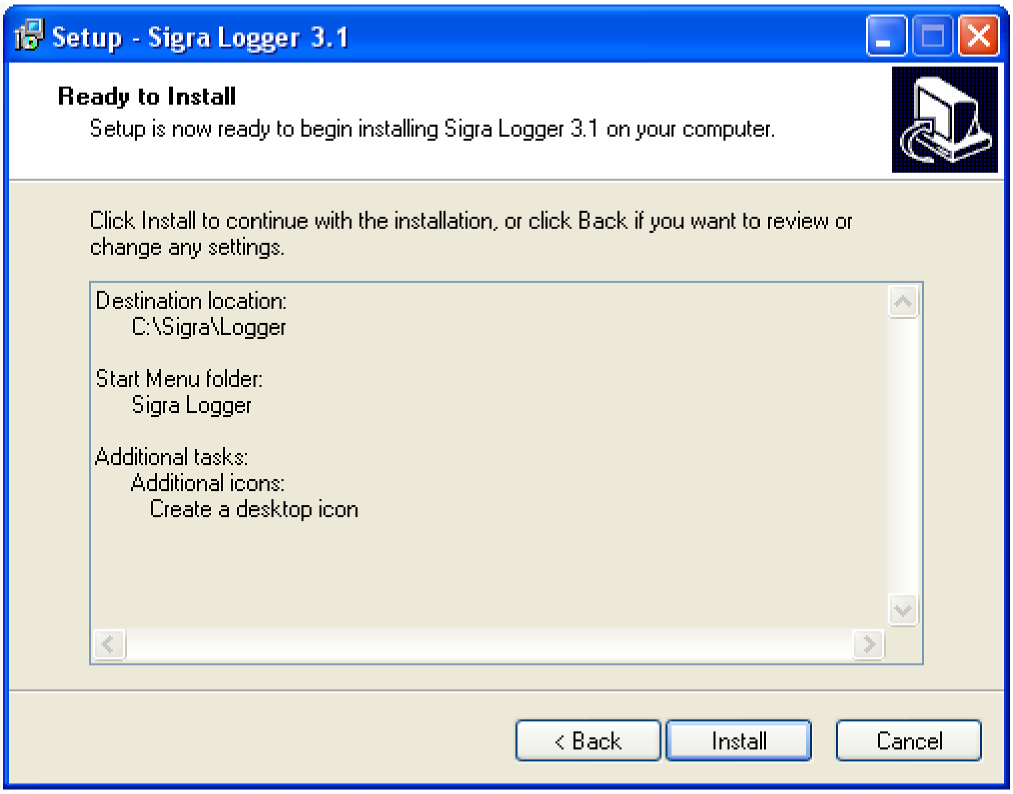


Figure 16: Summary of selected installation options.

3.3 Program file and directory structure

File naming conventions
Files with an extension of '.BIN' are binary files and data within these files is not human-readable. Files with an extension of '.TXT' are ASCII text files and data within these files is viewable using a text file viewer (*e.g.*, Window's notepad).

Some files are associated with a particular logger and this is reflected by the inclusion of the 3-digit serial number within the file name. In the manual, 'nnn' in a file name is used to refer to such files, where 'nnn' is the 3-digit serial number (*e.g.*, SETnnn.BIN could match SET010.BIN).

The character '*' is also used in file names in the manual and is used to represent zero or more characters (*e.g.*, UPGRADE*.BIN could match UPGRADE061.BIN).

Program install directory
The program install directory (the directory specified during installation) contains files that are necessary to execute the program. It also contains a program configuration file (LOG2.CFG) that is read at start up and contains a copy of the options that are displayed in the Program Options Menu. If the firmware on a logger is to be upgraded, firmware upgrade files (UPGRADE*.BIN) should also be placed in this directory.

Program install directory
(*e.g.*, C:\SIGRA\LOGGER)

Executable files:
SIGRALOG.EXE

Configuration files:
LOG2.CFG

Firmware upgrade files:
UPGRADE*.BIN

Figure 17: Program directory structure.

Data directories
Each data directory contains three subdirectories: SETTINGS, DATA and NETWORK (see Figure 18). Multiple data directories can exist. The currently selected logger group defines which data directory is used to read/store data and settings. Each of the three subdirectories is described below.

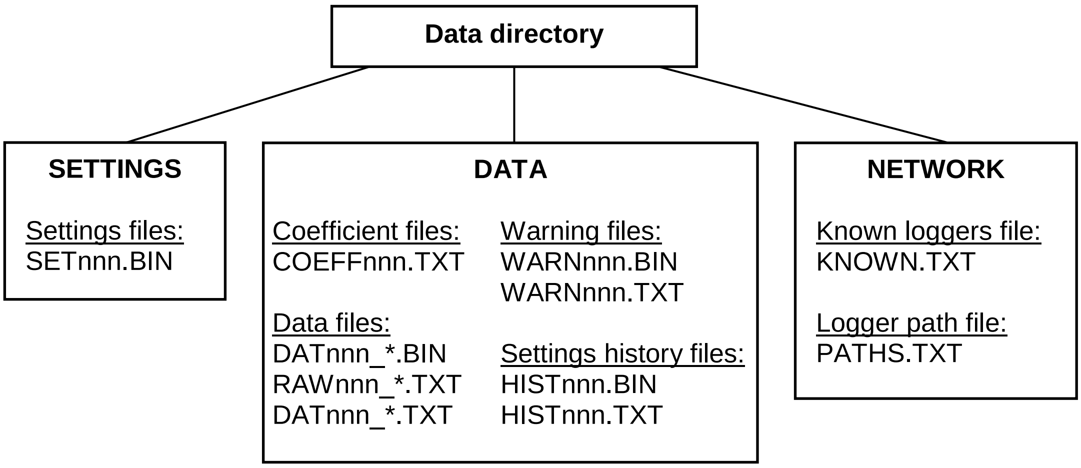


Figure 18: Data directory structure.

- **SETTINGS subdirectory**. The SETTINGS subdirectory contains local copies of the settings stored on loggers (SETnnn.BIN). If the settings file for a logger does not exist or cannot be read, the settings will have to be re-downloaded or reset to their default values in order to change the settings on the logger.

- **NETWORK subdirectory**. The NETWORK subdirectory contains files describing the configuration of the logger network for a given logger group. A known logger list (KNOWN.TXT) contains a list of logger serial numbers associated with a logger group that the program will attempt to connect to (using RF) upon start up and when changing to the group. The contents of the file can be edited using the Group Menu (see Section 3.12) or using the 'Edit Logger List' option in the Connect Menu (see Section 3.5.5). A network path file (PATHS.TXT) defines the path (route) through the logger network to a given logger from the PC. It is automatically generated.

- **DATA subdirectory**. The DATA subdirectory contains files associated with the data recorded by the logger. Downloaded settings histories are stored in binary form in the file HISTnnn.BIN. When the settings history for a logger is viewed, an ASCII version is generated in the file HISTnnn.TXT.

Downloaded raw data is stored in binary form in the files DATnnn_*.BIN (see Section 3.6.1 for details about the file name format). When 'List Raw Data' option is selected for a logger, an ASCII version of the raw data is generated in the file RAWnnn_*.TXT. When a 'List Data' option is selected, an ASCII version of the calculated data is generated in the file DATnnn_*.TXT. Coefficient records contained in the coefficient file for the logger (COEFFnnn.TXT) are used to convert the raw data into calculated data.

Warnings that are received by a logger are stored in binary form in WARNnnn.BIN. When a 'List Alarms' option is selected, an ASCII version of the warnings is generated in the file WARNnnn.TXT.

Backing up and restoring data directories
To back up a data directory, the complete data directory, including all three of its sub-directories, should be copied. To restore a data directory or merge data from other computers, copy the data to an appropriate location and then create/edit a logger group and assigned the group data directory to the location of the data directory just restored.

Overwriting files when restoring data may result in data loss.

3.4 Message Boxes

Message boxes may occasionally appear on the screen during the operation of the software to convey informational, warning and error messages. An example of a message box is shown in Figure 19. A list of action choices is displayed near the bottom of the box. The desired action can be selected by pressing the first letter of the choice (*e.g.*, press 'O' for OKAY or 'C' for CANCEL). Pressing ESC is equivalent to selecting CANCEL in most message boxes.

```
This operation will reset the current logger
settings on the PC to their default values.
It will NOT automatically update the
settings stored on the logger. Are you sure
you want to do this?

               OK     CANCEL
```

Figure 19: Example of a message box.

3.5 Main Screen

The layout of the main screen is shown in Figure 20. The screen is divided into 4 windows:

- Menu window;
- Active logger information window;
- Connected logger list window; and
- Message window.

All user interaction occurs in the Menu window. Information is displayed in the other three windows on the right hand side of the screen. Menu options in the Menu window can be selected by pressing the corresponding number. The screen's main areas of interest are described in Sections 3.5.1 - 3.5.5.

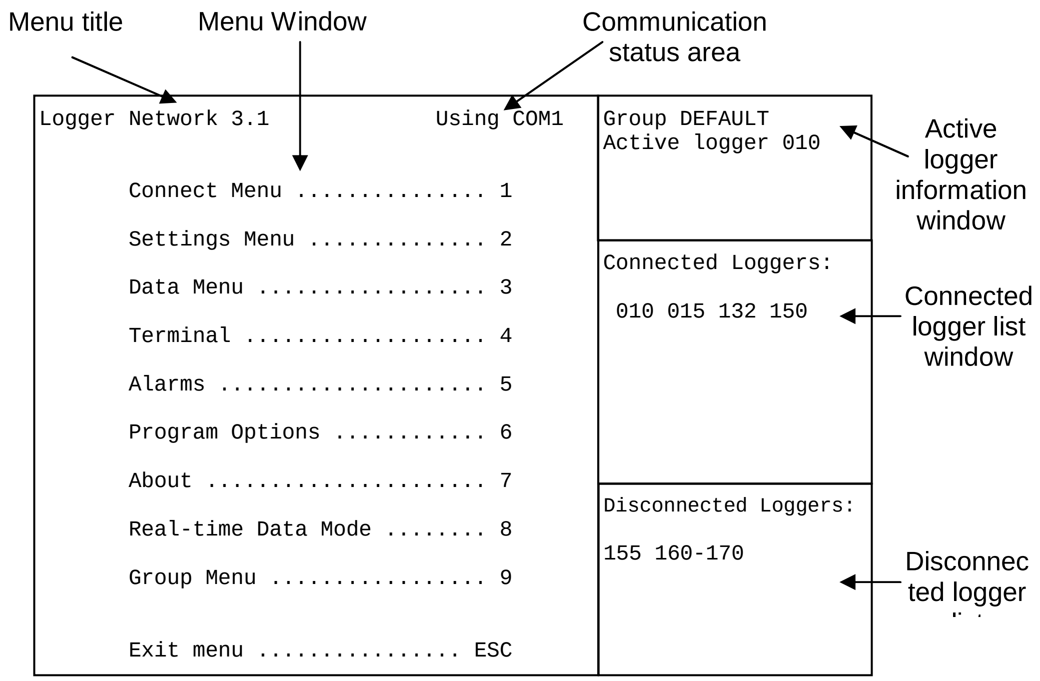


Figure 20: Screen layout.

3.5.1 Communication status area

This area shows the current method of communication being used between the PC and loggers. The type of communication can be either a RS232 cable or a modem.

RS232 connections

When using RS232 communication, the communication status area shows the serial port being used on the PC (as defined in the Program Settings menu) and whether the serial port can be accessed. If the serial port can be successfully accessed, then 'Using COMn' appears as shown in Figure 21(a), where *n* is the serial port number (1-9).

```
Using COM1
```

(a) COM port successfully opened.

```
Unable to open COM6
(COM6 doesn't exist)
```

(b) COM port cannot be accessed.

Figure 21: RS232 connection status messages.

If the serial port cannot be accessed then an error message appears together with the reason it cannot be accessed, as shown in Figure 21(b). Some of the common reasons for not being able to access a serial port are listed in Table 7 below.

Message	Meaning
COMn doesn't exist	The specified serial port is not installed in the operating system or the user doesn't have the required permission to access the serial port.
COMn already in use	The specified serial port is already in use by another program. The software requires exclusive access to the serial port and hence the other application using the serial port must first be closed.

Table 7: COM port error messages.

Modem connections

If a modem is detected on the serial port specified in the Program Settings menu, one of the messages listed in Table 8, indicating that modem connection status, is displayed.

Message	Meaning
Modem offline	A modem has been detected on the serial port specified in the Program Settings menu but the modem is currently disconnected from the logger.
Modem online	A modem has been detected on the serial port specified in the Program Settings menu and the modem is currently connected to a logger.

Table 8: Modem connection status messages.

3.5.2 Active Logger Information Window

This window aims to provide a summary of the available details about the currently active logger. The layout of the information window is shown in Figure 22 below.

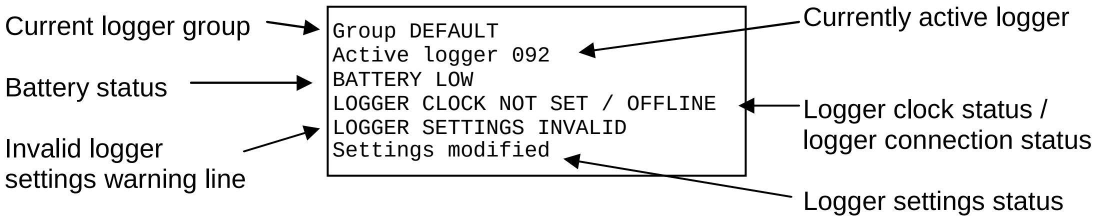


Figure 22: Active Logger Information Window.

Some information will only become available when the logger is accessed using the Logger menu. A description of each information line is as follows:

Logger group
The currently selected logger group is displayed. The logger group determines the location of the data directory that is used to read/store data/settings and which loggers the PC software will attempt to search for using RF at start up or when changing logger groups. If no groups are defined the DEFAULT logger group will be used.

Active logger
The currently active logger is displayed. The active logger number determines the logger that commands (*e.g.*, settings changes or data downloads) will be sent to. If no logger is active then 'No active logger' is displayed.

Battery status
If the batteries of the logger are low then 'BATTERY LOW' will appear. This feature is only supported by firmware versions 0.59 and later. To enable this feature on older loggers requires the firmware to be upgraded to a more recent version.

Logger clock status
If the logger clock is not set then 'LOGGER CLOCK NOT SET' will appear. The logger clock MUST BE SET in order for the logger to record data. It will need to be set each time the logger's batteries are disconnected.

Logger connection status
'OFFLINE' will appear if the logger is currently not connected, either directly or indirectly, to the PC. This message will disappear once communication is established with the logger.

Settings status line
This line reflects the current status of the logger's settings and the settings stored locally on the PC. If the current settings stored on the logger match the current settings stored on the PC this line will be blank, otherwise one of the messages listed in Table 9 will appear.

Message	Meaning
Settings modified	The settings in memory on the PC have been modified by the user but have not been uploaded onto the logger and are therefore different from the settings physically stored on the logger.
Settings missing	No valid settings are stored locally on the PC and therefore the settings stored on the logger are unknown. The logger's settings cannot be modified until either the settings are downloaded from the logger or the settings on the PC are reset to their default values.

Settings mismatched	The settings stored on the PC are known to be different from those stored on the logger. This may occur, for example, if multiple PCs are used to update the settings on the logger and a PC has an old copy of logger settings stored on it. In this situation, the current settings stored on the logger can be downloaded; the settings stored on the PC can be uploaded onto the logger; or the mismatch can be ignored.
Settings unknown	No communication has been made with the currently active logger and hence the status of the logger settings is currently unknown. This message will disappear once communication with the logger has been established.

Table 9: Settings status messages.

Invalid logger settings warning line
In the event that the settings stored on the logger are corrupt, then 'LOGGER SETTINGS INVALID' will appear. This means the logger will not function properly and new logger settings should be uploaded onto the logger. Under normal circumstances this message should never appear.

3.5.3 Connected Logger List Window

This window shows a list of the loggers that communication has been established with (see Figure 23). The first logger in the list is the logger that is directly connected to the PC, either by modem or RS232 cable. Other loggers can communicate with the PC by relaying messages through the first logger (which acts as a base-station). The loggers that are indirectly connected to the PC are listed in ascending order. Consecutive sequences of loggers are indicated using '-' to indicated a range of loggers, *e.g.*, 006-008 represents loggers 006, 007 and 008.

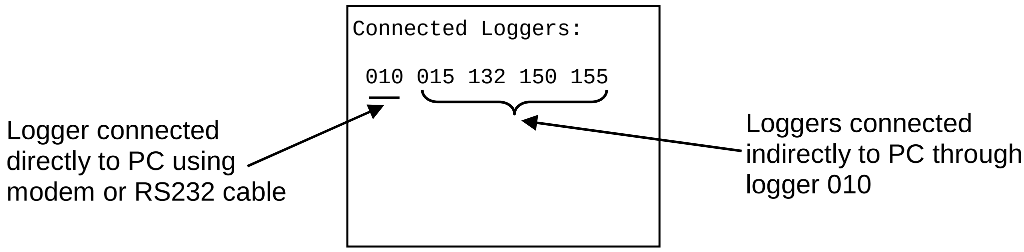


Figure 23: Connected logger list window.

As an example, the logger network shown in Figure 24 would produce the connected logger list shown in Figure 23.

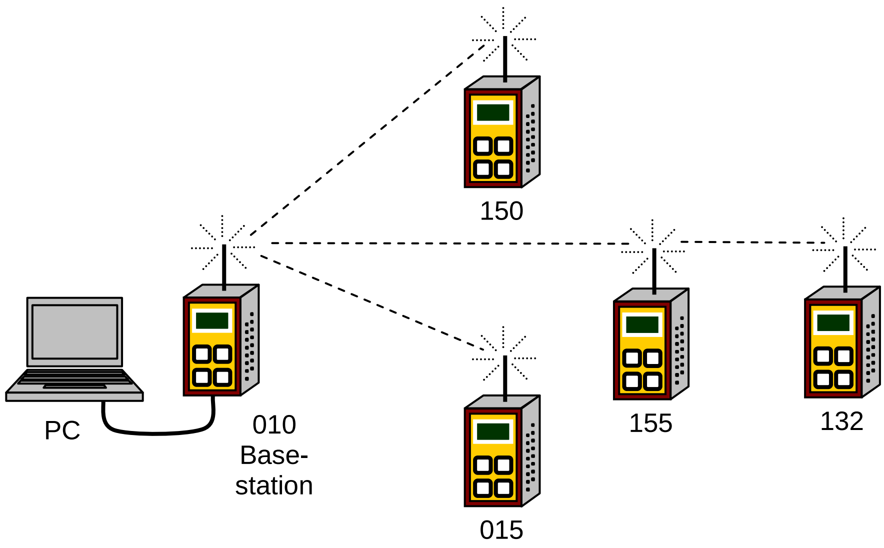


Figure 24: Modem installation.

If an alarm has been received from a logger the corresponding number in the connected window list will be highlighted in red, as shown in Figure 25. The alarms from the logger can be viewed using the Alarm Menu.

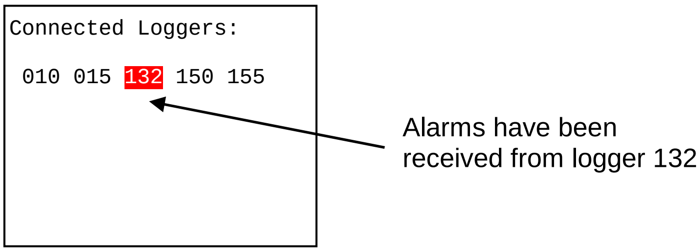


Figure 25: Alarm received indication.

3.5.4 Disconnected Logger List Window

This window shows a list of the loggers that are specified in the known logger list for the currently selected logger group but for which communication has not been established with (see Figure 26). A highlighted logger number represents the logger the PC is currently trying to connect to (*e.g.*, in Figure 26, the PC is currently trying to contact logger 161. A logger is moved from the disconnected logger list to the connected logger list once communication is established with the logger. Consecutive sequences of loggers are indicated using '-' to indicated a range of loggers, *e.g.*, 006-008 represents loggers 006, 007 and 008.

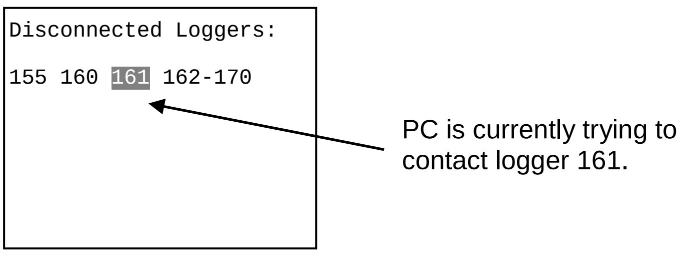


Figure 26: Disconnected logger list window.

3.5.5 Connect Menu

The Connect Menu contains options for connecting to loggers in the logger network. The loggers that will be searched for using RF for the currently selected logger group can also be defined. Finally, the menu allows the firmware on a logger to be re-programmed.

The layout of the Connect Menu is shown in Figure 27. All options may not necessarily be visible at any given time. If a modem is detected connected to the COM port, option 1 (Connect Directly) will not be available. If a logger is connected directly to the COM port, option 2 will not be available. Pressing ESC will leave the Connect Menu and return to the Main Menu.

A list of known loggers for the currently selected group is displayed in the Disconnected Logger List Window. Upon start up or selecting a re-connect option, the PC software attempts to connect to each of the known loggers in turn using RF by using the logger directly connected to the PC as a base-station. The logger the PC is attempting to contact is highlighted in the Disconnected Logger List Window. As communication is established with a logger it is moved from the Disconnected Logger List Window to the Connected Logger List Window.

Note: The PC will wait for up to 5 seconds for a response from a logger. It also will make up to 3 attempts to connect to a logger. Therefore, if loggers which aren't functioning or are out of range are included in the known logger list, delays can be experienced as the PC software attempts to established communication with these loggers. To improve the detection speed of widely-spaced loggers it is advised to use logger groups to split long logger lists into smaller lists (each logger can be in its own logger group if need be).

The menu options are described in following sections.

