



Manual
Starlogger
Model 6004



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1.0 INTRODUCTION

The Starlogger (Model 6004D) is a battery powered data gathering unit manufactured by Unidata. It is ideally suited for automatic data collection at remote, unmanned locations. The Starlogger incorporates the latest advanced CMOS technology and intelligent auto calibration techniques to provide a very accurate, low cost, programmable data collection system.

The Starlogger is an upward compatible development of the Starlog Portable Data Logger (Model 6003) - it offers all the features of the Portable Data Logger plus the extensions provided by 10-bit resolution and universal memory storage. Like all Starlog products it is battery-powered, has a simple robust construction, is available at a low cost, and has a universal application.

The Starlogger is designed to be operated with the Starlog Software Support Package

2.0 STARLOGGER OVERVIEW

Starlogger offers 12 input channels, two high speed serial input/output busses and two outputs. It also provides two power sources for external instruments. The range of scan rates extends from 125 milliseconds to 5 minutes. The Starlogger communicates using standard asynchronous RS-232 serial communication standards which allow it to communicate with an PC using a standard cable



All setting up and adjustments associated with range changing and calibration are performed by firmware. Full programmability is provided by Starlog software

The Starlogger was designed for very low power consumption. Power is provided by an internal battery with a typical life of one year. Data is stored in a 512K low power CMOS RAM memory. An internal crystal clock provides accurate time referencing of all recorded data and also controls the adjustable scan rate. The Logger's only external connections are: a connector (labelled **INPUT SIGNALS**) for instrument inputs, user power supplies, and controls; and a connector (labelled **COMPUTER**) used for communication with a computer.

The Starlogger and its battery are housed in a small, robust, dustproof enclosure.

The Starlogger is available as a basic unit Model 6004D-1 or with a display Model 6004D-2

2.1 Programming Overview

The Starlogger is a microprocessor based device designed to be programmed using Unidata's Starlog V4 software package. This package, designed to run on Windows computers, creates and implements instructions that control the Logger.

Through a series of windows and menus, the Starlog V4 Software Package allows you to define how and when the Starlogger records, what channels to record and what signal types to measure.

Note: The Starlogger must be programmed before it will record/log or display readings.

2.2 Operation Overview

The Starlogger must be "initialised" before it can be used. This is done automatically when you load a scheme.

The Starlogger switches on once a scan. The scan rate is specified by the user. It performs three operations each time it is switched on: scanning, inter-log analysis, and RS-232 "comms" check. It performs a fourth operation, logging, at a user-specified interval.

These operations are described below:

1. Scan rates, which may be from 125 milliseconds to 5 minutes, determine how frequently the Logger switches on. When it switches on the logger scans its input signals. These signals, called the "hardware values", are recorded in the Starlogger memory. The hardware values are updated in the logger memory every scan.
2. Then the logger program runs and performs an "inter-log" analysis of the hardware values, storing the analysed values in a different part of the logger's memory (referred to as the Register). The operations done at program run time in the "inter-log analysis" include: averaging and storing maximum, minimum and raw values. For instance, if a certain channel is programmed to store maximum values of its input, the logger will check to see if the hardware value is higher than the value already stored in the Register. If so, then it updates the Register. If not, then it changes nothing and goes to the next instruction. The Register is used to store data between log intervals.
3. Next, if the Starlogger is operating in SCAN SYNCHRONISED communications mode (default) the logger checks to see whether it is connected to a computer. If so, it sends a prompt (*C/R) to the computer and awaits a command response.
4. When the scan occurs at a log interval, the logger program records data found in the Register into another part of its memory. Here, the data remains until the logger is unloaded (or until the entire memory storage space is filled, then earlier stored data may be overwritten when recent data is logged).
5. Finally, it switches off.

This sequence repeats every scan interval.

Input Signals

The Starlogger offers 12 channels for input signals. These are:

- 8 Analog channels (any combination of up to 8 single-ended voltage inputs, 10-bit resolution) .These channels accept signals 0 to +2.55 Volts full scale.
- 2 High Speed Serial Ports (bi-directional synchronous, eight 16 bit channels on each)
- 4 Counter input channels (16-bit resolution)
- 2 Sense input channels (used for LOG START and SDI-12 signals)

2.2.1 Instruments

To complement the Data Logger, a range of low power instruments and sensors is available. They can be powered either by the Data Logger’s battery or their own battery and are designed for direct connection to the Data Logger.

2.3 Outputs

The Starlogger offers two outputs and two power sources for external instruments. The outputs have a wide range of uses, for instance; to set off an alarm, or switch on another device.