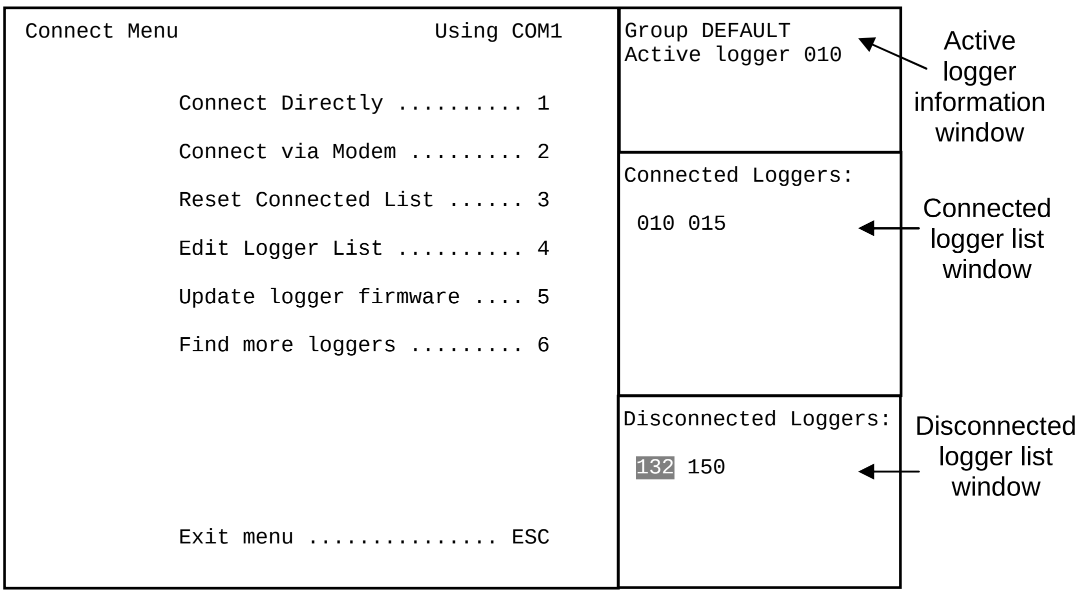


Figure 27: Connect Menu screen layout.

Connect Directly

This option can be used to manually connect to a logger that is directly connected to the COM port. Its use may be required if for some reason the attached logger is not automatically detected by the software (*e.g.,* logger not attached before running software, COM port does not initialise properly) or the attached logger is replaced by another logger.

Connect Via Modem

This option can be used to manually connect to a remote logger using a modem connected to the COM port. To remotely access a logger, the logger must be connected to a modem and correctly configured to listen for incoming connections using the modem (see Section 3.5.10 on page 43). Once selected, a phone number must be entered. The software then initialises the modem using the modem initialisation string defined in the Program Options Menu (see Section 3.9) and then dials the specified number to connect to a remote logger. After connection, this menu option will appear as 'Disconnect Modem' and can be used to terminate the modem connection with the logger.

Reset Connected List

This option will cause the software to clear the Connected Logger List Window and attempt to reconnect, in turn, to each of the loggers specified in the logger list for the currently selected group (see below). This option can be used if a connection with a logger cannot be established.

Edit Logger List

This option can be used to edit the list of loggers associated with the current logger group. The same function can also be achieved using the Group Menu. The logger list defines the serial numbers of the loggers that the software will attempt to communicate with at start up (using RF). The logger list consists of a sequence of 3 digit serial numbers separated by commas. It is not necessary to specify loggers that are directly connected to the PC using a modem or RS232.

Update Logger Firmware

This option allows the firmware of a logger to be reprogrammed. The firmware is code that is stored on the logger's microcontroller and controls the behaviour of the logger. The firmware can be upgraded to change or improve functionality. Only loggers that are directly connected to the PC's COM port can be re-programmed. Re-programming using radio communication or modem is not supported. Upgrading the firmware is safe and it is not possible to permanently disable the logger. If an error occurs during programming, it may be necessary to reset the logger by disconnecting the battery and repeating the re-programming process. The logger's serial number may not appear in the Connected Logger List but re-programming will still work.

Before re-programming the firmware, all data and settings history stored on the logger should be downloaded.

The file containing the firmware image should be placed into the directory where the logger software was installed (*e.g.,* C:\SIGRA\LOGGER). If more than one upgrade file exists, a screen will allow the user to select the upgrade file to be used.

Find More Loggers

This option can be used to attempt the redetection to any loggers in the known logger list for the current selected logger group which were not previously detected and displayed in the Connected Logger List Window. Loggers may not be detected due to transmission errors, low power or being out of range. This option eliminates the need to redetect loggers that have previously been detected all over again.

3.5.6 Settings Menu

The Settings Menu allows the behaviour of the logger to be configured. The settings are grouped under one of the following headings:

- *Clock options*. These clock options are for settings and reading the value of the logger's clock. The logger's clock must be set before it will record any data;
- *Modem settings.* These modem settings allow a modem connected to the logger's RS232 port to be configured;
- *System settings*. The system settings are general logger parameters for the LCD display and communication;
- *Sensor settings*. The sensor settings define the types of sensors connected to the logger;
- *Recording settings*. The recording settings control how often the sensors are sampled and which samples are recorded in the logger's memory; and
- *Warning alarm settings*. The alarm settings enable the logger to be configured to generate warning alarms when certain data value conditions have been met.

Options also exist for:

- downloading settings from the logger;
- uploading new settings onto the logger;
- resetting the settings to the default factory values; and
- modifying existing settings.

Before the logger can be put into field operation, all the necessary settings parameters must be properly configured. The settings are stored in non-volatile memory on the logger and will not be lost if the battery is disconnected. Since radio communication may be slow, it is impractical to repeatedly download the settings from the logger each time they are to be modified. Therefore a copy of the logger settings is also stored on the PC's hard drive. A third copy of the logger settings is maintained in the PC's memory as the user edits them. Thus, in normal operation, up to three individual copies of the logger settings can exist:

- *Remote Settings*. The logger settings physically stored in the logger's memory;
- *Disk Settings.* A cached copy of the logger settings stored on the PC's hard drive; and
- *Current Settings.* A copy of the logger settings stored in the PC's memory which are currently being modified by the user and may be different from both the Remote Settings and Disk Settings.

To determine whether two copies of settings are identical, a CRC (digital signature) is calculated. Identical copies of settings have identical CRCs. The CRC of the logger's settings is retrieved when the logger is first accessed (see Figure 28) and before uploading new settings. The state of the Current Settings, compared to that of the Remote Settings, is displayed in the Active Logger Information Window.

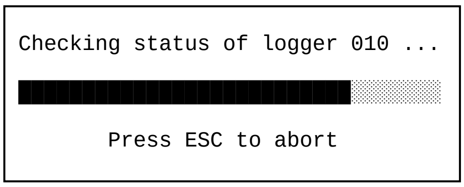


Figure 28: Checking the status of the logger.

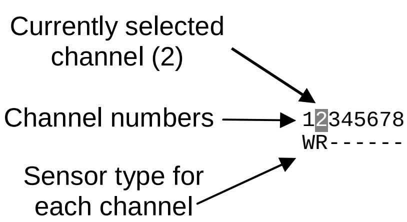
The layout of the Settings Menu is shown in Figure 29. All options may not necessarily be visible at any given time. If more than one logger is connected then options 1 and 9 will be visible and can be used to move between loggers. The currently active logger is displayed in the Active Logger Information Window. Pressing ESC will leave the Settings Menu and return to the Main Menu. Settings can be downloaded from the logger or new settings uploaded onto the logger. The settings can also be reset to their default factory values (*e.g.*, when configuring new loggers). Settings do not necessarily need to be uploaded before leaving the Settings Menu. However, if the program is exited any settings changes will be lost. The remaining sub-menus are described in Sections 3.5.9-3.5.14.

```
Settings Menu                                Using COM1



      Next logger .......................... 1
      Clock Menu ........................... 3
      Modem Menu ........................... 4
      System Menu .......................... 5
      Sensor Menu .......................... 6
      Recording Menu ....................... 7
      Alarm Menu ........................... 8
      Download logger settings ............. D
      Update logger settings ............... U
      Reset settings to default values ..... R
      Select logger ........................ 9
      Exit menu .......................... ESC

 This menu configures the settings on the logger.
 The logger clock must be set using the Clock Menu
 before any data will be recorded. The Recording
 and Alarms menus will only appear if sensors have
 been configured using the Sensor Menu.
```

Figure 29: Settings Menu screen layout.

3.5.7 Channel summary

A configuration summary of all the channels is displayed at the top of the screen of many Settings sub-menus, enabling the user to see the logger's sensor configuration at a glance. The numbers on the top line represent the channel number and the symbol below each number represents the type of sensor currently configured for that channel, as shown in Figure 30(a) below. A list of sensor type representations is given in Figure 30(b). The currently selected channel number is highlighted.



(a) Channel summary layout

Symbol	Sensor type
-	Unused
R	Resistance
V	Voltage
W	Vibrating wire transducer
F	Frequency
S	Switch
?	Invalid sensor type

(b) Sensor type symbols

Figure 30: Channel sensor configuration summary.

3.5.8 Editing settings parameters

To edit the settings parameters in Settings sub-menus, press ENTER to enter edit mode. The currently selected settings parameter will be highlighted. A brief help description will be displayed on the bottom-half of the screen. Some parameters only allow one of a set of values to be selected and for these parameters, use the SPACE BAR or the first letter of the desired value to switch between values. A summary of available key choices will appear in the bottom-right window (see Table 10).

If the settings have been modified, an Undo option will appear in the current sub-menu that, when selected, will undo all changes made in the current sub-menu. If changes are made to any settings parameters, the settings status in the Active Logger Window will become 'Settings modified' to reflect this.

Key	Description
TAB and SHIFT-TAB	Move between parameters.
CTRL-Y	Clear currently selected parameter.
ENTER	Accept currently selected parameter and move to next parameter. In the case of the last parameter, pressing ENTER will also leave edit mode.
ESC	Cancel the changes made in the current editing session and leave edit mode.

Table 10: Edit mode key options.

3.5.9 Clock Menu

The Clock Menu screen layout is shown in Figure 31. The menu enables the logger's clock to be read and set if necessary. The menu also allows the PC's clock to be set. If the PC software detects that the logger's clock is not set, LOGGER CLOCK NOT SET will appear in the Active Logger Information Window.

The logger's clock must be set before it will not record data. The clock will need to be re-set each time the logger's batteries are disconnected.

```
Set Logger Clock                        Using COM1


                      System Time

                  YYYY/MM/DD HH:MM:SS
                  2004/01/07 13:04:55


 The menu allows the clock on the logger to be
 checked or set to the PC's clock. The PC's clock
 can also be adjusted if necessary.

 IMPORTANT: THE LOGGER CLOCK MUST BE SET FOR
 LOGGING TO OCCUR. THE CLOCK WILL NEED TO BE RE-SET
 EACH TIME THE BATTERIES ARE DISCONNECTED.


           Set logger time ............ 3
           Check logger time .......... 4
           Set PC time ................ 5
           Exit menu ................ ESC
```

Figure 31: Clock Menu screen layout.

Pressing ESC leaves the Clock Menu and returns to the Settings Menu. The three menu options are described below.

3.5.9.1 Set Logger Time

This option sets the time on the logger's clock. It is essential that the PC's clock is accurately set since the logger's clock is set using the time on the PC. After setting the logger's clock it should be checked for accuracy using the Check Logger Time option. The logger's clock cannot be set to a time that is older than the time-stamp of the last data record stored in the logger's memory. This is necessary to ensure that all data recorded in the logger's memory is stored in a chronologically increasing sequence. If the logger's clock needs to be set to an earlier time then all data and settings history must be downloaded and then erased. This can be accomplished using the following procedure:

1. Use the Data Menu to download all data and settings history; and
2. Use the Terminal Menu to erase the logger's memory.

This procedure will not affect the current settings in the logger. The warning message shown in Figure 32 will appear if an attempt is made to set the logger's clock to a time that is before the time-stamp on the last data record stored on the logger. If all data has previously been downloaded from the logger, ERASE can be selected to automatically and **PERMANENTLY** erase all data on the logger and set the logger's clock to the current PC time.

```
You have tried to set the logger's clock to a time that is
older than the last data record stored on the logger.

Data in the Logger must be stored in a chronological
sequence. Therefore, before the clock can be set to this
time, all data and settings history (if supported) must be
downloaded and then erased.

The logger can be erased now if this has already been done.

WARNING: Selecting ERASE will PERMANENTLY erase all recorded
data and settings history (not the current settings) on the
logger.

                    ERASE     CANCEL
```

Figure 32: Warning message when resetting the logger's clock backwards.

3.5.9.2 Check Logger Time

This option retrieves the time from the logger’s clock and displays it in a pop-up box.

3.5.9.3 Set PC Time

This option allows the date and time on the PC to be set (see Figure 33). The PC’s clock can also be set externally to the PC software if desired using the Date/Time item in the Control Panel of Windows. In both cases you may need to have administrator privileges to set the time in Windows NT, 2000 or XP.

The date is entered using the digit keys 0-9. The arrow keys can be used to move left and right; CTRL-Y blanks the date; ESC cancels all changes and returns to the Clock Menu. The time is set to the entered value at the moment when the ENTER key is pressed.

```
Set Logger Clock                        Using COM1


                      System Time

                  YYYY/MM/DD HH:MM:SS
                  2004/01/07 13:06:45


 This option sets the current time and date on the
 PC. The time and date will be set when ENTER is
 pressed.

 You may need administrator privileges to set the
 clock in Windows.



 ←,→    = Left/right             ESC   = Cancel
 CTRL-Y = Clear date             ENTER = Accept date
```

Figure 33: Setting the PC clock.

3.5.10 Modem Menu

In a typical modem installation (see Figure 34), a logger connected to a data modem (GSM, CDMA, PC) acts as a base-station to provide a connection between the rest of the logger network and a remote PC. Using a modem, the logger can be configured to:

- relay warning alarms to the remote PC if an alarm condition is detected for the sensors of one of the loggers in the logger network; and
- allow the PC to remotely access loggers to download data and change their settings.

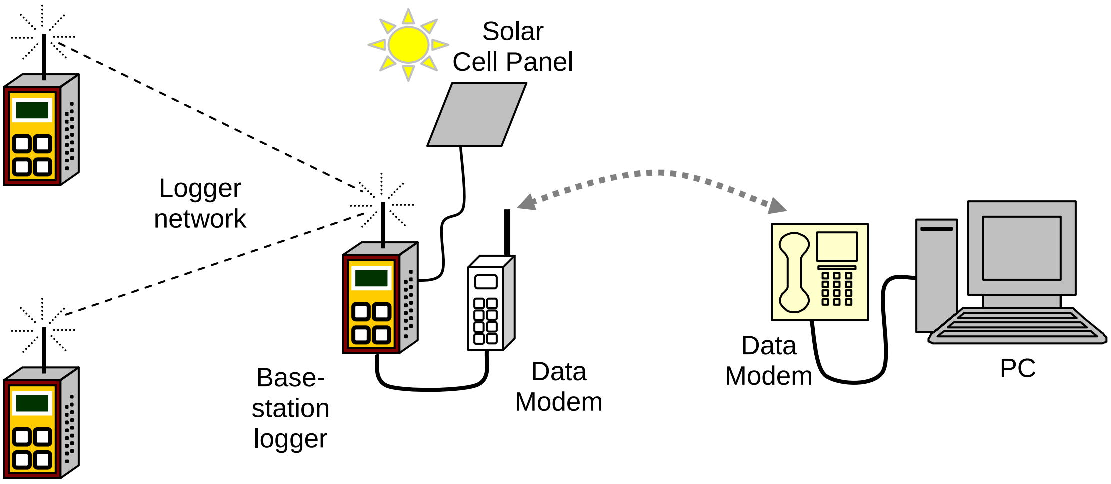


Figure 34: Typical modem installation.

NOTE: Modems consume significant power and will flatten the standard logger batteries quickly. Therefore, an external power supply such as a solar cell panel or mains power is strongly recommended for all modem installations.

The Modem Menu contains options for configuring a modem that is connected to the logger's RS232 port. The layout of the Modem Menu is shown in Figure 35.

```
Modem Menu                                      Using COM1


 Modem type: CELLULAR

 Logger -> PC alarms modem options:
 Phone number:    12345678
 Modem init str:  AT&F
 Connect timeout:    60 s    Redials:          1
 Redial delay:       60 s    Idle timeout:     60 s

 PC -> logger dialup modem options:
 Idle timeout:       60 s

 This menu is for configuring a modem connected to
 the logger's RS232 port. It contains options for
 when the logger dials up a PC to send an alarm, as
 well as options for when a PC dials up a logger.

        Undo changes ...................... U
        Edit settings ................. ENTER
        Exit menu ...................... ESC
```

Figure 35: Modem Menu screen layout.

The menu is divided into three main groups of parameters:

- modem type;
- Logger → PC options; and
- PC → Logger options.

Modem Type

The MODEM TYPE parameter defines the type of modem connected to the logger's RS232 port. The value choices for the parameter are listed in Table 11.

Changes to the MODEM TYPE parameter will only take effect once the logger is reset or the batteries are disconnected and then reconnected.

Value	Description
NONE	No modem is connected to the logger. All remaining menu parameters will be hidden if this choice is selected.
NORMAL	A PC-type data modem is connected to the logger.
CELLULAR	A cellular phone data modem is connected to the logger. Cellular phone data modems may require special instructions to interact with them, so the cellular phone should be selected rather than NORMAL if a cellular phone is attached to the logger.

Table 11: MODEM TYPE parameter choices.

When the logger has been configured for modem use, it will periodically attempt to detect a modem. 'OFFLINE' will be displayed on the logger's LCD display once a modem has been detected. The logger's LCD display 'MODEM' when it is configured to use a modem.

Logger → PC Options

This group of parameters controls the operation of the modem whenever the logger uses the modem to dial up a remote PC to deliver warning alarms. A description of each parameter is given in Table 12.

Parameter	Description
PHONE NUMBER	Specifies the phone number to dial when sending an alarm. Up to 19 characters can be entered.
MODEM INIT STR Default: (blank)	Defines a string for initialising the modem before sending an alarm. Up to 33 characters can be entered. Consult the modem manual for the AT commands necessary to initialise the modem. Leave blank to use the default modem initialisation string.
CONNECT TIMEOUT Units: Sec Range: 30-240 Default: 60	Specifies the maximum time period the logger will wait for a connection to be established with a remote PC. The modem connected to the PC should be configured to answer within this time period.
REDIALS Units: - Range: 0-50 Default: 0	Specifies the number of times the logger will attempt to re-dial the remote PC if a connection cannot be established. Reasons for connection failures include: • incorrect phone number; • engaged phone line; • no dial tone; • modem not connected to remote PC; and

	• PC logger software not running.
REDIAL DELAY Units: Sec Range: 30-240 Default: 60	Specifies the delay between successive re-dial attempts.
IDLE TIMEOUT Units: Sec Range: 1-65535 Default: 60	The logger will disconnect the modem if no communication has taken place with the PC for a period of IDLE TIMEOUT seconds. Longer connect times will prevent multiple phone calls for repeating alarms. Enter 'NEVER' to disable this function so that the logger never disconnects the modem when sending alarms.

Table 12: Logger → PC options.

Telecommunications authorities in some countries limit the number and frequency of automated dialing attempts. It is the responsibility of the user to ensure that the parameters are set to comply with local regulations.

PC → Logger Options

This group of parameters for controls the operation of the modem when a PC dials up to remotely access the logger to download data or modify the logger's settings. A description of each parameter is given in Table 13.

Parameter	Description
IDLE TIMEOUT Units: Sec Range: 1-65535 Default: 60	The logger will disconnect the modem if no communication has taken place with the PC for a period of IDLE TIMEOUT seconds. Enter 'NEVER' to disable this function.

Table 13: PC → Logger modem options.

Configuring the modems

To ensure correction operation, both modems will need to be configured.

3.5.11 System Menu

The System Menu contains parameters related to the general operation of the logger. The default parameter values should be suitable for most logger applications. In applications where battery life is important the System Menu parameters can be optimised to reduce power consumption to extend battery life.

Changing the values of the parameters in the System Menu can affect battery life and communication performance.

The logger is designed to conserve power. Consequently, the logger normally operates in a low-power mode in which the RF and RS232 interfaces are powered down. Periodically, the logger powers up the RF interface for periods of 50 ms to check for incoming RF transmissions (see Figure 36). How often the logger checks for incoming RF transmissions is defined by the RF WAKEUP parameter. Any incoming RF transmissions are not received during the periods in between the checks.

In order for RF transmissions to be recognised by loggers, all RF transmissions are preceded by a special RF signal pattern (*preamble*). While listening for incoming RF transmissions, if a logger detects the RF preamble it will remain powered up to receive the message following the preamble rather than powering down and going into a low-power mode. The length of the preamble is defined by the RF DETECT parameter. In order for RF transmissions to be reliably sent, the length of the transmitted RF preamble must be at least as long as the time interval at which the receiving logger checks for RF transmissions, *i.e.*, the value of the RF DETECT parameter of a transmitting logger should be greater or equal to the value of the RF DETECT parameter of the receiving logger.

The RF DETECT parameter defines the length of the preamble that will be transmitted before each RF transmission. The preamble is a special signal that other loggers can recognise as the start of a RF transmission. If a logger checks for RF transmissions and detects the RF preamble signal it will power up the RF interface and receive the RF transmission.

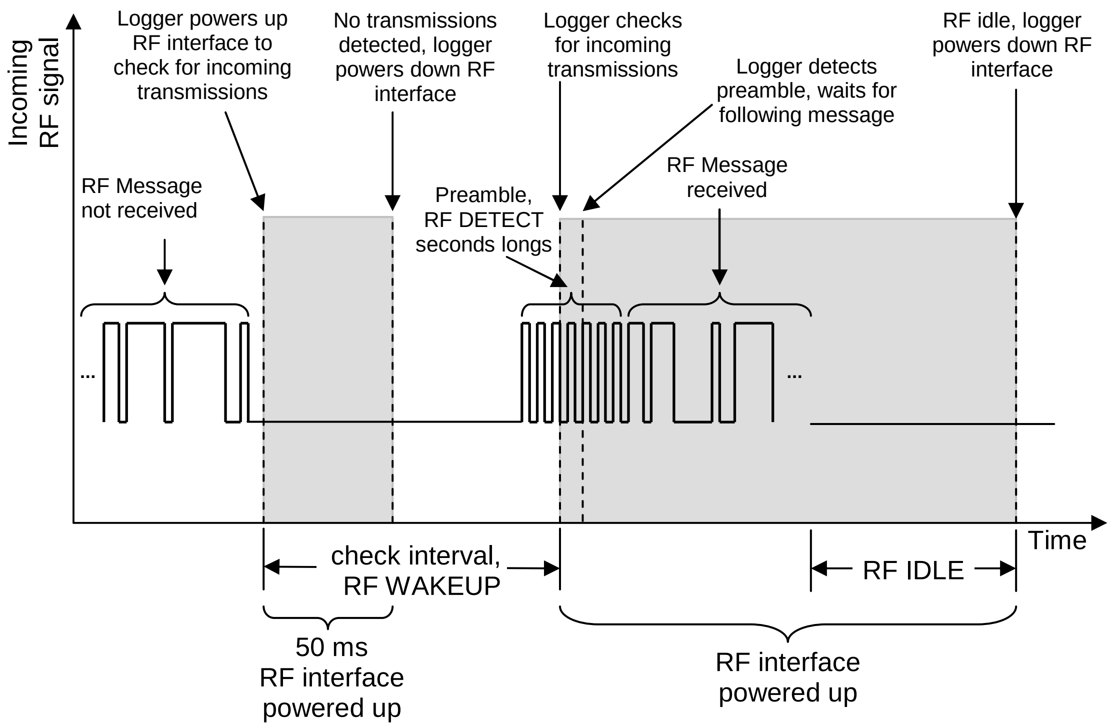


Figure 36: Incoming RF transmission check.

The screen layout of the System Menu is shown in Figure 37. The System Menu parameters are described in the following sections and a summary of the parameters and their default values is given in Table 14.

```
System Menu                              Using COM1


 LCD blank:      4000 ms
 RS232 Idle:     8000 ms
 RF Idle:        8000 ms
 RF Detect:         1 s
 RF Wakeup:         1 s
 RF Power Amp:     ON

 This menu contains general logger settings. The
 default setting values should be suitable for most
 logger applications.


        Edit settings ................. ENTER
        Exit menu ....................... ESC
```

Figure 37: System Menu screen layout.

LCD BLANK

The LCD BLANK parameter defines the delay for blanking the LCD display on logger when it is not in use. Larger values will cause the LCD display to stay on longer when displaying messages allowing messages to be read for longer. However, this also increases power consumption and therefore decreases the battery life expectancy. Enter 'NEVER' to disable this function (*i.e.*, the LCD screen will always remain on).

RS232 IDLE

The RS232 IDLE parameter defines the delay for powering down the logger's RS232 interface when it is no longer in use. This option can be set to a small value if the RS232 cable is not used, or infrequently used, to access the logger. A 1.5s delay is required to power up the RS232 interface after it has previously been powered down. During this period, the message 'WAKE' is displayed on the LCD display. Therefore, small values will decrease RS232 communication responsiveness (because of repeated power-up delays) but will increase battery life, whereas large values will increase responsiveness but will decrease battery life. Enter 'NEVER' to disable this function (only recommended for applications where an external power supply is available).

RF IDLE

The RF IDLE parameter defines the delay for powering down the logger's RF interface when it is no longer in use. Each time the logger sends/receives a RF transmission; its RF interface will remain powered up for at least this period. This option can be set to a small value if the RF communication is not used, or infrequently used, to access the logger. When the RF interface is powered up, the logger is able to continuously detect RF messages sent to the logger. Once the RF interface is powered down, the logger will only periodically check for RF communication (as defined by the RF WAKEUP option). Therefore, small values will decrease RF communication responsiveness (because checks for RF communication only occur periodically) but will increase battery life, whereas large values will increase responsiveness but will decrease battery life. Enter 'NEVER' to disable this function (only recommended for applications where an external power supply is available).

RF DETECT

The RF DETECT parameter defines the length of the preamble that will be transmitted before each RF transmission. The preamble is a special signal that other loggers can recognise as the start of a RF transmission. If a logger checks for RF transmissions and detects the RF preamble signal it will power up the RF interface and receive the RF transmission. The RF DETECT value should be at least as long as the RF WAKEUP value.

RF WAKEUP

The RF WAKEUP parameter defines how often the logger will check for RF transmission from other loggers when the logger's RF interface is powered down. If a RF transmission is detected, the logger will power up its RF interface and receive the transmission. The RF interface will subsequently be powered down again after the period defined by RF IDLE. Larger values mean the logger will check less often for RF transmissions, resulting in decreased RF communication responsiveness but will increase battery life, whereas small values mean the logger checks more often for RF transmissions, resulting in improved RF responsiveness but decreased battery life. By default, the RF WAKEUP parameter value is 1 second to enable easy configuration of the logger, but can be increased when the logger is deployed in the field to maximise battery life (see Section 2.4 for more information about power considerations).

RF POWER AMP

The RF POWER AMP parameter defines whether the logger's inbuilt RF power amplifier is enabled. RF range with the RF power amplifier enabled is typically beyond 500 m. Disabling this option will decrease RF range to under 20m but will increase battery life.

Parameter	Description
LCD BLANK Units: ms Range: 4-99996 Default: 4000	Defines the delay for blanking the LCD display on logger when it is not in use. Enter 'NEVER' to disable this function.
RS232 IDLE Units: ms Range: 4-99996 Default: 8000	Defines the delay for powering down the logger's RS232 interface when it is no longer in use. This option can be set to a small value if the RS232 cable is not used, or infrequently used, to access the logger. Enter 'NEVER' to disable this function (only recommended for applications where an external power supply is available).
RF IDLE Units: ms Range: 4-99996 Default: 8000	Defines the delay for powering down the logger's RF interface when it is no longer in use. Each time the logger sends/receives a RF transmission, its RF interface will remain powered up for at least this period. This option can be set to a small value if the RF communication is not used, or infrequently used, to access the logger. Enter 'NEVER' to disable this function (only recommended for applications where an external power supply is available).
RF DETECT Units: s Range: 0-255 Default: 1	Defines the length of the preamble that will be transmitted before each RF transmission. The preamble is a signal that other loggers can recognise as the start of a RF transmission. If a logger checks for RF transmissions and detects the RF preamble signal it will power up the RF interface and receive the RF transmission.
RF WAKEUP Units: s Range: 0-255 Default: 1	Defines how often the logger will check for RF transmission from other loggers when the logger's RF interface is powered down. If an RF transmission is detected, the logger will power up its RF interface and receive the transmission. The RF interface will subsequently be powered down again after the period defined by RF IDLE.
RF POWER AMP Units: - Range: ON/OFF Default: ON	Defines whether the logger's inbuilt RF power amplifier is enabled. RF range with the RF power amplified enabled is typically beyond 500 m. Disabling this option will decrease RF range to under 20m but will increase battery life.

Table 14: Summary of System Menu settings parameters.

3.5.12 Sensor Menu

The Sensor Menu enables the sensors connected on each of the logger's 8 channels to be configured. The layout of a typical Sensor Menu screen is shown in Figure 38. A summary of how the logger's channels are configured is displayed at the top of the screen. The rest of the screen displays the sensor parameters for the currently selected channel (which is displayed in the top left as well as the channel summary) and on-screen help. Some sensor parameters may be hidden, depending on the type of the sensor currently being configured. The channel number can be selected by pressing 1-8 while not in edit mode. To enter edit mode and modify the parameters for the current channel, press ENTER. Pressing ESC leaves the Sensor Menu and returns to the Settings Menu.

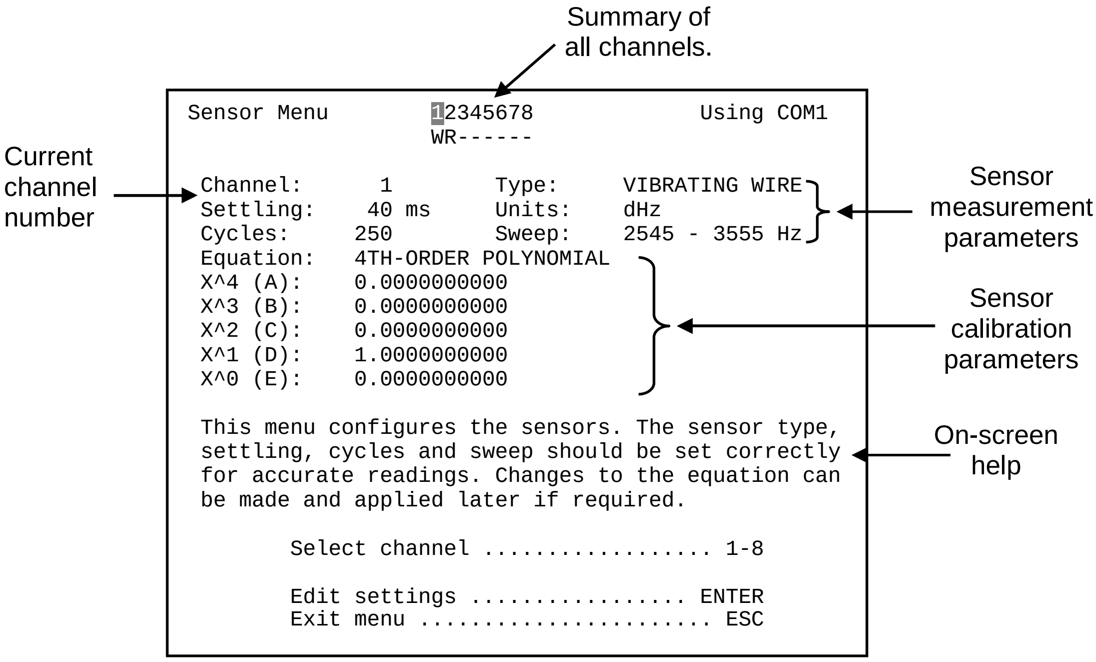


Figure 38: Sensor Menu screen layout.

3.5.12.1 Sensor measurement parameters

The sensor measurement parameters are associated with the physical sensor signal measurement. THEY MUST BE SET CORRECTLY IN ORDER TO GET ACCURATE RAW DATA MEASUREMENTS. This is important since it not possible to correct inaccurately measured raw data and subsequent data calculations using the inaccurate raw data will be meaningless. Not all sensor measurement parameters are applicable to each sensor type. Table 15 lists the applicability of sensor measurement parameters to sensor type. An explanation of each of the sensor measurement parameters follows.

	SETTLING	CYCLES	SWEEP FREQUENCY RANGE
UNUSED			
RESISTANCE	✔		
SWITCH	✔		
VOLTAGE	✔		
FREQUENCY	✔	✔	
VIBRATING WIRE	✔	✔	✔

Table 15: Applicability of sensor measurement parameters to sensor type

TYPE
The TYPE parameter defines the type of sensor connected to the current channel and affects how the sensor signal is measured. A list of the allowed sensor types is given in Table 16. It is important to select the correct value for the sensor.

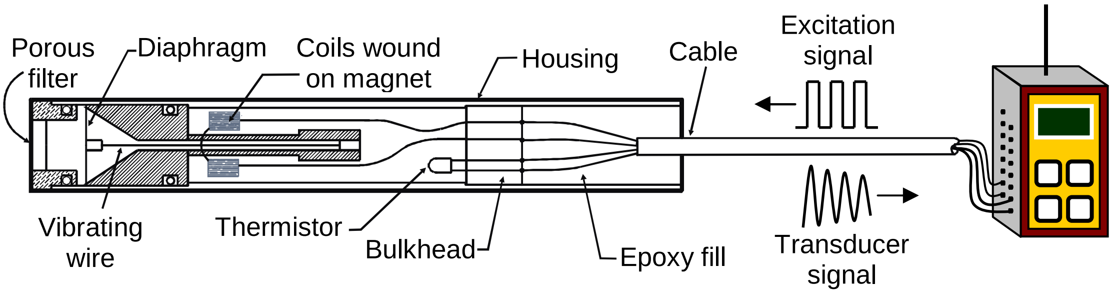
Sensor type	Description	Signal Range	Raw data units
UNUSED	Select this type when no sensor is connected to the current channel. Leaving unused channels configured with sensors increases: • the time required to sample all channels; • each data sample record size (less data records can fit in the logger's memory); and • power consumption (decreases battery life).		
RESISTANCE	Select this type to measure the resistance between the terminals of the current channel.	0-65 kΩ	1 Ω[†]
SWITCH	Select this type to measure the state of an open/close switch between the terminals of the current channel (low Ω = closed, 65 kΩ = open). Note: The logger should be configured to sample frequently enough to detect all transitions in switch state. (firmware>0.73 only)	0-65 kΩ	1 Ω[†]
VOLTAGE	Select this type to measure the voltage between the terminals of the current channel. If the sensor voltage is above the maximum voltage, external circuitry will be required to reduce the channel terminal voltage down to the maximum voltage. For logger serial numbers below 475, a resistor of at least 1000Ω should be connected in series between the voltage source being measured and the logger terminal.	Logger serial number below 475. 0-3.3 V	0.50354x10^{-4}V[†]
		Above 474. 0-5 V	0.76142x10-4[†]
VIBRATING WIRE	Select this type to measure the frequency of a vibrating wire transducer. An excitation signal to cause the wire to vibrate is generated by the logger before each sensor measurement. NOTE: Vibrating wire sensors can only be used on channels 1-4.	0.5-5.0 kHz	0.1 Hz
FREQUENCY	Select this type to measure the frequency of the signal between the terminals of the current channel. Do not select this sensor type for measuring vibrating wire piezometers.	0.5-5.0 kHz	0.1 Hz

[†] Nominal value. To obtain precise measurements a calibration of both the sensor and logger together as a single system is advised.

Table 16: Sensor types.

Vibrating wire transducers operate by measuring the resonant frequency of a piece of vibrating wire tensioned within the transducer. A change in the tension of the wire changes the frequency the wire vibrates at: increasing the tension increases the resonant frequency, whereas decreasing the tension lowers the resonant frequency. In vibrating wire piezometers, one end of the wire is attached to a pressure-sensitive diaphragm that causes the tension of the wire to decrease with pressure (see Figure 39). In vibrating wire strain gauges, the tension of the wire varies with strain.

To measure the resonant frequency of the vibrating wire transducer, an excitation signal at a range of frequencies (*sweep frequency range*) is passed through the transducer's coils, causing the wire to vibrate (see Figure 39). For non-resonant excitation frequencies, the vibrations in the wire attenuate quickly, whereas for near-resonant excitation frequencies the vibrations persist longer. An electrical output signal, with the same frequency at which the wire is vibrating, is induced in the coils as the vibrating wire cuts the coils' magnetic fields.



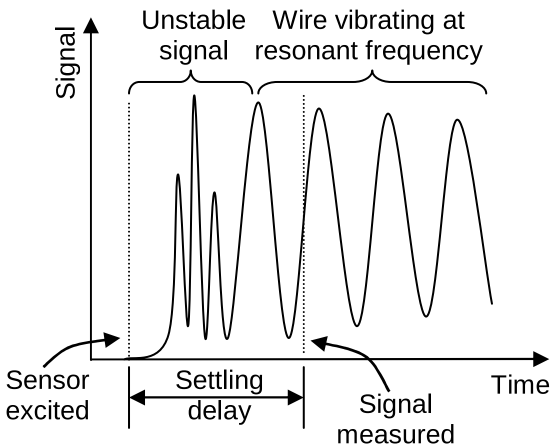
The frequency of the output signal is measured by the logger and converted into real-world measurements.

Figure 39: Operation of a typical vibrating wire transducer.

Some vibrating wire transducers also house an internal temperature-sensitive device (*e.g.*, thermistor) for measuring the temperature at which the frequency readings were taken. This allows the real-world transducer measurements to be temperature-compensated.

SETTLING

The SETTLING parameter defines the time the sensor signal is allowed to 'settle' before taking a reading, as shown in Figure 40(a). This delay allows internal logger voltages to stabilise before measuring the signal. In the case of vibrating wire sensors, the settling delay is the delay between sending the excitation signal and when the signal is measured and allows non-resonant signal frequencies to attenuate. The recommended default values for the SETTLING parameter are shown in Figure 40(b). Try increasing the SETTLING parameter if a steady signal is not being measured consistently.



Sensor type	Default value
Vibrating wire	40 ms for > 1 kHz 10 ms for < 1 kHz
All other sensors	40 ms

(a) Graphical depiction. **(b) Default values.**

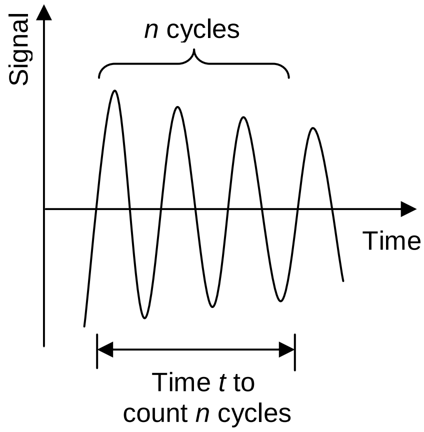
Figure 40: SETTLING parameter.

CYCLES (Frequency and vibrating wire sensors only)

The CYCLES parameter defines the number of signal cycles frequency readings are averaged over. The logger counts the time t required to count n cycles (see Figure 41(a)), where n is the value of the CYCLES parameter, and calculates the frequency f of the signal using the equation:

$$f = \frac{n}{t} \tag{2}$$

The recommended default values for the CYCLES parameter are shown in Figure 41(b).



Sensor type	Default value
Vibrating wire	250 for > 1 kHz 100 for < 1 kHz
Frequency	250

(a) Graphical depiction. **(b) Default values.**

Figure 41: CYCLES parameter.

SWEEP (Vibrating wire sensors only)
The sweep frequency range defines the range of frequencies used to excite the vibrating wire. Exciting the vibrating wire transducer causes the internal wire to vibrate at the resonant frequency of the wire. In order to make accurate measurements, the excitation sweep frequency range must cover the range of frequencies that is expected to be measured (consult the vibrating wire transducer manufacturer's specifications for determining the appropriate frequencies). It is recommended to allow an extra ±10% of the range difference (*e.g.,* for an expected operating range of 2500-3500 Hz, allow an extra ±100 Hz). For optimum performance you may have to experiment with different settings to ensure you get consistent readings. Alternatively, Sigra can analyse your particular sensor type and provide optimum settings on a consulting basis.

3.5.12.2 Sensor calibration parameters

Sensor calibration parameters define how values of real-world properties (*e.g.*, pressure and temperature) are obtained (interpreted) from raw data values (*e.g.*, frequency and resistance). It is important to note without accurate raw data values, any real-world data values will be meaningless; hence it is critical that the sensor measurement parameters are correctly configured and tested. The logger records all sensor measurements as raw data values, allowing the way in which the raw data is interpreted to easily be modified at a later date. Therefore, the setting of the sensor calibration parameters is not critical (and can even be omitted if they are not known) before the logger goes into the field, unless warning alarms or record on value change logger functionality is enabled, in which case the calibration parameters should be set accurately. The sensor calibration parameters are described below.

UNITS
The UNITS parameter allows a three-character units label to be associated with readings. The label is purely informational and does not affect the interpretation of raw data in any way whatsoever (and can be left blank if desired). The label is appended to data readings displayed on the logger's LCD and to data record lines in data files. When entering a units label, special symbols can be accessed using the keystrokes listed in Table 17.

Keystroke	Symbol
CTRL-A	° (degrees)
CTRL-O	Ω (ohms)

Table 17: Special units symbols.

EQUATION

The EQUATION parameter defines the type of calibration function that will be used to interpret raw data. Two calibration functions are supported:

- *4th-order polynomial*. This is a general-purpose calibration function applicable to many transducers and is defined as:

$$f(x) = ax^4 + bx^3 + cx^2 + dx^1 + ex^0 \tag{3}$$

  where: x = the raw data sample value; and
  a,b,c,d,e = calibration constants.

- *Steinhart-Hart log 3rd-order polynomial.* This is a calibration function specifically designed for temperature measurements using thermistors and is defined as:

$$f(x) = -273.15 + \frac{1}{b\ln(x)^3 + d\ln(x) + e} \tag{4}$$

  where: x = the raw data sample value;
  b,d,e = calibration constants; and
  $f(x)$ = the measured temperature in degrees Celsius.

  It can only be selected for resistance-type sensors.

X^4 – X^0

These parameters are the calibration constants for the selected calibration function. The calibration constants are transducer-dependent and are usually supplied by the transducer manufacturer. A calibration constant can be any number between –3.4E+38 … +3.4E+38 and can be entered in exponential form (*e.g.*, 1E-1) or as a general number (*e.g.*, 0.1). Lower-order equations can be obtained by setting the upper-order constants to 0. For example, setting *a=b=c=0* specifies the linear equation given in Equation 5.

$$f(x) = dx + e \tag{5}$$

To view the raw data readings in electrical units (*i.e.*, voltage, resistance or frequency), select a 4th-order polynomial equation and use calibration function given by Equation 6.

$$f(x) = kx \tag{6}$$

where: k = the appropriate raw data units ↔ electrical units conversion factor from column 4 of Table 16.

The logger also supports the dynamic offset compensation of one channel using the computed result from another channel by specifying ‘FROM CH <n>’ for the X^0 constant of the channel to be compensated, where the calculated result of channel number <n> is used as the X^0 offset of the compensated channel. This, for example, allows the direct calculation of a temperature-compensated pressure reading for a vibrating wire transducer with internal thermistor (see Figure 42). A detailed example of dynamically compensated channels in given in Tutorial Two.

$$P \;=\; \left(F_0 - F'\right)C_P + \left(T - T_0\right)C_T \;=\; kF^2 + m$$

where: P = temperature-compensated pressure reading (kPa);
F = vibrating wire frequency reading (dHz);

F' = squared vibrating wire frequency (Hz^2) = $\left(\dfrac{F}{10}\right)^2$

T = temperature (℃);

C_P, F_0, C_T, T_0 = vibrating wire compensation coefficients;

$k \;=\; -\dfrac{C_P}{10^5}$; and

$m \;=\; F_0 C_P + \left(T - T_0\right)C_T$.

```
Channel:    1     Type:  VIBRATING WIRE
Settling:  40 ms  Units: kPa
Cycles:   250     Sweep: 2368 - 3203 Hz
Equation:   4TH-ORDER POLYNOMIAL
X^4 (A):    0.0000000000
X^3 (B):    0.0000000000
X^2 (C):    -7.853000E-6
X^1 (D):    0.0000000000
X^0 (E):       FROM CH 2

X = 30000   (VW Freq = 3000.0 Hz)
P = f(X) = CX^2 + 7679.44
         = 611 kPa
```

```
Channel:    2     Type:  RESISTANCE
Settling:  40 ms  Units: kPa

Equation:   4TH-ORDER POLYNOMIAL
X^4 (A):    1.618500E-13
X^3 (B):    -5.873499E-9
X^2 (C):    7.4652998E-5
X^1 (D):    -4.371500E-1
X^0 (E):    8631.9003906

X = 5000   (Temperature = 24.68 °C)
f(X) = AX^4 + BX^3 + CX^2 + DX^1 + EX^0
     = 7679.44 kPa
```

Figure 42: Dynamic offset compensation.

3.5.13 Recording Menu

The Recording Menu configures the data recording mode for the logger. The menu will only be visible if one or more sensor channels are configured. The logger periodically samples (measures) the sensor values at a time interval specified by the user (the *Sample Interval*). The *Recording Mode* dictates whether the data sample is recorded in the logger's memory. There are two recording modes:

- *Record Every Sample*. Every data sample is recorded in the logger's memory; and
- *Record On Value Change*. A data sample is only recorded if one of the following conditions is met:
  - o a calculated (not raw data) value has varied from the last recorded value by more than a specified amount for one or more of the sampled sensors;
  - o no data samples have been recorded for a time period specified by the *Record Interval*; or
  - o if calculated value causes an alarm condition to be satisfied (see Section 3.5.14).

Whenever a data sample is to be recorded in the logger's memory, all configured sensor channels are recorded not just an individual channel. The Sample Interval and Record Interval parameters apply to all channels, whereas the value changes that must be exceeded can be individually specified for each channel.

The layout of a typical Recording Menu screen is shown in Figure 43. A summary of how the logger's channels are configured is displayed at the top of the screen. The rest of the screen displays the recording parameters for the logger, the record on change value settings for each channel and on-screen help. Some parameters may be hidden, depending on the current configuration. Press ENTER to enter edit mode and modify the recording parameters. Pressing ESC leaves the Recording Menu and returns to the Settings Menu. Pressing 'U' will undo any changes made in the current session in the Recording Menu.