The two “user power sources” (UPS) – described fully in Chapter 9.0, Configuration Table – are:

- +5 Volts regulated, scan synchronised
- +6 Volts unregulated, continuous

2.4 Status Indicators

The Starlogger has four LED indicators which flash briefly each scan (5 seconds) to show status of the battery and logging Scheme.

2.4.1 Battery Status LEDs

The top two indicators (labelled **BATTERY**) show the internal battery status (see section 4.3).

2.4.2 Scheme Status LEDs

When the Starlogger has been programmed with a Scheme, using the Starlog software, the lower two indicators show the status of the Scheme operation.

LED On	Description	State
none	Waiting to be unloaded	Stopped
	Waiting for input signals to be connected.	Primed
Green	Waiting to begin logging.	Primed
Green & Red	Actively recording.	Logging
Red	(No Scheme loaded.)	(Invalid)

When the Starlogger has been programmed with a Scheme the lower two indicators show the status of the Scheme operation.

2.5 Display and Keyboard

Starlogger Model 6004–2 has a 32 character Liquid Crystal Display (LCD) and an eight key operator keyboard.

<i>LCD DISPLAY</i>	STARLOGGER	301	LINE 1
	V20.2	BAT=OK	LINE 2



The Display may be activated by pressing the ON key. The Display will turn OFF automatically after a delay of 20 seconds (when no further keys have been pressed).

» NOTE: Whilst the Display is active, the Starlogger is in high power mode and uses about 100 times more battery power than in normal scanning mode.

2.5.1 Keys Definition

ON	Activates Display and displays the first entry of the STATUS LIST .
SCHEME	Displays the first entry of the SCHEME LIST .
CONFIG	Displays the first entry of the CONFIG LIST .
ENTER	Used only in the CONFIG LIST to save the current SETUP entry or perform the current SETUP action.
↓↑	Scroll UP ↑ or DOWN ↓ the current list entries.
↔	Adjust the current CONFIG entry UP in value → or DOWN in value ←. Used only in CONFIG LIST .

2.6 Using the Keyboard and Display

The Display shows you three lists of useful information.

STATUS LIST – Lists information about the logger, battery and channel readings (unscaled).

SCHEME LIST – Lists details of the current Scheme compose by Starlog Software V2.1. This is normally blank unless a Scheme has been loaded.

CONFIG LIST – Lets you adjust some logger configuration parameters (change the scan rate) and execute some useful commands (such as, setting the logger to the "sleep mode").

IMPORTANT - Saving altered Setup Entries using the Enter key will cause data stored in memory above 64K to be lost.

2.6.1 Selecting a Display List and List Entry

Whenever the **ON**, **SCHEME** or **CONFIG** keys are pressed the first entry in the Status, Scheme or Config list is displayed. Note: The **ON** key will also turn the Display **ON** if not already on.

By pressing the scroll keys, you display the next Entry in the list (DOWN key) or the previous Entry (UP key).

Note: Entries may be one or two lines, therefore the scroll keys will move the Display UP or DOWN one or two lines, depending on whether the Entry is two lines or not.

2.6.2 Auto Key Repeat

When a key is held down, it automatically repeats. This is a quick way to scan up or down a list of display entries (Releasing the key stops the repeat mode).

2.6.3 Adjusting a Config Entry

To alter a Logger Config Entry, scroll to the desired Entry in the Config List and use the Adjust keys to adjust the Config Entry to the required settings, then press **ENTER** to save the new setting PERMANENTLY. If you do not want to save the Config Entry, press any other key (or no keys at all).

IMPORTANT - Pressing the Enter key whilst displaying a Config Entry with the message "...use & ENTER" on Line 2 will cause data stored in memory above 64K to be lost.

2.6.4 Commands in the Config List

Some entries in the Config List are simple commands, they do not use the Adjust keys and they do not cause loss of memory when executed (**ENTER** pressed). A useful command "TURN DISPLAY OFF" is the first entry in the Setup List. Therefore, whenever you have finished viewing the Display, press **CONFIG**, then **ENTER** keys.

Note: The Display will automatically turn OFF anyway after 20 seconds if no keys are pressed.

2.6.5 Using a PIN# (Password)

The Model 6004-2 Starlogger is fitted with a keyboard and display. This enables you to configure various functions of the logger without a computer. To ensure that only authorised users alter the operation of the logger, an optional 4-digit PIN# (personal identification number) may be entered. The factory default for the PIN# is 0.