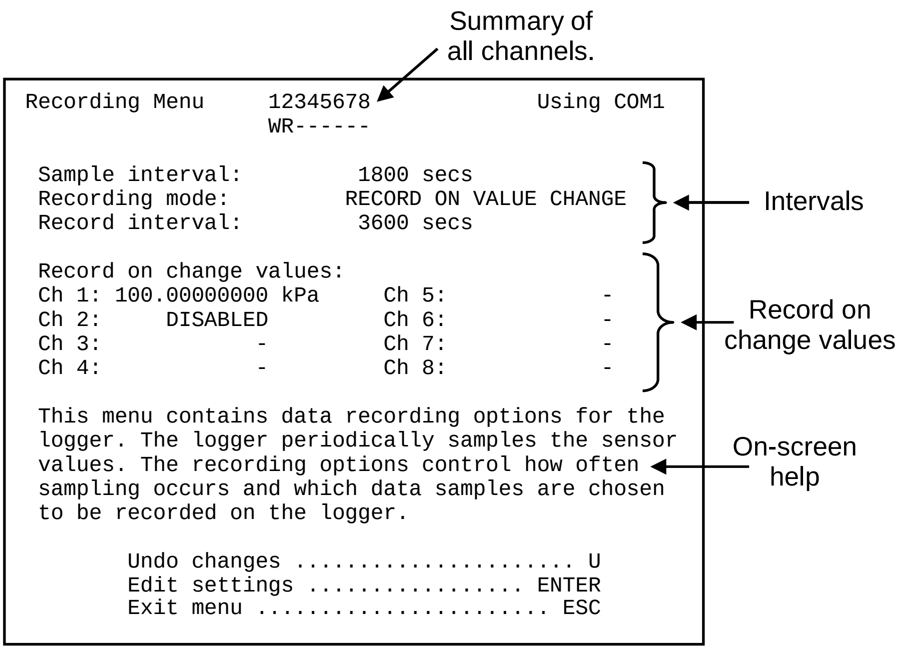
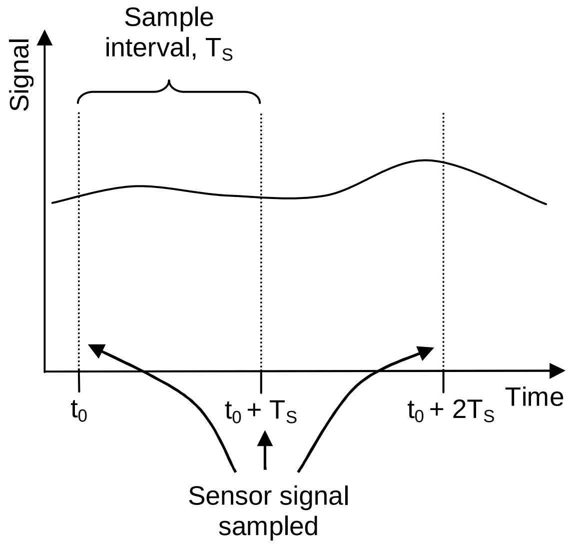


Figure 43: Record Menu screen layout.

SAMPLE INTERVAL

The SAMPLE INTERVAL parameter defines how often (in seconds) each of the configured sensors is measured (see Figure 44). The SAMPLE INTERVAL parameter applies to all channels. Choosing the sample interval involves a compromise between how frequently the sensor signals are sampled and power consumption. A low sample interval results in frequent sensor signal sampling but consumes more power, whereas a high sample interval results in less frequent sensor signal sampling but doesn't consume as much power.



Units	Value Range	Default value
Seconds	1 - 65535	1800 s

Figure 44: SAMPLE INTERVAL parameter.

RECORDING MODE

The RECORDING MODE parameter dictates which sampled data values are recorded in the logger's memory. The RECORDING MODE parameter applies to all channels. Values for the RECORDING MODE parameter value are listed in Table 18.

Value	Description
RECORD EVERY SAMPLE	Each time the sensor signals are sampled they are also recorded in the logger's memory. The RECORD INTERVAL and RECORD ON CHANGE VALUES parameters are not applicable when this value is selected and will be hidden.
RECORD ON VALUE CHANGE	Sampled data will only be recorded in the logger's memory if one of the following conditions is met: • the calculated data value for one or more sensors has varied from the its last recorded value by more than a user-specified amount (RECORD ON CHANGE VALUES parameters); or • no data samples have been recorded for a time period specified by the RECORD INTERVAL parameter.

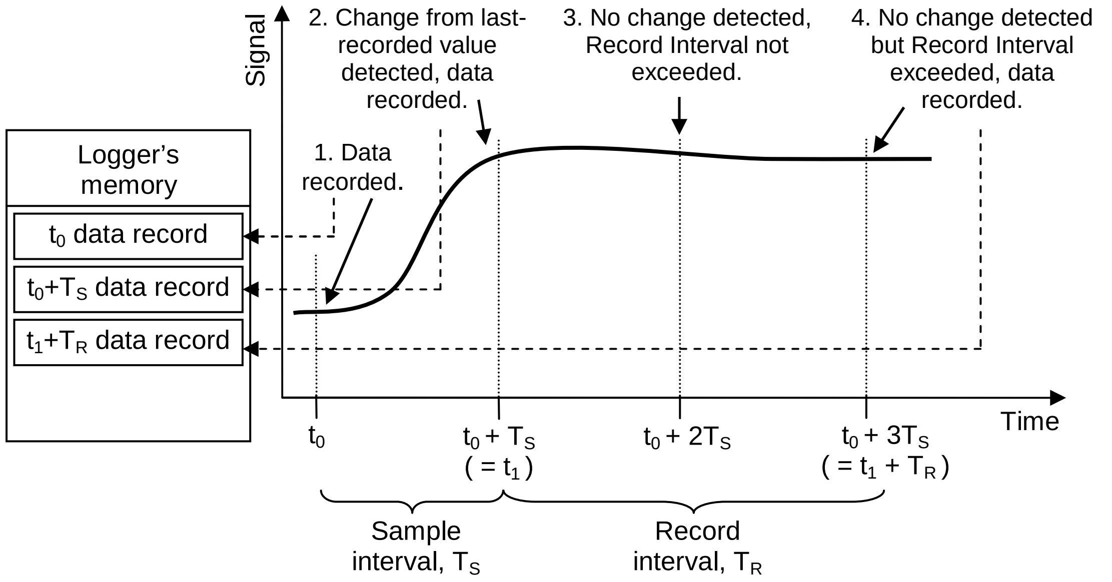
Table 18: RECORDING MODE parameter values.

The RECORD ON VALUE CHANGE option is useful for applications where small fluctuations in the values of the monitored sensors are acceptable but large fluctuations need to be recorded.

RECORD INTERVAL

The RECORD INTERVAL parameter is only applicable to the RECORD ON VALUE CHANGE recording mode. Data samples will be recorded in the logger's memory if no changes in the calculated data values for any of the channels have been recorded over the time period (in seconds) defined by the RECORD INTERVAL parameter value (see Figure 45). Therefore, it defines the maximum period between consecutive data samples stored in the logger's memory in the RECORD ON VALUE CHANGE recording mode. The RECORD INTERVAL parameter value should be greater than the SAMPLE INTERVAL parameter value. The logger will round the RECORD INTERVAL parameter value up to the nearest multiple of the

SAMPLE INTERVAL parameter value. The RECORD INTERVAL parameter value must be in the range 1-65535. The default value is 3600 seconds (1 hour).



Units	Value Range	Default value
Seconds	1 - 65535	3600 s

Figure 45: RECORD INTERVAL parameter.

RECORD ON CHANGE VALUES

The RECORD ON CHANGE VALUES parameters are only applicable to the RECORD ON VALUE CHANGE recording mode. They define the absolute change (up or down) in value from the last recorded value for each of the channels that must be exceeded before a data sample is recorded in the logger's memory. Changes are specified in terms of the sensor's calculated data values, not its raw data values. If a change in one sensor's value is exceeded, the data values for all configured sensors are recorded. If a sensor is not configured, its value is displayed as '-' and cannot be modified. A sensor's units are displayed if they are defined; otherwise 'units' is displayed as the sensor's units. If it is decided that data on a particular sensor should not be able to trigger a record, then 'DISABLED' should be entered for the change value for that channel. Entering a change value of zero for any of the channels will cause all channels to be recorded on every sample.

3.5.14 Alarm Settings Menu

The Alarm Menu configures the logger to send warning alarms if user-specified criteria have been satisfied for one or more of the configured sensor channels. The menu will only be visible if one or more sensor channels are configured. The menu allows the user to specify:

- upper and lower *alarm conditions* which, if satisfied for a given number of consecutive sample intervals, will trigger a warning alarm; and
- an *alarm method* that defines how alarms are to sent to a remote PC.

Alarm conditions are specified in terms of value and/or rate changes and can be configured on a per-channel basis, whereas the alarm method applies to all channels.

The layout of a typical Alarm Menu screen is shown in Figure 46. A summary of how the logger's channels are configured is displayed at the top of the screen. The rest of the screen displays the alarm conditions for the currently selected channel; the alarm delivery method; and on-screen help. Some parameters may be hidden, depending on the current configuration. Channels can be selected by pressing 1-8 while not in edit mode. Press ENTER to enter edit mode and modify the Alarm Menu parameters. Pressing ESC leaves the Alarm Menu and returns to the Settings Menu. Pressing 'C' will undo any changes made in the current session in the Alarm Menu. The Alarm Menu settings parameters are described in the following sections.

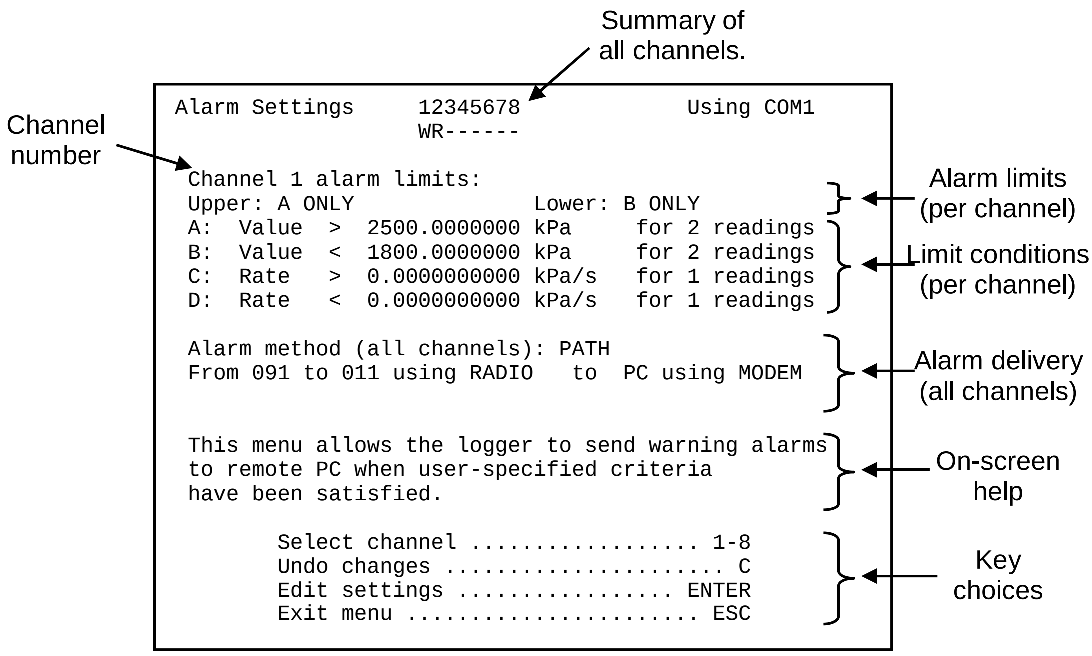


Figure 46: Alarm Menu screen layout.

UPPER/LOWER ALARM LIMITS

The UPPER and LOWER ALARM LIMIT parameters define limits that, if exceeded, will trigger alarms. Limits are defined as simple logic expressions involving four conditions, A – D. Each condition is displayed on a line in the format shown in Figure 47. It consists of the condition name, the condition type (value or rate of change), an operator (< or >), the condition value, the condition units and the number of consecutive readings the condition must hold for.

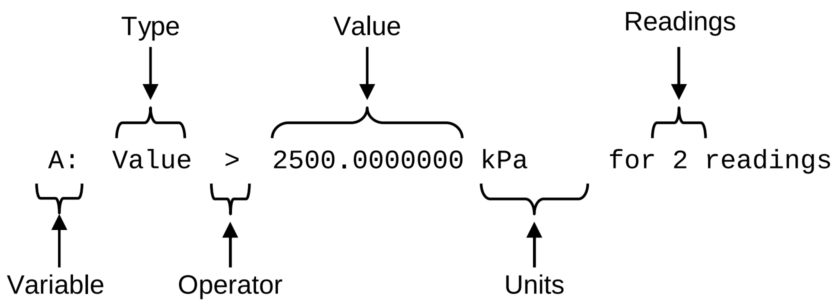


Figure 47: Alarm condition line format.

Conditions A and B defined upper and lower absolute values, whereas conditions C and D define increasing and decreasing rate of changes, respectively. If used, Condition C should be defined as positive value and Condition D defined as a negative value. Examples of sensor signals required to satisfy Conditions A and C for *n* readings are shown in Figure 48 (a) and (b) respectively. Increasing the number of readings for a condition is useful for smoothing spurious readings in electrically noisy environments that could otherwise produce false alarms. However, the disadvantage of this is that the detection of a significant change is delayed by one or more sample intervals.

Expressions for the UPPER/LOWER ALARM LIMITS parameter are listed in Table 19. Each term in an alarm limit expression must be true to trigger an alarm. Limits defined as ‘DISABLED’ are ignored. If both upper and lower limits are defined then an alarm will be triggered if either the upper limit or the lower limit is exceeded.

LOWER LIMIT expressions
DISABLED
A ONLY
C ONLY
A AND C
A AND D
A AND (C OR D)

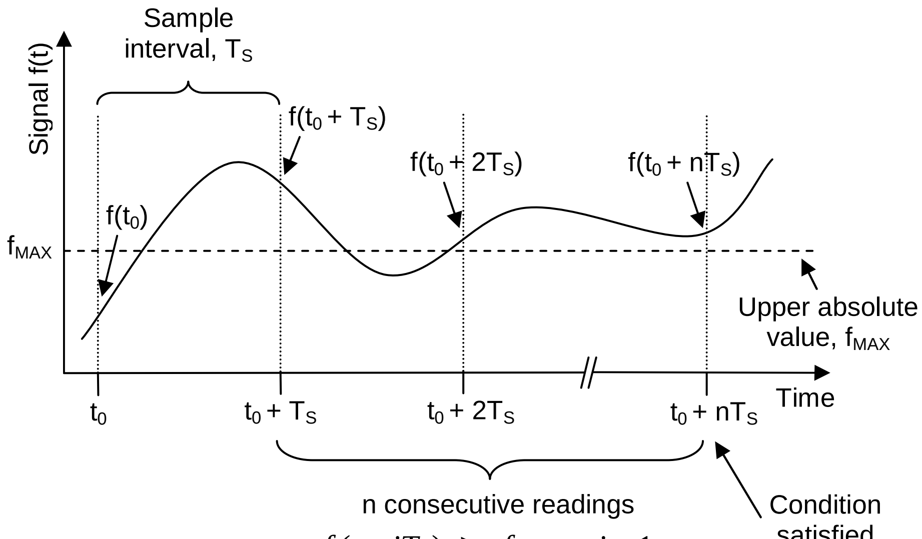
UPPER LIMIT expressions
DISABLED
B ONLY
D ONLY
B AND C
B AND D
B AND (C OR D)

Table 19: UPPER and LOWER ALARM LIMIT parameter values.

When an alarm is triggered, the logger performs two tasks:

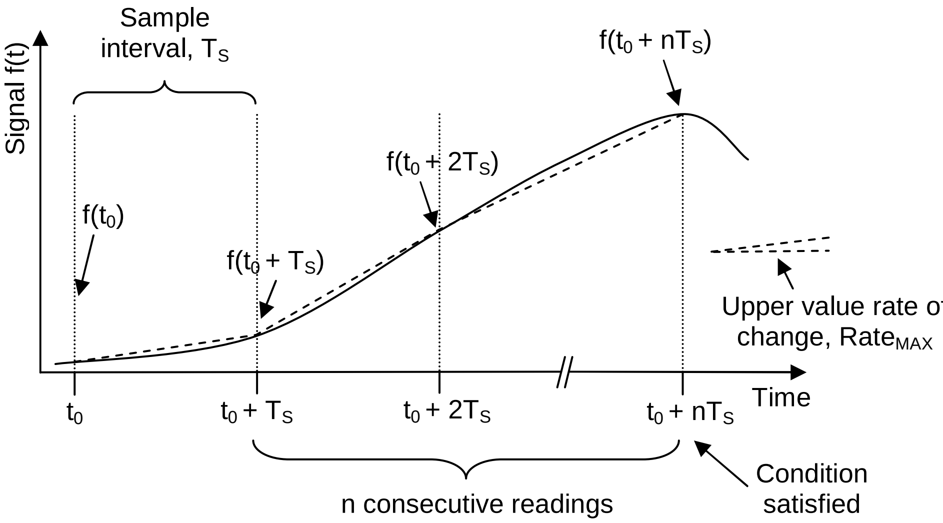
- It stores an alarm record in the logger’s memory which can be downloaded as part of other recorded data; and
- It sends a warning alarm, if enabled, to a remote PC using a method defined by the ALARM METHOD parameter.

When the PC software receives an alarm, the colour of the logger number in the Connected Logger List Window (Section 3.5.3) changes to red to indicate that an alarm for the logger has been received. The alarm can be viewed by using the Warning Menu. Loggers make only one attempt to send warning alarms and the alarm is lost if it fails to reach the PC (although it is recorded in the logger’s memory for reference).



$$f(t + iTs) \;\geq\; f_{MAX}, \quad i = 1 \ldots n$$

(a) Condition A example: the values of *n* consecutive readings exceed the defined upper absolute value, f_{MAX}.



$$Rate_i \;=\; \frac{\Delta f}{\Delta t} \;=\; \frac{f(t_0 + iT_S) - f(t_0 + (i-1)T_S)}{T_S} \;\geq\; Rate_{MAX}, \quad i = 1 \ldots n$$

(b) Condition C example: the value rate of changes between *n* consecutive readings exceed the defined upper rate of change, $Rate_{UL}$.

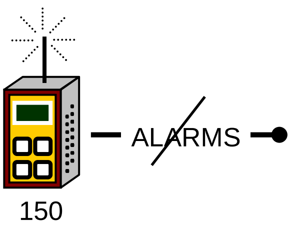
Figure 48: Examples of absolute value and value rate of change alarm conditions.

ALARM METHOD

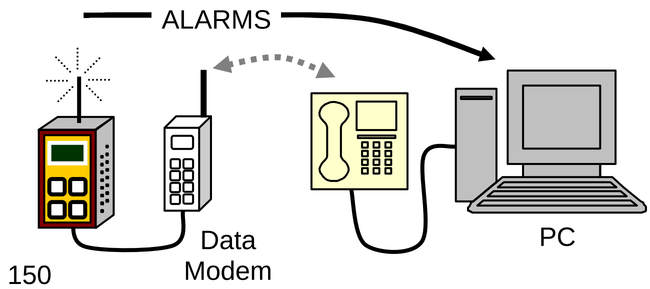
The ALARM METHOD parameter defines what method is used to send a warning alarm to a remote PC. Values for the ALARM METHOD parameter are listed in Table 20. The 'DISABLED' and 'MODEM' ALARM METHOD types are illustrated in Figure 49 and the 'PATH' type is discussed in the following section.

Value	Description
DISABLED	The logger will not attempt to send warning alarms to a remote PC. The logger will still relay alarms for other loggers in the logger network.
MODEM	The logger will send warning alarms by dialing up a remote PC using a data modem connected directly to the logger's RS232 interface.
PATH	The logger will send warning alarms using the specified path (route) through the logger network.

Table 20: ALARM METHOD parameter values.



(a) DISABLED. No alarms are sent by the logger.



(b) MODEM. A directly-connected modem is used

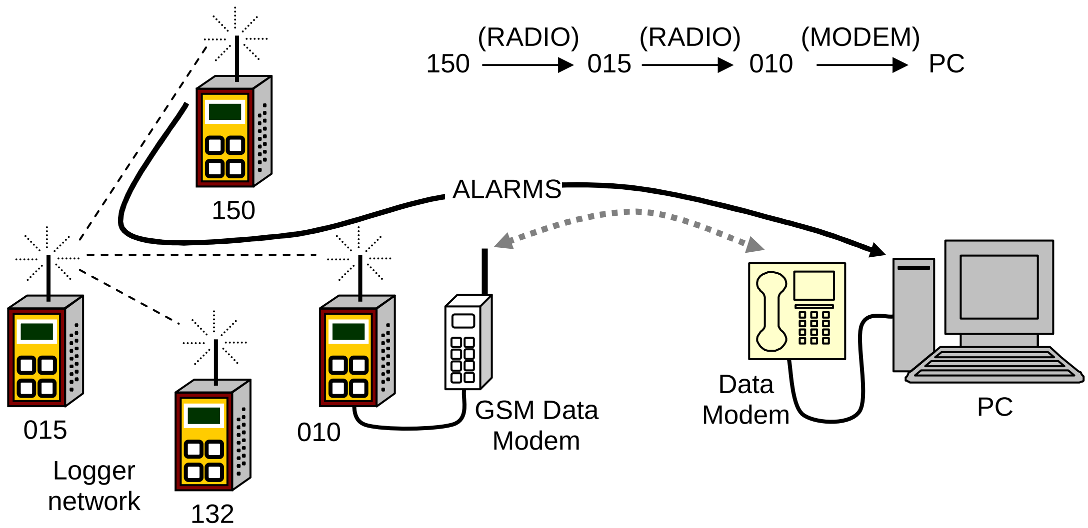
Figure 49: ALARM METHOD types.

ALARM PATH

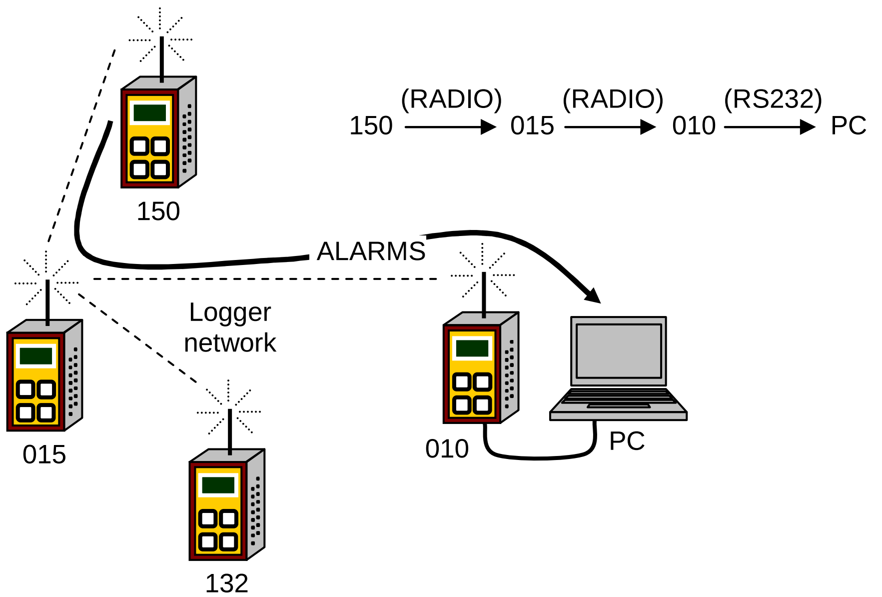
The ALARM PATH list defines a path (route) through the logger network to a remote PC. The path is defined as a sequence of hops with each hop defining which logger the alarm should be relayed onto and what communication method should be used to achieve this (see Table 21). Knowledge of the configuration of the logger network is required to properly define the path. Incorrectly defined paths will result in warning alarms not being delivered to the PC. The last hop in the ALARM PATH list must be 'PC'. The 'MODEM' and 'RS232' communication methods in Table 21 can only be used in conjunction with a PC (*i.e.*, it is not possible for one logger to dial-up or be directly connected using RS232 with another logger). Some examples of ALARM PATH lists are shown in Figure 50.

Value	Description
RADIO	Use the logger's RF interface to relay the alarm.
MODEM	Use a modem directly connected to the logger's RS232 interface to relay the alarm. The logger will dial-up if necessary.
RS232	Use the logger's RS232 interface to relay the alarm.

Table 21: ALARM PATH communication method values.



(a) Alarm path from logger 150 to PC. Logger 010 will dial-up the PC using the GSM data modem whenever it is required to relay an alarm to the PC from the logger network to the PC.



(b) Alarm path from logger 150 to PC.

Figure 50: Example ALARM PATH lists.

3.6 Data Menu

The data menu allows logger data to be downloaded, viewed and managed. The layout of the Data Menu is shown in Figure 51. All options may not necessarily be visible at any given time. Options 1 and 9, which can be used to move between loggers, are only visible if multiple loggers are currently connected. The currently active logger is displayed in the Active Logger Information Window. It is not necessary to be connected to a logger to view or manage previously downloaded data. Pressing ESC will leave the Data Menu and return to the Main Menu. The remaining sub-menus are described in Sections 3.6.1 - 3.6.3.

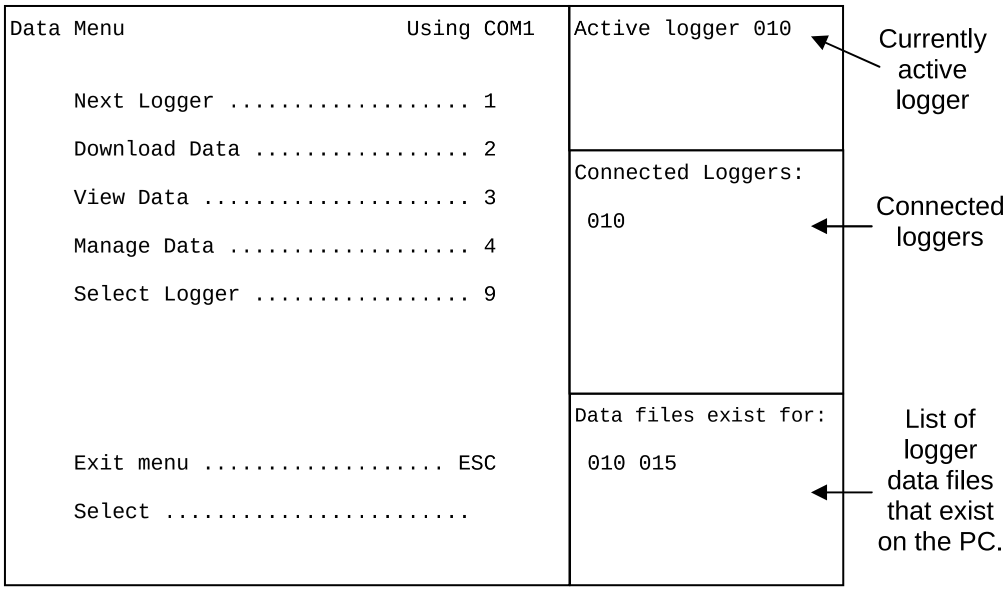


Figure 51: Data Menu screen layout.

3.6.1 Download Data Menu

Data recorded by the logger is stored in the logger’s non-volatile memory until it can be downloaded to a PC. The logger can store between 18000 – 45000 data samples, depending on the number of channels being recorded. Once the logger’s memory is full, the oldest data in the memory will be overwritten by new data. Therefore, to avoid data loss data should be downloaded regularly. Downloading data from the logger does not permanently erase it from the logger’s memory and hence it is possible to re-download previously downloaded data from the logger (assuming it has not been overwritten by new data).

The layout of the Download Data Menu is shown in Figure 52. All options may not necessarily be visible at any given time. Options 1 and 9, which can be used to move between loggers, are only visible if multiple loggers are currently connected. Pressing ESC will leave the Download Data Menu and return to the Data Menu. The remaining sub-menus are described in Sections 3.6.1.1 - 3.6.1.5.

The download window shown in Figure 53 appears when data is being downloaded. It shows an estimate of the total number of data records available for download and a progress bar indicating what proportion of the data records has been downloaded. Downloading data using a radio connection is slower than when directly connected to the logger using a RS232 cable. Data downloads can be interrupted by pressing ESC. There may be a small delay between pressing ESC and when the software cancels the download.

The logger remembers the time-stamp of last data record that was successfully downloaded to a PC (*the data checkpoint date*). The data checkpoint date is stored in non-volatile memory and hence is not lost when the logger batteries are disconnected. The function of the data checkpoint date is explained in Section 3.6.1.2 on page 64.

Downloaded raw data is stored in binary form (not human-readable) in a file with a name of the form:

DATnnn_ssssssssssssss-eeeeeeeeeeeeee.BIN

where: *nnn* = the 3-digit logger serial number;
ssssssssssssss = the 14-digit timestamp of the first data record in the file; and
eeeeeeeeeeeeee = the 14-digit timestamp of the last data record in the file.

The 14-digit start and end timestamps are of the form *yyyymmddhhmmss, i.e.,* the year (4 digits) followed by the month, day, hours, minutes and seconds.

Use the 'View Data' option in the Data Menu to view the downloaded data (see Section 3.6.2).

```
Download Data Menu                          Using COM1



    Next Logger .............................. 1
    Download from checkpoint on logger ........ 2
    Download from last data on PC ............. 3
    Download from a date range ................ 4
    Reset or set checkpoint on logger ......... 5
    Download logger settings history .......... 6
    Select Logger ............................. 9









    Exit menu .............................. ESC

    Select
```

Figure 52: Download Data Menu screen layout.

```
Downloading 488 data records ...


            Press ESC to abort
```

Figure 53: Data download progress bar.

3.6.1.1 Download from last data on PC

The time-stamp of the most recent data record stored on the PC is found from all data files for the logger in the data directory. All data on the logger that is dated after this time-stamp is downloaded and appended to a data file on the PC. The data checkpoint date is updated to reflect the time-stamp of last successfully downloaded data record. This download option is useful if data already exists on the PC and it is desired to update the PC's data to that stored on the logger.

3.6.1.2 Download from checkpoint on logger (firmware versions > 0.54)

This download option enables different PCs, which may not contain data files for the logger, to be used to download only the data that has not previously been downloaded from the logger. Specifically, all data that is time-stamped after the data checkpoint date is downloaded. For new loggers or loggers that have been erased, the data checkpoint date is reset to 1970/01/01 00:00:00. The data checkpoint date can be reset or altered using the 'Reset or set checkpoint on logger' option (see Section 3.6.1.4).

NOTE: Only loggers with firmware version 0.54 onwards support the data checkpoint date function. Older loggers must be reprogrammed to access this feature (see Section 3.5.5).

3.6.1.3 Download from a date range

This download option allows previously downloaded data from within a specific time interval to be re-downloaded. Note that once the logger's memory is full, the oldest data in the memory will be overwritten by new data and cannot be retrieved. This download option does not alter the data checkpoint date. The user is prompted for a date range as shown in Figure 54. Open-ended date ranges can be specified by leaving a start- or end-date blank. Leaving both start- and end-dates blank will download all data stored on the logger. Dates are entered using the digit keys 0-9. The arrow keys can be used to move left and right; CTRL-Y blanks the date; ESC cancels all changes and returns to the Download Data Menu.

```
Download Data Menu                       Using COM1


          Start Date               End Date

      YYYY/MM/DD HH:MM:SS  -  YYYY/MM/DD HH:MM:SS
      2004/01/05 00:00:00     2004/01/05 23:59:59




   Enter start and end dates for the data. Leave
   a date blank for an open-ended date range.


 ←,→    = Move left/right        ESC   = Cancel
 CTRL-Y = Clear date             ENTER = Accept date
 TAB    = Move between dates
```

Figure 54: Download From Date Range screen layout.

3.6.1.4 Reset or set checkpoint on logger (firmware versions > 0.54)

This option allows the logger's data checkpoint date to be reset or set to a specific time. The current data checkpoint date is read from the logger and displayed on the screen. A new data checkpoint date can then be entered (refer to Section 3.6.1.3 for information about entering dates). Leaving the new date blank resets the data check point to 01/01/1970 00:00:00 (*i.e.*, the next Download from checkpoint on logger operation will download all data on the logger).

3.6.1.5 Download logger settings history (firmware versions > 0.54)

This option downloads all new settings history records from the logger. This option is useful if a history of the sensor settings changes for the logger is required (*e.g.*, to interpret old raw data). All settings history records that are dated after the time-stamp of the most recent settings history record stored in the data directory on the PC are downloaded. The downloaded records are appended, in binary form (not human-readable), to the files SETnnn.BIN in the data directory, where nnn = the logger serial number. To view the settings history, use the 'View settings history' option in the View Data Menu.

3.6.2 View Data Menu

The View Data Menu allows previously downloaded data to be viewed. There are four types of files that are fundamental to viewing data. They are:

- raw data files;
- coefficient files;
- calculated (real-value) data files; and
- settings history files.

The relationship between these files and the operations available for data viewing are shown in

Figure 55. Raw data is downloaded from a logger and stored in binary form in raw data files (DAT*.BIN). A human-readable ASCII version of a raw data file (RAW*.TXT) is automatically generated by the software each time the user views the raw data for a logger.

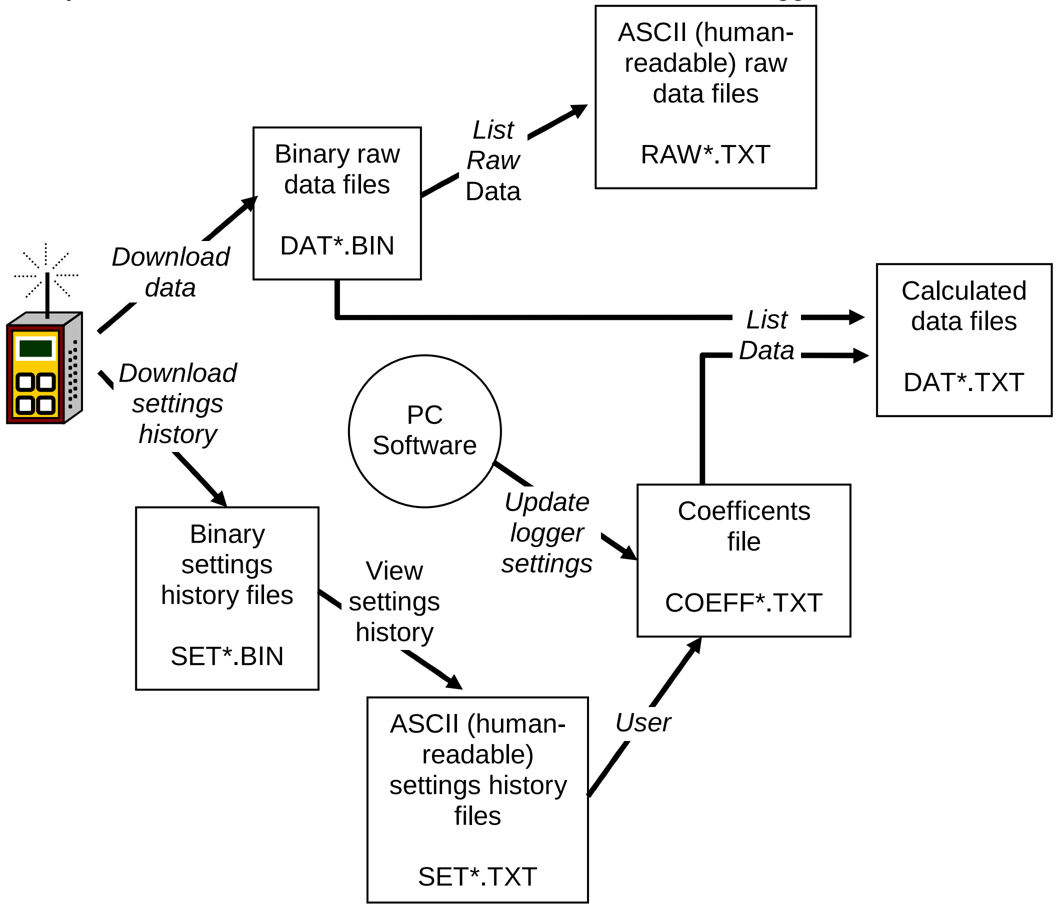


Figure 55: Relationship between files and data-viewing operations.

Settings history files (SET*.BIN and SET*.TXT) contain a time-stamped history of the sensor configuration for a logger (only supported by loggers with firmware version > 0.54). Each time a logger's sensor configuration is updated the logger also records a copy of the changes in its non-volatile memory. The settings history can later be downloaded and stored in binary form in settings history files (SET*.BIN). A human-readable ASCII version of a settings history file (SET*.TXT) is automatically generated by the software each time the user views the settings history for a logger.

Calculated data files (DAT*.TXT) are generated from raw data files using the information contained in coefficient files (COEFF*.TXT). The coefficient file for a logger is a time-stamped history of the sensor configuration and calibration information. A copy of the sensor configuration for the logger is appended to the file each time the sensor settings for the logger are updated. The coefficient file information, rather than the current logger settings, is used to determine how a raw data value at a given date is interpreted. It can also be edited directly by users. Because the interpretation of the data is independent of the logger's settings, modifications to the real-value data calculations can be easily made and retrospectively applied to previously downloaded raw data.

The layout of the View Data Menu is shown in Figure 56. All options may not necessarily be visible at any given time. Options 1 and 9, which can be used to move between loggers, are only visible if multiple loggers are currently connected. Pressing ESC will leave the View Data Menu and return to the Data Menu. The remaining sub-menus are described in Sections 3.6.2.1 - 3.6.2.4.

```
View Data Menu                           Using COM1

          Next Logger ................... 1

          Edit coefficient file ......... 2

          List raw data ................. 3

          List data ..................... 4

          View settings history ......... 5

          Select Logger ................. 9




          Exit menu ................... ESC

          Select ........................
```

Figure 56: View Data Menu screen layout.

3.6.2.1 Edit coefficient file

Each logger has a coefficient file associated with it that controls how real-value data is calculated from the raw data for the logger. The file is independent of the current logger settings and can be edited by the user. It contains a time-stamped history of the sensor configuration and calibration information for the logger. A copy of the sensor configuration for the logger is appended to the file each time the sensor settings for the logger are updated. A new file is created using the current logger settings if one doesn't exist, however it will need editing to configure it to interpret the raw data. The editor application that is used to modify the coefficient file is defined by the 'EDIT PATH' option in the Program Options Menu (see Section 3.9).

The format of a coefficient file is shown in Figure 57. It consists of a sequence of one or more *coefficient records* that describe the sensor configuration that applies from specified dates. More recently dated records take precedent over older records. The records are sorted before use so they do not need to be in a chronologically increasing sequence.

Each line in a coefficient record consists of a parameter name followed by one or more parameter values. White space and blank lines are ignored and all parameter names/values, except for UNITS parameter values, are case-insensitive. The first line of the record must contain the start date for which the coefficient record applies. The remaining lines are arranged as parameter names followed by zero or more columns of parameter values separated by commas. Each column of parameter values corresponds to a channel. The association between columns and channels is defined on the CHANNEL parameter line. Unused channels do not need to be specified.

The DATE, CHANNEL and TYPE parameter lines are mandatory and must appear in that order. Sensor measurement parameter lines (SETTLE, CYCLES and SWEEP) are optional (they do not play a role in interpreting data). They are automatically generated by the software for informational purposes only and can be ignored when manually creating a record if they are unknown or not important. Sensor calibration parameter lines are mandatory. Each type of parameters in a coefficient record is described in the following sections.

Coefficient record #2 defines the sensor configuration that applies from 2004/01/05 13:10:22 onwards (until it is superseded by another coefficient record). It defines a vibrating wire (VW) sensor on channel 1 and a resistance (RESIST) sensor on channel 4.

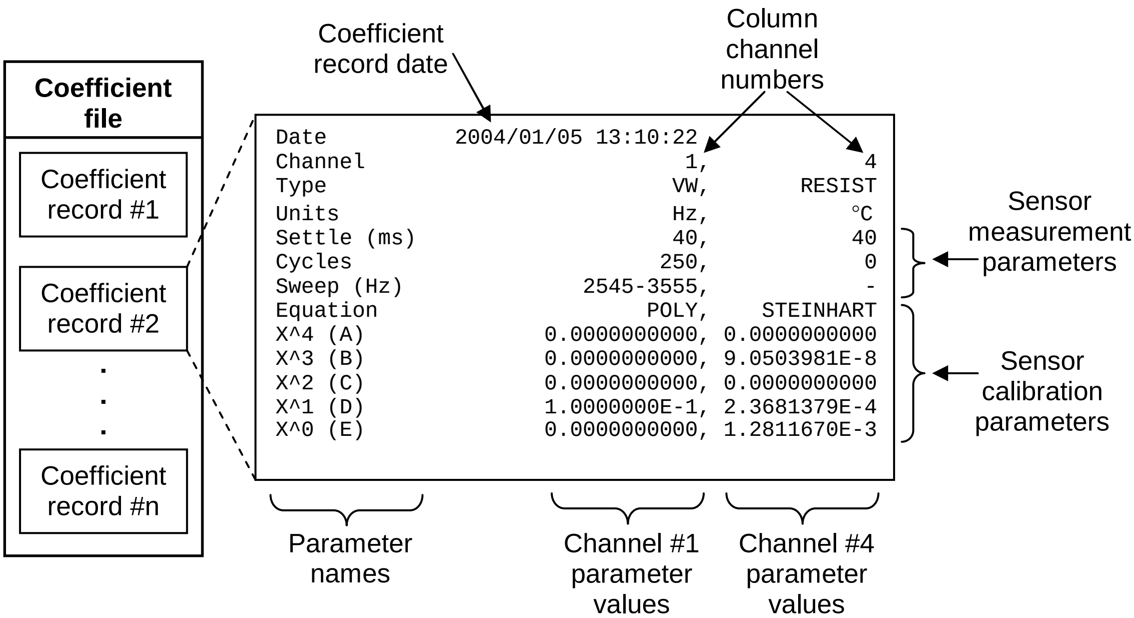


Figure 57: Coefficient file format.

DATE

The DATE parameter line specifies the date fr/m which the coefficient record applies and must appear as the first line in the coefficient record. The format for the date is YYYY:MM:DD HH:MM:SS. More recently dated coefficient records supersede older coefficient records. The sensor configuration contained in the coefficient record applies to all raw data time-stamped on or after the coefficient record date, until it is superseded by a more recent record. Each time a raw data record is interpreted, the coefficient file is searched for a record that is applicable at the date of the raw data record time-stamp (see the example in Figure 58). A raw data record cannot be interpreted if no applicable coefficient record can be found.

CHANNEL

The CHANNEL parameter line defines which logger channels (1-8) are connected to sensors at the date of the coefficient record. Specifying unused channels is optional. Channel numbers do not have to be specified in ascending order (*e.g.*, 1,8 and 4,1 are both acceptable), but duplicate channel numbers are not permitted. The number of defined channels can vary between coefficient records. The CHANNEL parameter line must appear immediately after the DATE parameter line.

TYPE
The TYPE parameter line defines the sensor type for each defined channel. Sensor types can be specified using either the numbers or names listed in Table 22. The TYPE parameter line must appear immediately after the CHANNEL parameter line.

UNITS (optional)
The **UNITS** parameter line defines a units label (maximum of 3 characters) for each defined channel. The units label is appended onto the end of lines in calculated data files and plays no other role in the interpretation of raw data. Commas cannot appear in the label. The UNITS parameter line is informational only and can be omitted if desired.

SETTLE (optional)

The SETTLE parameter line defines settling time (in milliseconds) for each defined channel. '(ms)' can be included directly after the 'SETTLE' parameter name (optional). '-' can be specified for a parameter value if the settling time for a channel is unknown. The SETTLE parameter line is informational only and can be omitted if desired. Each raw data record is interpreted using the sensor settings contained in the coefficient record that is applicable at the date of raw data record's time-stamp.

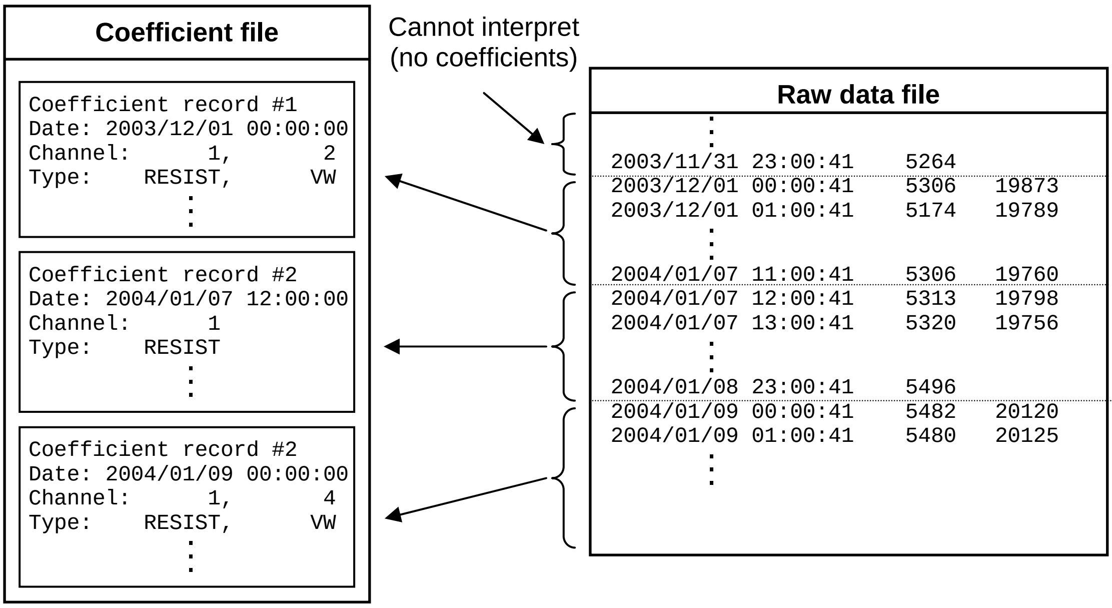


Figure 58: Example of using the coefficient file to interpret raw data records.

Value Name	Value Number	Description
UNUSED	0	Channel unused
VW	1	Vibrating wire transducer
FREQ	3	Frequency transducer
VOLT	5	Voltage transducer
RESIST	6	Resistance transducer
SWITCH	4	Switch transducer

Table 22: Coefficient record TYPE parameter values.

CYCLES (optional)
The **CYCLES** parameter line defines number of cycles the sensor readings are averaged over. '-' can be specified for a parameter value if the cycles value for a channel is unknown or not applicable to the sensor type. The CYCLES parameter line is informational only and can be omitted if desired.

SWEEP (optional)
The **SWEEP** parameter line defines sweep frequency range (in Hertz) for each defined channel. '(Hz)' can be included directly after the 'SWEEP' parameter name (optional). Ranges are specified as a start and stop frequency separated by a hyphen. '-' can be specified for a parameter value if the sweep frequency range for a channel is unknown or not applicable. The SWEEP parameter line is informational only and can be omitted if desired.

EQUATION
The **EQUATION** parameter line specifies the type of calibration function used to interpret the raw data for each channel (see Section 3.5.12.2 for more information about calibration functions). Calibration function types can be specified using either the numbers or names listed in Table 23.

Value Name	Value Number	Description
POLY	0	4^{th}-order polynomial
STEIN	1	Steinhart-Hart log 3^{rd}-order polynomial

Table 23: Coefficient record EQUATION parameter values.

X^4 – X^0
The **X^4 – X^0** parameter lines define the calibration coefficients for each channel (see Section 3.5.12.2 for more information about calibration coefficients). In the case of the Steinhart-Hart log 3^{rd}-order polynomial, unused coefficients can be specified as '-' or 0. If a channel is dynamically offset compensated, enter 'FROM CH <n>' for the X^0 coefficient ('<n>' = channel number).

3.6.2.2 List Raw Data

The List Raw Data option lists the contents of one or more raw data files for the currently active logger. This option will be hidden if no raw data files exist on the PC for the logger. Raw data is normally stored in binary form (not human-readable) in raw data files (DAT*.BIN) in the data directory. Selecting the List Raw Data option automatically generates an ASCII (human-readable) version of the raw data file (RAW*.TXT) and displays the file using a text file viewer. The text viewing application that is used to list the data file is defined by the 'LIST PATH' option in the Program Options Menu.

ASCII data files are automatically generated (*i.e.*, overwritten) each time the List Raw Data option is selected. If you wish to edit the ASCII file you should edit a copy of the file rather than editing the file generated by the software.

If multiple data files exist for a logger in the data directory, the file selection screen shown in Figure 59 is display that enables a particular raw data file to be selected. The screen displays a list of data file date ranges sorted by either start time, end time or file creation time. A data file can be selected by using the UP/DOWN arrows key to move to the desired data file and pressing ENTER to display its contents. Pressing 'S' will change the sort order of the file list. Pressing ESC will return to the View Data Menu.

```
View Data Menu                                Using COM1


 Select a data file:  (Sorted by end time)

     2003/11/31 00:00:41  -  2004/01/07 23:00:41
     2003/11/21 16:39:38  -  2003/11/31 23:00:41
     2003/01/01 00:00:00  -  2003/02/01 00:00:00





ENTER = Select ↑ = Up   HOME = Top PGUP = Pg Up
 ESC   = Cancel ↓ = Down END  = End PGDN = Pg down
 S     = Toggle sort order
```

Figure 59: Data file selection menu.

The contents of the raw data file will appear similar to that shown in Figure 60. The first line displays the date range of the data within the file. The remaining lines display the data records contain within the data file. Each line consists of a timestamp followed by zero or data values in the range of 0-65535. The number of data values per line may not necessarily be the same, since only the channels that are configured at any given time are recorded and channels that are not configured are not displayed. The 'OUTPUT FORMAT' option in the Program Option (Section 3.9) defines how the data values are formatted (in columns or in CSV format).

```
Data from 2003/11/31 00:00:41 to 2004/01/07 23:00:41

2003/11/31 00:00:41   5397
2003/11/31 01:00:41   5386
2003/11/31 02:00:41   5375
        :
        :
2003/11/31 21:00:41   5496
2003/11/31 22:00:41   5351
2003/11/31 23:00:41   5264
2003/12/01 00:00:41   5306  19873
2003/12/01 01:00:41   5174  19789
2003/12/01 02:00:41   5173  19764
        :
        :
2004/01/07 09:00:41   5306  19760
2004/01/07 10:00:41   5313  19798
2004/01/07 11:00:41   5320  19756
2004/01/07 12:00:41   5396
2004/01/07 13:00:41   5278
2004/01/07 14:00:41   5244
        :
        :
2004/01/07 23:00:41   5301
```

Date range of raw data

Raw data values

Figure 60: Example raw data file format (COLUMNS output format).

3.6.2.3 List Data

The List Data option lists the contents of one or more calculated data files for the currently active logger. This option will be hidden if no raw data files exist on the PC for the logger. Selecting the List Data option interprets a raw data file using a coefficient file for the logger, generates an ASCII (human-readable) version of the calculated data file (DAT*.TXT) and displays the file using a text file viewer. The text viewing application that is used to list the data file is defined by the 'LIST PATH' option in the Program Options Menu.

ASCII data files are automatically generated (*i.e.*, overwritten) each time the List Data option is selected. If you wish to edit the ASCII file you should edit a copy of the file rather than editing the file generated by the software.

If multiple raw data files exist for a logger in the data directory, a file selection screen (see Figure 59) is displayed that enables a particular raw data file to be selected. The view of the calculated data file is similar to that shown in Figure 61. The 'OUTPUT FORMAT' option in the Program Option (Section 3.9) defines how the data values are formatted (in columns or in CSV format). The output consists of blocks of interpreted data. Each block is preceded by the sensor settings that were used to interpret the block's raw data.

Informational messages, preceded by '***', may also appear within in the data file. They appear in the following situations:

- logger's clock time was changed;
- an alarm condition occurred;
- the data is not in a chronologically increasing sequence;
- there are no applicable coefficient records to interpret a sample; or
- the number of channels in a data sample does not match the number of channels defined in the applicable coefficient record (*i.e.*, channel mismatch).

If a data value cannot be calculated due to an arithmetic error (*e.g.*, divide by zero), the calculated data value appears as 'UNDEF'.

For SWITCH sensor types, the cumulative total of the number of times the switch has gone from an opened state to closed state (transitions from high resistance to low resistance) is display instead of resistance values. The cumulative total at the start of a data file is always zero. The maximum cumulative total for a single data file is 2^{32} (4,294,967,296). To view the measured resistance values of the switch, the List Raw Data option (Section 3.6.2.2) should be used. Using a RECORD ON VALUE CHANGE recording mode is useful for reducing the amount of recorded data for SWITCH sensor types (*e.g.*, recording on a change of > 30kΩ will record transitions from opened state to closed state and visa versa).

```
Data from 2003/11/31 00:00:41 to 2004/01/07 23:00:41

2003/01/01 15:33:17 *** CLOCK CHANGED FROM PC,
   OLD TIME WAS 1970/01/01 00:00:00

2003/11/31 00:00:41 *** No applicable settings for date. Unable
to interpret raw data. Edit sensor coefficients file to correct.

----------------------------------------------------------------
Date                2003/12/01 00:00:00    (YYYY/MM/DD HH:MM:SS)

Channel                          1,            2
Type                        RESIST,           VW
Units                           °C,           Hz
Equation                 STEINHART,         POLY
X^4 (A)               0.0000000000, 0.0000000000
X^3 (B)               9.0503981E-8, 0.0000000000
X^2 (C)               0.0000000000, 0.0000000000
X^1 (D)               2.3681379E-4, 1.0000000E-1
X^0 (E)               1.2811670E-3, 0.0000000000

POLY Equation = f(X) = A*X^4 + B*X^3 + C*X^2 + D*X^1 + E*X^0
STEINHART Equation = T(X) = -273.15 + 1/(E + D*ln(X) + B*ln(X)^3)

Other parameters not used in the data calculations:
Settle (ms)                     40,           40
Cycles                           0,          250
Sweep (Hz)                       -,    1800-2200
----------------------------------------------------------------

2003/12/01 00:00:41      23.64583   °C   1987.300   Hz
2003/12/01 01:00:41      24.21664   °C   1978.900   Hz
2003/12/01 02:00:41      24.22102   °C   1976.400   Hz
        :
2004/01/07 09:00:41      23.64583   °C   1976.000   Hz
2004/01/07 10:00:41      23.61601   °C   1979.800   Hz
2004/01/07 11:00:41      23.58624   °C   1975.600   Hz

----------------------------------------------------------------
Date                2004/01/07 12:00:00    (YYYY/MM/DD HH:MM:SS)

Channel                          1
Type                        RESIST
Units                            Ω
Equation                      POLY
X^4 (A)               0.0000000000
X^3 (B)               0.0000000000
X^2 (C)               0.0000000000
X^1 (D)               1.0000000000
X^0 (E)               0.0000000000

POLY Equation = f(X) = A*X^4 + B*X^3 + C*X^2 + D*X^1 + E*X^0

Other parameters not used in the data calculations:
Settle (ms)                     40
Cycles                           0
----------------------------------------------------------------
2004/01/07 12:00:41      5396.000   Ω
2004/01/07 13:00:41      5278.000   Ω
2004/01/07 14:00:41      5244.000   Ω
        :
```

Date range of data

Clock changed

Cannot interpret raw data – no applicable settings.

Sensor settings applicable from 2003/12/01 00:00:00 onwards.

Interpreted data

Sensor settings applicable from 2004/01/07 00:00:00 onwards.

Interpreted data

Sample time-stamps

Values

Units

Figure 61: Example calculated data file format (COLUMNS output format).

3.6.2.4 View settings history

The View Settings History option displays the contents of the settings history file for the currently active logger. This option will be hidden if no settings history files exist on the PC for the logger. The settings history for a logger is normally stored in binary form (not human-readable) in settings history files (SET*.BIN) in the data directory. Selecting the View Settings History option generates an ASCII (human-readable) version of the settings history file (SET*.TXT) and displays the file using a text file viewer. The text viewing application that is used to list the settings history file is defined by the 'LIST PATH' option in the Program Options Menu.

ASCII data files are automatically generated (*i.e.*, overwritten) each time the View Settings History option is selected. If you wish to edit the ASCII file you should edit a copy of the file rather than editing the file generated by the software.

The settings history file contains one or more time-stamped sensor settings records. It can be used as a reference for the modifying coefficients files (records can be copied directly from the settings history file into a coefficients file).

3.6.3 Manage Data Menu

The Manage Data option allows new raw data files to be created that contain data within a specified date range from all data files in the data directory. This option is useful if multiple raw data files spanning several time periods exist or only a subset of the data contained within a raw data file is required. After entering a date range, a new binary raw data file is created in the data directory (see Section 3.6.1 for details of the file name format).

3.7 Terminal Menu

The Terminal Menu provides a means for sending commands directly to a connected logger. It is intended mainly for troubleshooting logger problems and is not intended for casual use.

Using the terminal it is possible to erase data and settings recorded on the logger.

The layout of the Terminal Menu screen is shown in Figure 62. The currently active logger is display in the Active Logger Window in the top-right corner of the screen. All terminal commands will be directed to this logger. A list of currently connected loggers is displayed in the Connected Loggers Windows. A list of some useful commands is shown in the Message Window in the bottom-right corner of the screen. To the left is the Terminal Window in which commands are entered and responses are displayed.

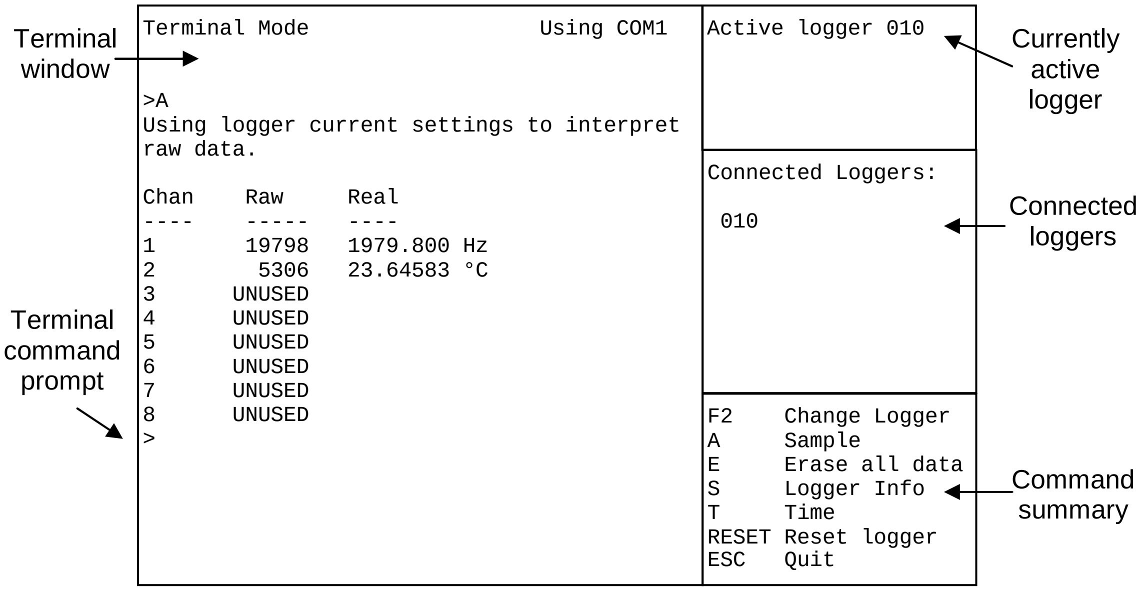


Figure 62: Terminal Menu screen layout.

Pressing ESC leaves the Terminal Menu and returns to the Main Menu. Pressing F2 cancels the current command and changes to the next logger in the connected logger list. Commands are entered at the command prompt ('>'). Some of the more useful commands are described in the following sections.

A Command
Entering 'A' causes the logger to sample all configured sensors and return their values. This command is useful when testing sensors after setup. For each configured channel, the channel number, the raw data value and the calculated real value and units are displayed. The current settings stored in the PC's memory, which may be different from those stored on the logger, are used to interpret the raw data values. The real data values will not be displayed if there are no settings available for the logger. Real data values that cannot be calculated because of arithmetic errors are displayed as 'UNDEF'.

T Command
Entering 'T' queries the logger for its clock time. The time is displayed in two formats:

- the number of seconds since 01/01/1970; and
- YYYY:MM:DD HH:MM:SS format.

S Command
Entering 'S' sends a query for generation information about the logger. This command is useful for ascertaining the logger's properties and current state. The returned information is:

- three-digit serial number; and
- firmware version.

Loggers with newer firmware (>0.54) will also return the following additional information:

- firmware bootloader version;
- CRC of the logger's settings;
- time-stamp of the last settings history record;
- time-stamp of the last data record stored on the logger;
- data checkpoint time;
- clock time; and
- battery status (OK or LOW).

ERASE Command
Entering 'ERASE' causes all data and settings history (not current logger settings) to be PERMANTLY erased from the logger. The command is useful before initial configuration of the logger or when the data on the logger is no longer of value.

RESET Command
Entering 'RESET' causes the logger to be reset. This is equivalent to pressing CH1 + CH3 + CH4 or disconnecting/reconnecting the batteries. There may be a short delay before the logger responds after invoking the RESET command.

3.8 Alarm Menu

The Alarm Menu allows alarms that have been received from loggers to be viewed. The layout of the Alarm Menu is shown in Figure 63. All options may not necessarily be visible at any given time. If more than one logger is connected then options 1 and 9 will be visible and can be used to move between loggers. The currently active logger is displayed in the Active Logger Information Window. Pressing ESC will leave the Alarm Menu and return to the Main Menu. The options available in the Alarm Menu are described in the following sections.

```
Alarm Menu                              Using COM1


           Next Logger ................ 1

           List alarms ................ 4

           Reset alarm flag ........... 5

           Select Logger .............. 9





           Exit menu ................ ESC

           Select .....................
```

Figure 63: Alarm Menu screen layout.

List Alarms
The List Alarms option displays a list of alarms generated by a particular logger. There are three types of alarms:

- low battery (<4.8V);
- clock changed (the logger's clock time has been changed – for informational purposes); and
- data alarm (a measured values has exceeded an alarm limit specified by the user).

Alarms from loggers are stored in binary form (not human-readable) in warning files (WARN*.BIN) in the data directory. Selecting the List Alarms option generates an ASCII (human-readable) version of the warning file (WARN*.TXT) and displays the file using a text file viewer. The text viewing application that is used to list the settings history file is defined by the 'LIST PATH' option in the Program Options Menu.

The warning file contains a list of alarms and the time at which they occurred.

Reset Alarm Flag
The Reset Alarm Flag option resets the alarm status of the currently active logger in the Connected Logger List. The colour of the logger will change from red to black.

3.9 Program Options Menu

The Program Options Menu allows the PC software to be configured. It contains options for specifying what COM port is used for communication, where files are located and how dates and data files are formatted.

The layout of the Program Options Menu screen is shown in Figure 64. A list of program options and their current values are displayed at the top of the screen. On-screen help for each option is displayed below the option list. The available key choices are displayed at the bottom of the screen. Press ENTER to enter edit mode and modify the program options. Pressing ESC leaves the Program Options Menu and returns to the Main Menu. Pressing ‘U’ will undo any changes made in the current session in the Program Options Menu. Each of the program options is discussed in the following sections.

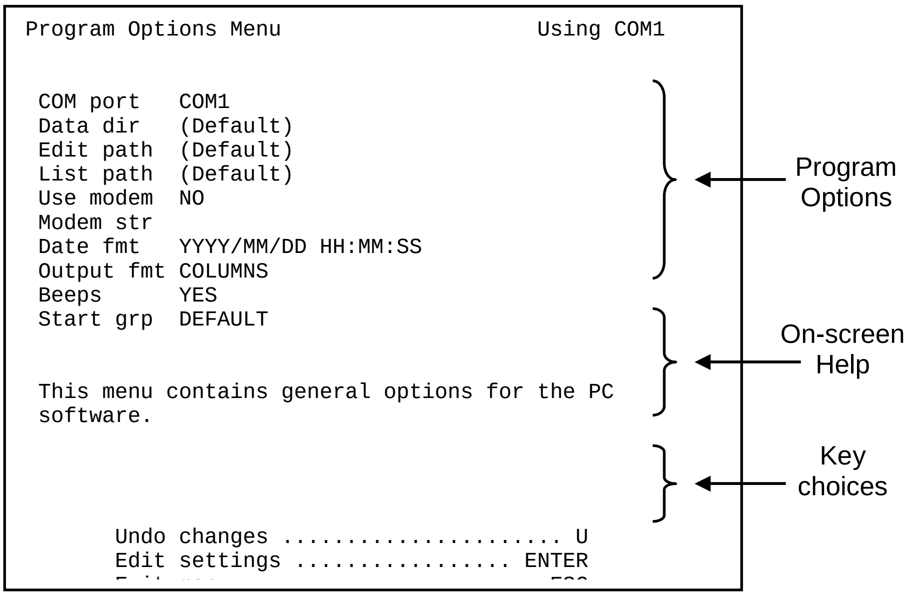


Figure 64: Program Options Menu screen layout.

COM PORT
The COM PORT option defines which COM port (COM1-9) is used for communication. Either a modem or a logger can be connected to the specified COM port. USB communication with loggers is supported through the use of a virtual COM port using a USB ↔ RS232 converter. If you are unsure of what the COM port number is, you can view the current hardware configuration using Window’s Device Manager (see Section 0 for more details).

Operating System	Menu Selection
Windows XP/2000/NT	Start | Settings | Control Panel | System | Hardware | Device Settings | Ports
Windows 95/98/ME	Start | Settings | Control Panel | System | Device Manager | Ports

Table 24: Accessing the Device Manager.

Figure 65 shows the appearance of the Device Manager. For USB virtual COM ports, the COM port number can be arbitrarily changed by right-clicking the virtual COM port, selecting Properties and entering a new COM port number.

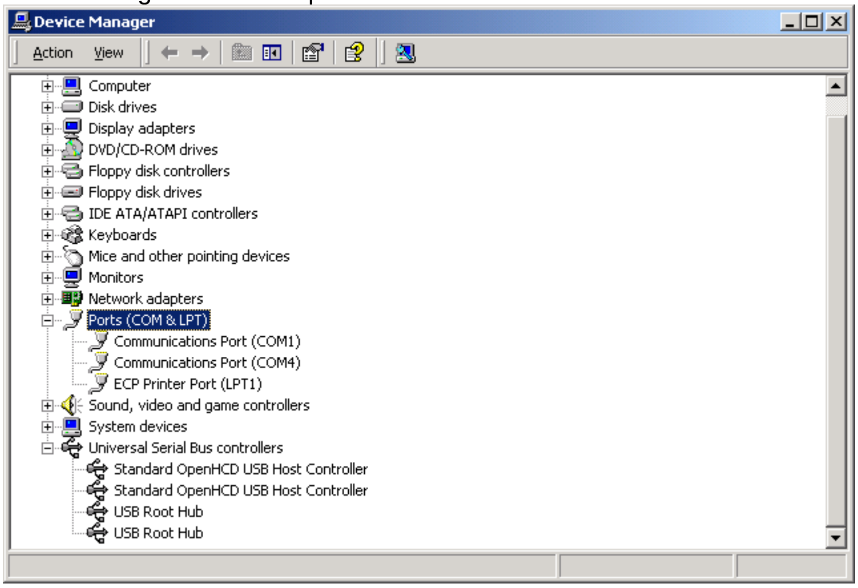


Figure 65: Viewing the COM ports using the Device Manager (Windows 2000).

DATA DIR

The DATA DIR option defines the where data files used by the program are stored. Three sub-directories will automatically be created *underneath* the directory defined by DATA DIR:

- *Settings.* This directory contains a cached copy of the settings for all loggers;
- *Data.* This directory contains all data, coefficient and warning files; and
- *Network.* This directory contains files describing the logger network.

Leaving this option blank will use the default directory. The default directory is the directory in which the PC software is installed (*e.g.*, C:\SIGRA\LOGGER).

EDIT PATH

The EDIT PATH option defines the path of an external text-editing program that will be invoked whenever a text file needs to be edited. The name of the text file is supplied as the only argument in the invocation command. Leaving this option blank will result in the default built-in text editor being used. To use notepad, specify ‘NOTEPAD.EXE’.

LIST PATH

The LIST PATH option defines the path of an external text-viewing program that will be invoked whenever a text file needs to be viewed. The name of the text file is supplied as the only argument in the invocation command. Leaving this option blank will result in the default built-in text viewer being used. To use notepad, specify ‘NOTEPAD.EXE’.

USE MODEM

The USE MODEM option defines whether the PC software will attempt to detect the presence of a modem at start up. This option should be set to YES if a modem is to be used to communicate with loggers. If a modem is not being used, disabling the modem detection will decrease the software start up time.

MODEM STR

The MODEM STR option defines a modem initialisation string. This string is used to initialise the modem prior to each time it is dialled to access a logger. This allows special or vendor-specific modems functions to be automatically configured (*e.g.*, disable call waiting). Consult the modem manufacturer’s manual for the necessary initialisation string. Leave this option blank if a modem is not being used or no special initialisation commands are required for the modem.

DATE FORMAT
The DATE FORMAT option defines the dates/times are formatted on the screen and in data files. The values of the DATE FORMAT option are listed in Table 25.

Value	Description
YYYY:MM:DD HH:MM:SS	The date is specified as the four-digit year, month, day, hour, minute and seconds separated by colons.
YYYY-MM-DD HH-MM-SS	The date is specified as the four-digit year, month, day, hour, minute and seconds separated by colons. This date/time format is supported by Excel and allows data files to be directly imported into Excel.

Table 25: DATE FORMAT values.

OUTPUT FORMAT
The OUTPUT FORMAT option defines the way in which data files are formatted. The values of the DATE FORMAT option are listed in Table 26.

Value	Description
COLUMNS	Data within data files is arranged in vertical columns separated by spaces.
CSV	Data files are written as a list of comma separated values (CSV). The CSV format is supported by Excel and allows data files to be directly imported into Excel.

Table 26: OUTPUT FORMAT values.

BEEPS
The BEEPS option defines whether or not an audible beep will be generated for error and informational messages.

START GRP
The START GRP option defines the name of the logger group that will be used at start up. If the specified logger group is not defined at start up, the DEFAULT logger group will be used instead.

3.10 About Menu

The About Menu displays details about the PC logger software and information for contacting Sigra Pty. Ltd. for support or further information (see Figure 66). If support is required, it is essential to know the current PC software version (displayed in the About Menu) and the firmware version of the logger (see Settings Menu or Active Logger Information Window or press CH1 + CH2 on the logger keypad).

Updates for both the PC software and logger firmware are available for download from the web site listed in the About Menu.

```
About Sigra Logger Software             Using COM1


 Version:    3.1.8
 Build Date: 2007/07/31

 For updates and support:
 WWW: http://www.sigra.com.au/logger/
 Email: support@sigra.com.au

 Sigra Pty Ltd
 21 Lombank St
 Acacia Ridge
 Brisbane QLD Australia 4110
 Phone: +61 7 3216 6344
 Fax: +61 7 3216 6988

 Copyright (c) 2003-2004 Sigra Pty Ltd.
 All rights reserved.

 Press any key to continue ...
```

PC Software Information (Version, Build Date)

Contact Information (updates and support, address, phone, fax)

Figure 66: About Menu screen layout.

3.11 Real-time Data Mode

The Real-time Data Mode allows data to be displayed in real-time on the PCs screen as it recorded by the logger. In this mode, whenever the logger stores a data sample in its memory it also sends a copy of the data to the PC. The PC displays the time-stamp and the calculated values of the data sample (the values are calculated using the current settings stored on the PC). Note: the data that is displayed on the screen is not stored in a data file. The Download Data Menu should be used to download the data stored on the logger.

The layout of the Real-time Data Mode screen is shown in Figure 67. Pressing ESC leaves the Real-time Data Mode and returns to the Main Menu. Only the configured channels are displayed. The logger's clock must be set before the logger will record data (and hence display it on the screen). The rate at which data is displayed on the screen is controlled by the recording options in the logger settings. Due to delays introduced by communication using RS232 or radio between the logger and the PC, the minimum interval between consecutive recorded data records while the logger is in the Real-time Data Mode (regardless of the logger's recording settings) is around 5 seconds (this depends on the type and speed of communication).

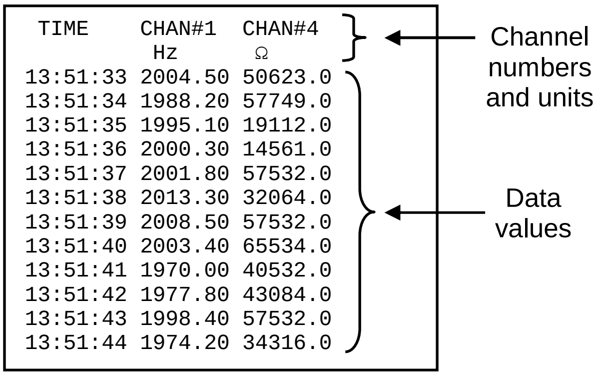


Figure 67: Real-time Data Mode screen layout.

3.12 Group Menu

The Group Menu allows groups of loggers to be defined and managed. Groups are useful for managing many loggers which may be associated with different projects. The Group Menu can be ignored if segregation of logger data is not important.

Groups are identified by a user-specified group name. Logger group names can contain any character and can be up to 25 characters in length. Logger group names are case-insensitive and must be unique.

Each logger group is associated with its own unique user-specified data directory. Changing logger groups effectively changes the data directory that settings for all loggers are written to/read from.

The logger group members defines a list of known loggers which the PC software will search for using RF when the group is selected. The list of known loggers is stored in the file KNOWN.TXT in the NETWORK subdirectory. For example, in Figure 68 two logger groups are defined: ‘A’ and ‘B’. The data directory for group ‘A’ is defined as c:\groupa. The known logger list file c:\groupa\NETWORK\KNOWN.TXT contains three loggers 001,002,003. Therefore these three loggers are the members of logger group ‘A’. Similarly for group ‘B’, the data directory is defined as c:\groupb and the loggers associated with the group are 004,005,006. Changing to logger group ‘A’ causes the data directory to change to c:\groupa. Data and settings files for all loggers will subsequently be written to this directory.

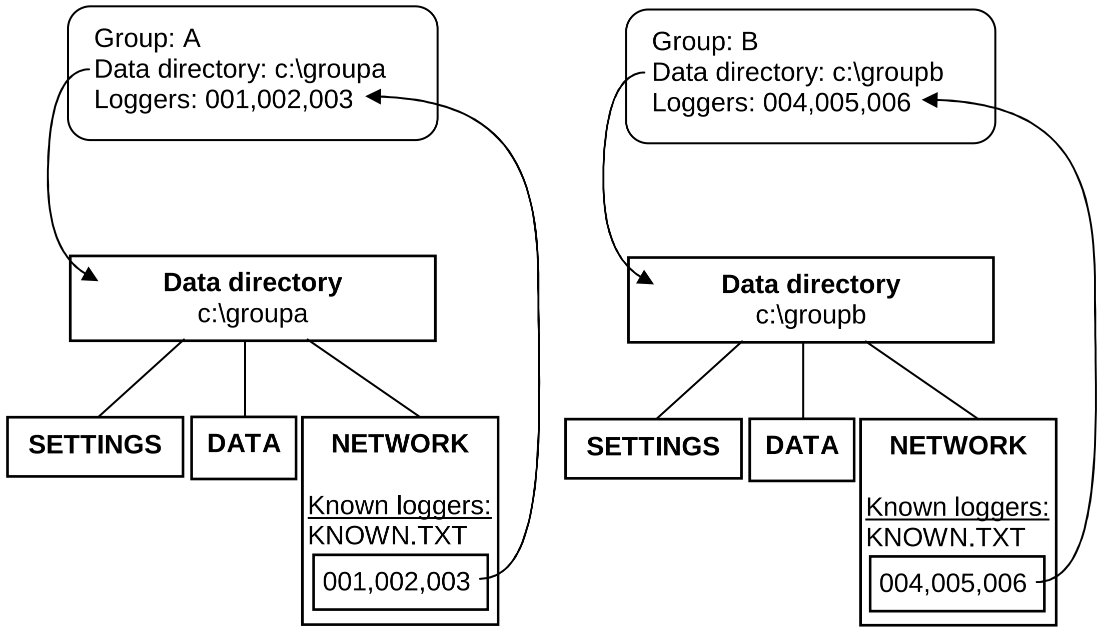


Figure 68: Example logger groups.

If no groups are defined then the default group name DEFAULT is used. The data directory for the DEFAULT group is the program install directory (*e.g.*, C:\SIGRA\LOGGER), though this can be changed using the Edit Groups option.

The logger group that is used each time the software starts up can be defined using the START GRP option in the Program Options Menu (see Section 3.9).

Changing logger groups

The Change Logger Group option in the Group Menu selects the current logger group to be used.

The layout of the Change Logger Group Menu is shown in Figure 69. A list of logger group names is displayed in ascending order, together with a list of known logger for each group. The DEFAULT group is always at the top of the list. The arrow keys can be used to move between logger group names. Pressing ENTER causes the PC software to change to the currently highlighted logger group. Changing groups causes the Connected Logger List Window to be cleared and all the known loggers associated with the selected group to be redetected. The data directory which is now used to read/write settings and data files for all loggers is that which is associated with the logger group. Pressing ESC will cancel group selection and return to the Group Menu.

```
Change Group Menu                        Using COM1

Select a logger group to use:

   GROUP NAME                     LOGGERS
   DEFAULT
   Site A                      001,002,003
   Site B                      004,005,006
   Site C                      007
   Site D                      008,009,010,011,012,...


 The group used each time the software starts up
 can be defined in the Program Options Menu.

 ENTER = Select ↑ = Up   HOME = Top PGUP = Pg Up
 ESC   = Cancel ↓ = Down END  = End PGDN = Pg down
```

Figure 69: Change Group Menu.

Editing logger groups
The Edit Logger Group option in the Group Menu allows logger groups to be managed (deleted, added, edited and renamed).

The layout of the Edit Logger Group Menu is shown in Figure 70. A list of logger group names is displayed in ascending order, together with a list of known logger for each group. The DEFAULT group is always at the top of the list. The arrow keys can be used to move between logger group names. Pressing ENTER allows the details of the highlighted logger group (name, data directory, loggers) to be edited. Pressing DEL will delete the highlighted logger group. Pressing INS will create a new logger group. Pressing ESC will cancel group selection and return to the Group Menu.

```
Edit Group Menu                          Using COM1

Select a logger group to modify:

   GROUP NAME                     LOGGERS
   DEFAULT
   Site A                      001,002,003
   Site B                      004,005,006
   Site C                      007
   Site D                      008,009,010,011,012,...


 The group used each time the software starts up
 can be defined in the Program Options Menu.

 ENTER = Modify ↑   = Up   HOME = Top PGUP = Pg Up
 ESC   = Cancel ↓   = Down END  = End PGDN = Pg down
 DEL   = Delete INS = New
```

Figure 70: Edit Group Menu.

3.13 Tutorials

3.13.1 Tutorial 1: Simple Temperature Logging System

The best way to become familiar with the Sigra Logger and its many features is to set it up for a simple application. A sample transducer, in the form of a calibrated thermistor (RS

Electronics Stock No 151-221)[2], has been supplied for this purpose. By working through the step-by-step instructions in this section, a first-time user will quickly produce a fully functional temperature measurement and logging system. This simple system can then be used to study the more complex areas of the logger software such as alarm generation.

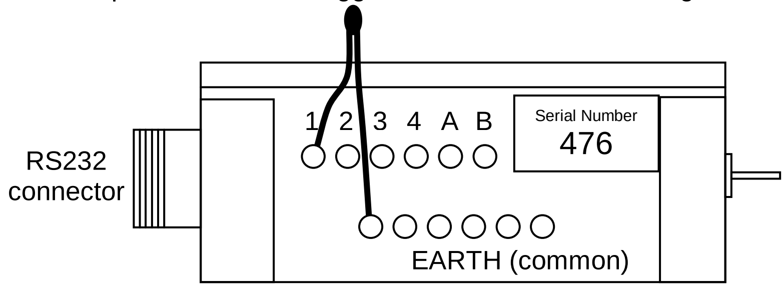


Figure 71: Connecting the sample thermistor.

1. **Connect the transducer**. This example assumes that the thermistor is connected to channel 1. One lead should be attached to channel 1 and the other lead attached to any of the earth terminals (see Figure 71). It does not matter which of the two leads is connected to earth.
2. **Check that the logger is functioning**. Press any key on the logger's keypad to ensure that it is operational. If no display is observed, check the logger's batteries (see Section 2.3 for details on connecting/changing the batteries);
3. **Connect the RS232 communication cable**. Connect the RS232 cable between a serial port on the PC and the logger's RS232 connector;
4. **Run and configure the PC software**. Run the PC software and, if needed, configure the serial port using the Program Options Menu;
5. **Erase previous data (optional).** Data may exist in the logger's memory from the factory. The data stored in the logger's memory can be erased by entering the Terminal Menu and typing 'ERASE' followed by ENTER;
6. **Reset the logger to its default factory settings**. Enter the settings menu. If a copy of the logger settings is not stored on the logger the software will produce a message box asking if you would like to download a copy of the settings from the logger. We will configure the settings from scratch using the default factory values so press 'C' for CANCEL. In the Settings Menu, press 'R' to reset the current settings to their default values (no changes are made to the logger's settings until the Upload Settings option is selected);
7. **Set the logger's clock**. Enter the Clock Menu and ensure that the displayed PC's clock is accurate. Select the Set Logger Time option to set the logger's clock to the current PC's clock time. Leave the Clock Menu;

   The logger's clock must be set each time the logger's batteries have been disconnected. No data will be recorded if the logger's clock is not set.
8. Leave the Modem Menu and System Menu parameters at their default values (in field use the System Menu parameters values can be modified to optimise battery life – see Section 3.5.11);
9. **Configure the thermistor channel**. Next configure the transducers that are connected to the logger. The thermistor has the calibration data shown in Table 27.

[2] A thermistor is a device whose electrical resistance varies with temperature. By measuring the resistance of the thermistor, and using the calibration data supplied with it, the temperature may be calculated, displayed and logged.

Coefficient	Steinhart-Hart log polynomial	4^{th}-order polynomial
A_{TH} (X^4)	-	1.1594E-14
B_{TH} (X^3)	9.0504E-08	-4.1958E-10
C_{TH} (X^2)	-	5.3162E-06
D_{TH} (X^1)	2.3681E-04	-3.1049E-02
E_{TH} (X^0)	1.2812E-03	9.2134E+01

Table 27: Calibration information for RS No. 151-221 thermistor.

Enter the Sensor Menu and configure a thermistor on channel 1 as shown in Figure 72. The calibration constants shown in Figure 72 are obtained from the thermistor's data sheet. To display Ohms rather than degrees Celsius, use a 4^{th}-order polynomial function with *X^4 = X^3 = X^2 = X^0 = 0* and *X^1 = 1*. Leave the Sensor Menu;

```
Sensor Menu        12345678           Using COM1
                   R-------

 Channel:      1        Type:     RESISTANCE
 Settling:   100 ms     Units:     °C

 Equation:   STEINHART-HART 3RD-ORDER LOG POLYNOMIAL

 X^3 (B):    9.0503981E-8

 X^1 (D):    2.3681379E-4
 X^0 (E):    1.2811670E-3
```

Figure 72: Thermistor channel configuration.

10. **Configure the recording mode and interval.** Next configure what data should be recorded and how often. Enter the Recording Menu and select a sample interval of 15 seconds and RECORD EVERY SAMPLE recording mode. This will sample and record the thermistor every 15 seconds. For the purposes of this tutorial, do not leave the sample interval this low permanently as the small sample interval will flatten the standard batteries over a short period of time. Leave the Recording Menu;
11. Leave the Alarm Settings Menu parameters as their default values (disabled);
12. **Store the settings on the logger**. The settings have been configured to sample and record a thermistor on channel 1 every 15 seconds. To upload these new settings to the logger, press 'U' to select the Update Logger Settings option in the Settings Menu**;**
13. **Check the thermistor readings.** On the front panel of the logger, press the CH1 button momentarily to cause the logger to sample channel 1 (the thermistor) and display the measured value. The thermistor is manufactured to have a resistance of 5000 Ohms at 25.0 ℃ and increases in resistance as the temperature decreases (see Figure 1). Holding the thermistor between your fingers for several seconds will cause the local temperature of the thermistor to change (press the CH1 button to view the change);
14. **Download the recorded data.** After allowing the logger to record data for one or two minutes, enter the Data Menu and select the Download Data | Download Since Last Data on PC option. Leave the Download Data Menu;
15. **View the recorded data.** To view the downloaded data, enter the View Data Menu. Select the List Data option to view the recorded data. The List Raw Data option will view the recorded raw data values.

3.13.2 Tutorial 2: Temperature-Compensated Vibrating Wire Logging System

This tutorial assumes that Tutorial One has been successfully completed. In Tutorial Two, a 3000kPa vibrating wire transducer is used to measure pressure down a borehole, as shown in Figure 73 (see Section 3.5.12 for details on the operation of vibrating wire transducers). The vibrating wire transducer houses an internal thermistor (the same type as in Tutorial One) that can be used to directly calculate a temperature-compensated pressure reading. The total cable length between the logger and the vibrating wire transducer is 213 m and the cable resistance is 117 Ω/km per pair of wires.

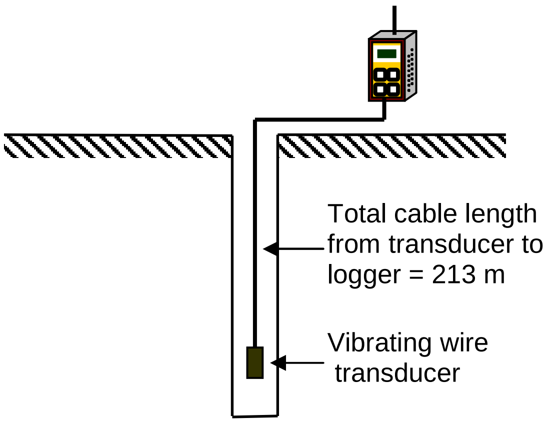


Figure 73: Measuring the pressure down a borehole.

Transducer calibration data
For the vibrating wire transducer, the calibration data given in Equation 7 and Figure 74 is assumed. The calibration information for the thermistor is given in Table 27.

$$P \quad = \quad \left(F_0 - F'\right) C_P + \left(T - T_0\right) C_T \qquad (7)$$

where: P = temperature-compensated pore pressure reading (kPa);
F = vibrating wire frequency reading (dHz);
F' = square of the vibrating wire frequency reading (Hz^2) = $\left(\frac{F}{10}\right)^2$;
T = vibrating wire temperature reading (°C);
F_{F0} = factory zero reading = 9758×10^3 Hz^2;
F_0 = zero reading at installation = assumed to be F_{F0};
C_P = pressure coefficient = 0.7853×10^{-3} kPa/Hz^2;
T_0 = factory temperature reading = 23.5 °C; and
C_T = thermal coefficient = 13.96 kPa/°C.

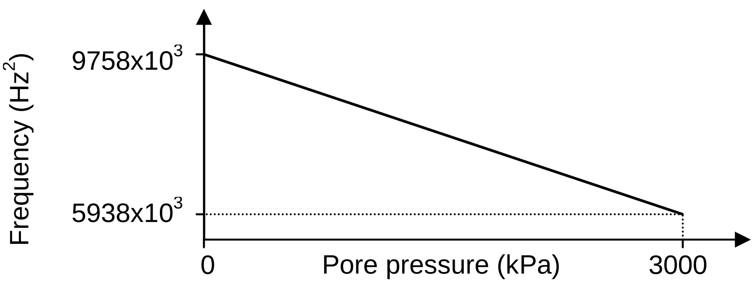


Figure 74: Vibrating wire pore pressure *vs.* frequency calibration chart.

Equation 7 can be rearranged into the form given by Equation 8. One channel (channel 2) will be used to measure the thermistor resistance (and hence T) to calculate the term m. This term will be used as an offset to the second channel (channel 1) that measures a vibrating wire transducer to calculate the temperature-compensated pore pressure P.

$$P = kF^2 + m \qquad (8)$$

where: $k = -\frac{C_P}{10^2}$; and (9)

$$m = F_0 C_P + (T - T_0) C_T . \qquad (10)$$

Determining the calibration parameters for the vibrating wire on channel 1

From Equation 8 it can be seen that there is one F^2 term (kF) and one F^0 term (m). The F0 term is dynamically obtained from the calculated value of the reading on channel 2. Therefore, the calibration constants that will be used for the vibrating wire transducer on channel 1 are:

A (X^4) = 0; (11)
B (X^3) = 0; (12)
C (X^2) = 0; (13)
D (X^1) = k = -0.7853x10^{-5}; and (14)
E (X^0) = FROM CH 2. (15)

Determining the vibrating wire measurement parameters

The default values will be used for the SETTLING and CYCLES parameters (40ms and 250 respectively). To determine the sweep frequency range, the pore pressure *vs.* frequency calibration chart in Figure 74 is used to determine the frequency range of the pressures that are expected to be measured. For this tutorial, the vibrating wire transducer will be used to measure all the possible pressures from 0–3000 kPa. From Figure 74, it can be seen that this corresponds to a frequency measurement range of 5938x10^3 - 9758x10^3 Hz^2, or 2437 – 3124 Hz. Allowing for another ±10% of the frequency range, the sweep frequency range should be around 2368–3192 Hz.

Determining the calibration parameters for the thermistor on channel 2

Resistance readings from the thermistor will also include the resistance of the cable between the thermistor and the logger. For long runs of cable, the cable resistance is significant and should be taken into account. The actual thermistor resistance can be calculated from the measured resistance using Equation 16.

$$R_T = R - R_C \qquad (16)$$

where: R_T = thermistor resistance (Ω);
R = resistance reading (Ω); and
R_C = total cable resistance = 117 Ω/km x 0.213 km = 24.921 Ω.

Unlike Tutorial One, a 4th-order polynomial is used to calculate the temperature since it is not possible to represent the *(R - R_C)* term in the Steinhart-Hart equation. The temperature of the thermistor can be calculated using Equation 17.

$$\begin{aligned} T &= A_{TH} R_T{}^4 + B_{TH} R_T{}^3 + C_{TH} R_T{}^2 + D_{TH} R_T{}^1 + E_{TH} R_T{}^0 \\ &= A_{TH}(R - R_C)^4 + B_{TH}(R - R_C)^3 + C_{TH}(R - R_C)^2 + D_{TH}(R - R_C)^1 + E_{TH}(R - R_C)^0 \\ &= A_{TH} R^4 + (B_{TH} - 4A_{TH} R_C) R^3 + (C_{TH} - 3B_{TH} R_C - 6A_{TH} R_C{}^2) R^2 + \\ &\quad (D_{TH} - 2C_{TH} R_C + 3B_{TH} R_C{}^2 - 4A_{TH} R_C{}^3) R^1 + \\ &\quad (E_{TH} - D_{TH} R_C + C_{TH} R_C{}^2 - B_{TH} R_C{}^3 + A_{TH} R_C{}^4) R^0 \end{aligned} \qquad (17)$$

The *m* offset in Equation 10 can be expressed in terms of the measured thermistor resistance by substituting Equation 17 into Equation 10 to give the expression shown in Equation 18.

$$
\begin{aligned}
m &= F_0 C_P + \left(T - T_0\right) C_T \\
&= A_{TH} C_T R^4 + (B_{TH} - 4A_{TH} R_C) C_T R^3 + (C_{TH} - 3B_{TH} R_C - 6A_{TH} R_C{}^2) C_T R^2 + \\
&\quad (D_{TH} - 2C_{TH} R_C + 3B_{TH} R_C{}^2 - 4A_{TH} R_C{}^3) C_T R^1 + \qquad (18) \\
&\quad (E_{TH} - D_{TH} R_C + C_{TH} R_C{}^2 - B_{TH} R_C{}^3 + A_{TH} R_C{}^4 + \frac{F_0 C_P}{C_T} - T_0) C_T R^0 \\
&= A' R^4 + B' R^3 + C' R^2 + D' R^1 + E' R^0
\end{aligned}
$$

where: $A' = A_{TH} C_T$; (19)

$B' = (B_{TH} - 4A_{TH} R_C) C_T$; (20)

$C' = (C_{TH} - 3B_{TH} R_C - 6A_{TH} R_C{}^2) C_T$; (21)

$D' = (D_{TH} - 2C_{TH} R_C + 3B_{TH} R_C{}^2 - 4A_{TH} R_C{}^3) C_T$; and (22)

$E' = (E_{TH} - D_{TH} R_C + C_{TH} R_C{}^2 - B_{TH} R_C{}^3 + A_{TH} R_C{}^4 + \frac{F_0 C_P}{C_T} - T_0) C_T$. (23)

Substituting in the values of A_{TH}, B_{TH}, C_{TH}, D_{TH}, E_{TH}, R_C, F_0, T_0, C_P and C_T into Equations 19-23 gives the following thermistor calibration coefficients:

A' = 1.6185×10^{-13}; (24)
B' = -5.8735×10^{-9}; (25)
C' = 7.4653×10^{-5}; (26)
D' = -4.3715×10^{-1}; and (27)
E' = 8.6319×10^{3}. (28)

Determining the thermistor measurement parameters.
The default value for the SETTLING and CYCLES parameter is used (40ms).

Logger configuration.
The two channels are configured as shown in Figure 75. Equation 7 calculates the pore pressure in kPa so the units for channels 1 and 2 will both be 'kPa'. After uploading the settings onto the logger, pressing the CH1 button will display the temperature-corrected pressure reading from the vibrating wire transducer. The calculated readings may vary slightly due to small fluctuations in temperature.

```
Channel:    1     Type:  VIBRATING WIRE
Settling:  40 ms  Units: kPa
Cycles:   250     Sweep: 2368 - 3203 Hz
Equation:   4TH-ORDER POLYNOMIAL
X^4 (A):    0.0000000000
X^3 (B):    0.0000000000
X^2 (C):    -7.853000E-6
X^1 (D):    0.0000000000
X^0 (E):       FROM CH 2

X = 30000   (VW Freq = 3000.0 Hz)
P = f(X) = CX^2 + 7679.44
         = 611 kPa
```

```
Channel:    2     Type:  RESISTANCE
Settling:  40 ms  Units: kPa

Equation:   4TH-ORDER POLYNOMIAL
X^4 (A):    1.618500E-13
X^3 (B):    -5.873499E-9
X^2 (C):    7.4652998E-5
X^1 (D):    -4.371500E-1
X^0 (E):    8631.9003906

X = 5000   (Temperature = 24.68 °C)
f(X) = AX^4 + BX^3 + CX^2 + DX^1 + EX^0
     = 7679.44 kPa
```

Figure 75: Channel configuration for temperature-compensated pressure readings.

4 Troubleshooting

PC software cannot communicate with any loggers

- Download cable is not attached to the PC or logger; or
- COM port setting in Program Options Menu (Section 3.9) is not correct.

Logger is not detected in software

- Batteries are flat/disconnected - press a button on the keypad to check for LCD screen activity. If nothing is observed, check/replace batteries; or
- Logger serial number has not been included in known logger list – Use Edit Logger List in the Connect Menu (Section 3.5.5) to add the logger number to the list.

Logger does not record data

- Logger clock is not set – press CH1+CH3 to display current time. Set the correct time using the keypad (CH1+CH4) or using the PC software;
- Sensors are not correctly configured – check settings using software; or
- Recording settings are not correctly configured – check settings using software.

Error messages when listing data

- Unable to interpret raw data - check that the coefficients file is correctly set up.

Software doesn't talk to modem

- COM port setting in Program Options Menu (Section 3.9) not correct;
- Modem detection is not enabled in the Program Options Menu (Section 3.9); or
- local echo setting on modem is not disabled – add ATE0 to modem initialisation string in the Program Options Menu (Section 3.9).

Measurements of steady signals fluctuate significantly between successive readings

- Check that the wires from the transducers are securely fastened to the logger's terminals.
- Try increasing the SETTLING parameter (Section 3.5.12.1) to let the signals stabilise more before a measurement is taken.

Detection of loggers at start up is slow

- The PC software will attempt to connect, in turn, to all loggers in the known logger list. Loggers that are out of range or not powered up will cause a small delay as the PC waits for a response. To improve detection speed it is recommended that logger groups (Section 3.12) are used to split long logger lists into smaller lists.\

5 Upgrading from earlier software versions

This section outlines the differences between the current software and previous software versions. It can be ignored if earlier software versions have not been used

The current software version can be installed over previous software versions to provide a seamless upgrade. However, as a precaution it is strongly recommended that a backup of all files, especially data, be made before attempting the installation.

1. The names of settings and data files have changed significantly

Old-style files will automatically be read and converted to new-style files when they are first encountered.

Logger settings files

Previously three separate settings files for each logger were stored in the SETTINGS sub-directory. Now only one file is used.

LOGnnn.MAS
LOGnnn.PTH → SETnnn.BIN
LOGnnn.SET

Data files

Previously all downloaded data for each logger was stored in a single binary file LBN.nnn in the DATA sub-directory. In the current software, multiple binary data files can exist for each logger. Additionally, time-stamps indicating the date of the first and last data record contained within the file have been added to the file name.

LBN.nnn → DATnnn_sssssssssssss-eeeeeeeeeeeee.BIN
LTX.nnn → DATnnn_sssssssssssss-eeeeeeeeeeeee.TXT
LTR.nnn → RAWnnn_sssssssssssss-eeeeeeeeeeeee.TXT

Warning files

The file names have changed as shown below.

WBN.nnn → WARNnnn.BIN
WTX.nnn → WARNnnn.TXT

Coefficient files

The format of coefficient files has changed slightly.

SETnnn.TXT → COEFFnnn.TXT

2. The way logger settings are updated has changed

Previously, pressing ‘0’ in a sub-menu updated the settings immediately. In the current version, settings changes can be entered but they are not updated until the Update Logger Settings option in the Settings Menu is selected.

3. Menu navigation has changed

Previously, pressing ‘0’ exited a menu. Now ESC is used.

4. Parameter units have changed

Previously, parameter values were displayed without units. In the current version, parameter value units are displayed and have been standardised where possible.

5. On-screen help

On-screen help has been included to explain settings parameters.

6. Some logger features may require a firmware upgrade

Some features described in the manual may require the firmware[3] on the logger to be upgraded (re-programmed) to the latest version. These features include:

- setting the logger clock using the keypad;
- setting changes history; and
- last downloaded data checkpoint function.

These features are enhancements and are therefore not critical to the operation of the logger. The logger's firmware can be left as is if the logger is in field use or it is inconvenient to re-program the logger. Features in the PC software that are not supported by the logger's firmware will be automatically disabled.

[3] The logger's firmware is the on-board software that controls the operation of the logger's microcontroller. It is not the same as the PC software that is used to interact with the logger.

6 Support

If support is required, it is essential to know the current PC software version (displayed in the About Menu) and the firmware version of the logger (see Settings Menu or Active Logger Information Window or press CH1 + CH2 on the logger keypad). For email support, send emails to support@sigra.com.au.

Updates for both the PC software and logger firmware are available for download from the web site http://www.sigra.com.au/logger.

7 Offset Errors in Polynomials

Given a sensor equation in terms of a raw data value x

$$f(x) = ax^4 + bx^3 + cx^2 + dx^1 + ex^0$$

which has been calibrated at a specific temperature T_0. If the sensor displays an offset Δx at another temperature T_1, then the sensor equation at this temperature is:

$$\begin{aligned} f(x+\Delta x) &= a(x+\Delta x)^4 + b(x+\Delta x)^3 + c(x+\Delta x)^2 + d(x+\Delta x)^1 + e(x+\Delta x)^0 \\ &= ax^4 + (a\Delta x + b)x^3 + (6a\Delta x^2 + 3b\Delta x^2 + c)x^2 + (4a\Delta x^2 + 3b\Delta x + 2c\Delta x + d)x^1 + \\ &\quad (a\Delta x^4 + b\Delta x^3 + c\Delta x^2 + d\Delta x + e)x^0 \\ &= ax^4 + b'x^3 + c'x^2 + d'x^1 + e'x^0 \end{aligned}$$

where
$b' = a\Delta x + b$;
$c' = 6a\Delta x^2 + 3b\Delta x^2 + c$;
$d' = 4a\Delta x^2 + 3b\Delta x + 2c\Delta x + d$; and
$e' = a\Delta x^4 + b\Delta x^3 + c\Delta x^2 + d\Delta x + e$.

From the above equation it can be seen that error introduced by a temperature change is in fact not a simple linear offset as previously described, but rather involves a change in all the lower-order coefficients of the calibration polynomial.

8 Specifications

Number of Logging Channels	8, of which up to 4 may be vibrating wire type.
Data Storage	Non-volatile flash RAM will hold 45K x 1-channel records to 18K x 8-channel records.
Sampling/Recording Interval	1 sec to 18 hours. A minimum of one sample is recorded every 18 hours.
Frequency Measurement Range	0.5 to 5.0kHz with 0.1Hz resolution.
Voltage Measurement Range	0 to 3.3 Volts or 5 Volts directly, higher voltages via optional interface. The voltage(3.3V/5V) depend in hardware version.
Resistance Measurement Range	0 to 65kΩ.
Analogue to Digital Converter	10 bit (0.1% resolution) with 64 samples/measurement
Low Power Radio Range	20 metres (typical) with whip aerial.
High Power Radio Range	500 metres (typical) with whip aerial, outdoors, clear line of sight.
Operating Radio Frequency	315.00MHz/433.92MHz (Country dependent).
Effective Radiated Power	Less than 1mW on high power using standard whip aerial.
Aerial	Quarter wave whip. (An optional magnetic base mount is available for vehicle use).
Battery Life	On average 2 months, depending on mode of operation selected.
Solar Power	Available as option with internal or external rechargeable batteries.
Switched Power Out	A 5 Volt supply may be used to power sensors only while sampling (optional).
Environmental Rating	The Sigra Logger is housed in a rugged, waterproof case.
Dimensions	170x100x60 millimetres plus aerial.

Table 28: Sigra logger specifications.

9 Logger Accessories

9.1 Logger accessories

Yagi antenna
The logger's standard vertical whip aerial is omnidirectional (*i.e.,* energy is radiated equally in all directions horizontally). Therefore, radio communication can be achieved from all directions around the logger. However, much of the energy radiated from the aerial will be wasted.

In situations where greater range is required, directional Yagi antennas can be used to focus the energy radiated from the antenna in a narrow beam (30-45°), thereby delivering a greater signal to the receiver. However, the receiver must be properly aligned with the transmitter (inside the beam) to receive the signal otherwise reception will be greatly attenuated.

Sigra can provide a range of Yagi antennas to improve the range of radio communication with the logger to 600+m. Antennas can be supplied in aluminium (light weight) or stainless steel (more rugged) with 6, 9 or 15 elements (more elements provides a greater gain but increases the length and weight of the antenna).

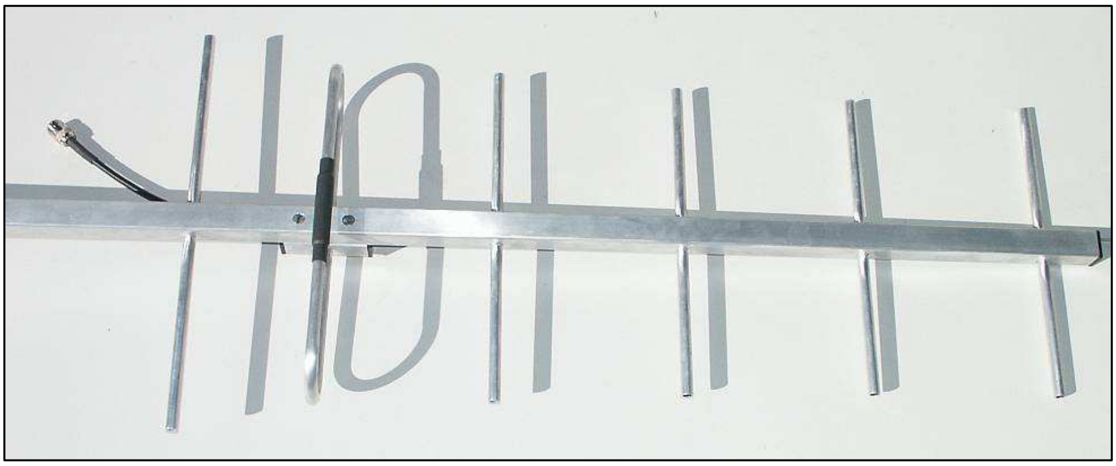


Figure 76: 6 element 9dBd 433.92MHz Yagi aluminium antenna (1.2m, 0.7kg).

USB to serial adaptor cable
The USB to serial adaptor cable (see Figure 80) enables a Sigra logger, with a standard RS232 download cable, to be accessed using a USB port on a computer. This may be useful if the computer does not have a serial port (an increasing trend in modern laptops) or the serial port is in used by another device. For further details see Section 0.

Note: the adaptor cable is not compatible with Windows 95/NT4 as these operating systems do not support USB devices.

Power supplies
The logger requires a regulated power supply of between 6 – 9V or 6 to 15V(Logger serial numbers greater than 474). The average battery life expectancy of the logger using the AA alkaline battery pack is 2-3 months (this is sensor and configuration dependent). For applications with greater power requirements, or where periodic replacement of batteries is not practical, a solar cell panel and rechargeable battery combination is ideal (see Figure 77). Since the solar panel configuration will vary depending on application requirements and location, it is advisable to contact Sigra to discuss the best solution. Some common solar panel configurations are:

- A small 6V amorphous solar cell panel can be used to trickle-charge a set of NiMH batteries. This combination eliminates the requirement to change periodic replace the batteries.
- For modem applications, a power supply of greater capacity is required. In this situation, a 12V solar cell panel with 12V lead acid battery and regulator can be used to adequately power the logger and modem.

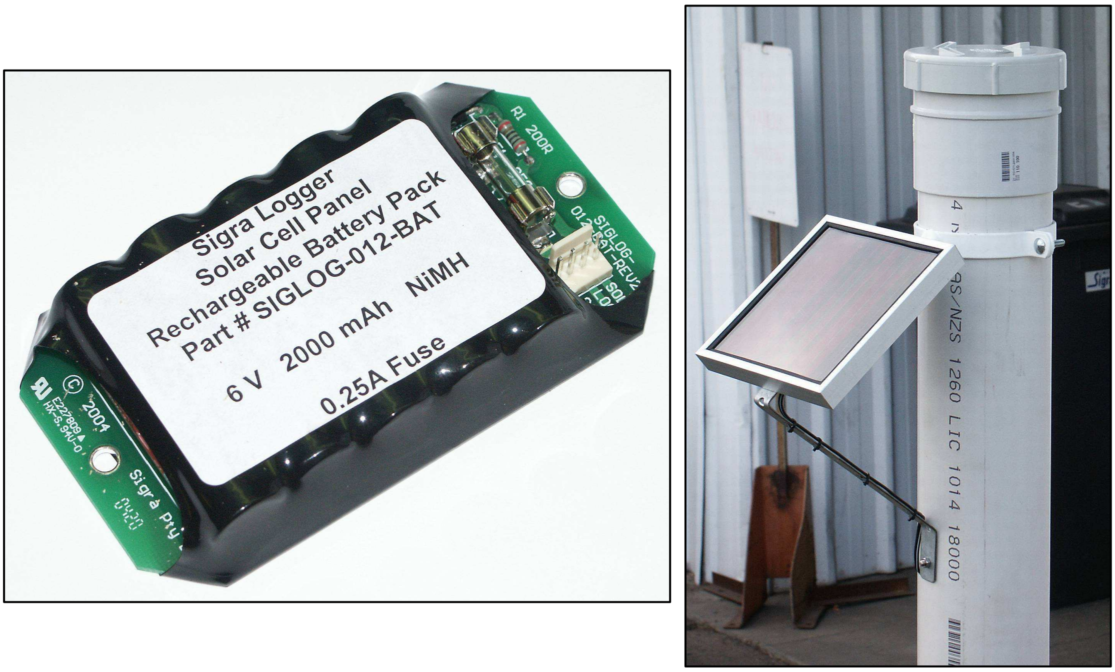


Figure 77: Rechargeable battery pack and solar cell panel.

Using the USB to serial converter cable with Sigra data loggers

Introduction
The USB to serial converter cable (see Figure 80) enables a Sigra logger, with a standard RS232 download cable, to be accessed using a USB port on a computer. This may be useful if the computer does not have a serial port (an increasing trend in modern laptops) or the serial port is in use by another device. The converter cable is connected in-line between the USB port and the DB9 connector on the RS232 download cable, as shown in Figure 78 below. Electronics in the converter cable provides the necessary signal conversion between the RS232 and USB devices.

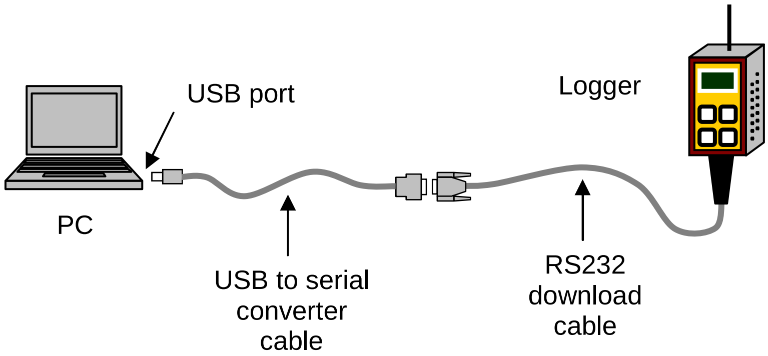


Figure 78: USB to serial converter cable connection.

Installation
Plug the USB to serial cable into the computer. The Windows operating system should detect the new hardware and prompt for a driver disk. Insert the supplied driver CD and specify the CD as the location for the driver files. A virtual COM port will have been created when the installation is complete. The number of the virtual COM port can be determined by viewing the current hardware configuration of the computer using Window's Control Panel (see Figure 79).

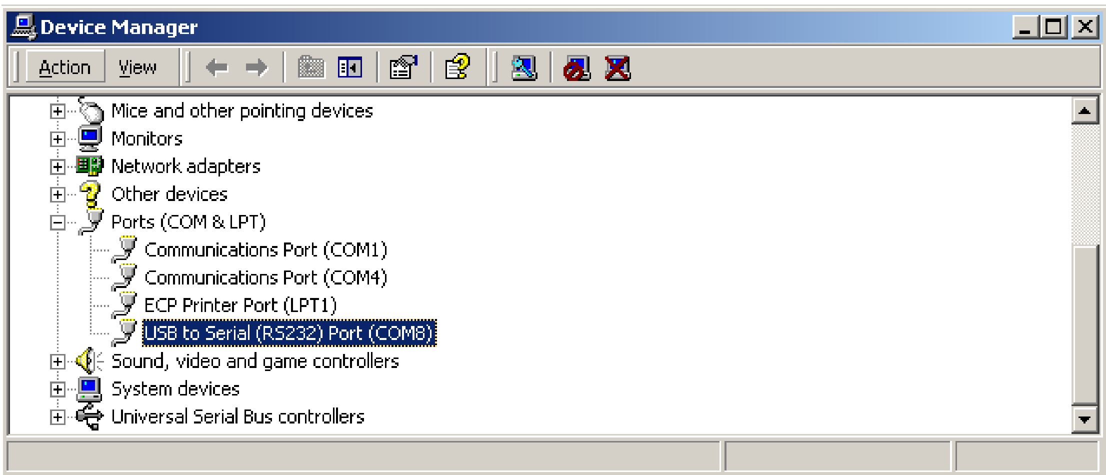


Figure 79: Example of determining the number of the virtual COM port.

The steps necessary to access the hardware configuration are listed in Table 29. The number assigned to the virtual COM port can be changed by right clicking on the USB to serial converter in the device list and selecting properties. Note that the PC software only software COM port numbers 1 through to 9 although Windows supports 1 through to 255.

Note: Administrator privileges may be required to install the device driver or change the device settings in Windows 2000/XP.

Operating System	Menu Selection
Windows XP/2000	Start | Settings | Control Panel | System | Hardware | Device Settings | Ports
Windows 98/ME	Start | Settings | Control Panel | System | Device Manager | Ports

Table 29: Procedure for viewing the current hardware configuration in Windows.

The PC logger software must be configured to use the correct number assigned to the virtual COM port in the Program Options Menu.

Compatibility
Windows 95/NT do not support USB devices and therefore the converter cable cannot be used with these operating systems. The USB to serial converter cable recommended and sold by Sigra is the Dolphin Peripherals FASTUSB-9103 USB to serial converter, which uses an FDTI FT8U232AM chipset (http://www.dolphinfast.com/products/9103.html). In Australia, it is also available from Dick Smith Electronics (part number XH6451). This cable has been tested and known to work correctly with the PC software. Sigra cannot guarantee compatibility with other converters. The converter must support break conditions in order to communicate with the logger.

Figure 80: USB to serial adaptor cable

10 Parts List

Part number	Description
SIGLOG-001-AU	Sigra Field Logger (complete) – 433.92 MHz (Australian)
SIGLOG-001-HK	Sigra Field Logger (complete) – 315.00 MHz (Hong Kong)
SIGLOG-002	Logger case. • Includes terminal connectors, RS232 connector, aerial connector • Excludes front panel with keypad.
SIGLOG-003	Front panel with keypad
SIGLOG-004	Logger circuit board (excluding LCD screen module)
SIGLOG-005	LCD screen module
SIGLOG-006	Battery holder and strap
SIGLOG-007	PC-Logger RS232 cable
SIGLOG-008-USB	USB to serial converter cable for SIGLOG-007. Not compatible with Windows 95/NT4.
SIGLOG-008	Modem-Logger RS232 cable (please specify modem connector type)
SIGLOG-009-AU	Standard whip aerial (range typically beyond 500 m for clear line of sight) – 433.92MHz Australian
SIGLOG-009-HK	Standard whip aerial (range typically beyond 500 m for clear line of sight) – 315.00MHz Hong Kong
SIGLOG-010-AU	Yagi-antenna for longer ranges – 433.92MHz Australian
SIGLOG-010-HK	Yagi-antenna for longer ranges – 315.00MHz Hong Kong
SIGLOG-011	Magnetic base mount for aerial SIGLOG-009 for vehicle use.
SIGLOG-012	6V 1W solar cell panel (amorphous) + 2000mAh NiMH battery pack. • Eliminates need for battery replacement • Not suitable for powering 12V modems
SIGLOG-013	12V solar cell panel (polycrystalline) + 12V lead acid battery + regulator suitable for powering modems
SIGLOG-014	Real-time clock board with 3V backup battery. • Eliminates need to set clock after disconnecting batteries.

Table 30: Sigra logger parts list.

Index

Sigra Pty. Ltd.

Drilling, Mining & Civil
Research, Development

ABN: 68 061 279 427

21 Lombank St, Acacia Ridge, Brisbane, Queensland 4110, Australia
Tel: (+61) (7) 3216 6344   Fax: (+61) (7) 3216 6988
http://www.sigra.com.au/