To change this PIN#, turn the display **ON** and then press **CONFIG**. Press the down arrow until CHANGE PIN# appears in the display. Press the left arrow key to select the digit and then the up or down arrow to alter the digit. Once you have selected a suitable 4 digit number, press the **ENTER** key. It is now impossible to change important configuration settings until the PIN# is re-entered.

Once a Starlogger has been protected by a non-zero PIN#, you must re-enter the correct PIN# before altering a configuration via the keyboard.

1. Turn the display **ON** and then press **CONFIG**.
2. Press the down arrow until ENTER PIN# appears.
3. Select the correct 4-digit code (using the arrow keys) and press **ENTER**.

You may now alter the logger's configuration.

To change the PIN#, you must enter the old PIN# first. A PIN# of 0 means that all settings may be changed without PIN# validation. (DEFAULT)

WARNING - As with all PIN#s, if you forget the PIN#, you are in trouble. The Starlogger will operate normally but you will not be able to use the keyboard configuration facility until the Starlogger is returned to Unidata for service.

2.6.6 Displaying the Scheme List

The Model 6004D-2 Display Starlogger has a two-line liquid crystal display (LCD) and eight key keyboard.

This Scheme Display List contains information similar to the Scheme Test Mode screen. A one-line display entry is provided for each Scheme Test Mode entry. You view two entries (lines) on the display at a time.

When the up/down scroll keys are pressed the display moves up/down this list one line at a time.

To view the readings of each transducer:-

1. Press the **ON** key firmly, the following is displayed -
`Starlogger 900`
`V022.01 BAT=OK`
2. Press the **SCHEME** key firmly -
`09:14:50 30APR93`
`Scheme: RMTEMP`
3. Press the ↓down key firmly -
`Scheme: RMTEMP`
`Status: Primed`
4. Press the ↓(down) key firmly -
`Status: Primed`
`Memory: 121K Free`
5. Press the ↓(down) key firmly -
`Memory: 121K Free`
`Log Inter 10 mins`
6. Press the ↓ (down) key again -
`Log Inter 10 mins`
`Temp 22.7deg C`
7. Continue pressing the until the end of the display list (the screen is blank).
8. Press **CONFIG** then **ENTER** keys to turn the display OFF.

The display turns OFF after 20 seconds, if no keys are pressed.

If the instrument being displayed uses a non-linear correction formula (such as a thermistor or wind direction) then the uncorrected (raw) mV reading will be displayed without units.

3.0 SPECIFICATIONS

This chapter lists the physical and performance specifications of the Starlogger

Material:	Grey, high impact rigid P.V.C.
Size:	211 x 108 x 81mm (H x W x D)
Weight:	2 kg incl. battery
Operating Temp:	-20°C to 60°C, not effected by humidity
Scan Rate:	0.125 second to 5 minutes programmable
Log Interval:	0.125 second to 1 week programmable
Memory:	Low power CMOS RAM 512K standard
Time Clock:	Crystal regulated, ± 10 seconds per month
Analog Inputs:	8 channels, 10-bit resolution Unipolar, single ended
Counters:	4 channels, 16-bit resolution
Starbus:	2 High Speed Serial lines with 8 channels on each, 16 bits, bi-directional, synchronous data & clock
SDI-12:	optional 1200 Baud instrument channel
Controls:	2 channels, 1 CMOS output, 1 uncommitted open collector output
Computer I/O:	Full duplex, Serial, RS-232C, Baud rates: 300/1200/2400/4800/9600/19200/38400/76800
Processor:	8 bit, 80C31 microcontroller, 14.7456 MHz
Battery Life:	Alkaline 1 year (typical)
Flat Battery Shutdown:	5.6 Volts
Instrument Power:	+5 V DC regulated 250ma (user programmable Model 6004C only), +6.5 V DC unregulated 1 mA continuous

3.1 Signal Specifications

Counter Channels:	DC to 20 kHz potential free contact or 0–5 V DC digital input
Analog Channels:	Voltage input in two ranges, programmable 0 to 2.550 Volts, 2.5 mV resolution, 0 to 255 mV, 250 mV resolution
Input Impedance:	>1 MW
Load Impedance:	for signals <500 mV: >1 MW for signals >500 mV: 10 kW
Recommended Source:	<10 kW
Drive Impedance	

4.0 POWER SUPPLY

All Starlog Data Loggers are powered by internal battery power. External power sources can be used either as an alternate supply (Sealed Lead Acid only).

A battery must remain connected at all times to protect memory storage.

The battery pack – which is available in Alkaline (Model 6910A) -is located in the base of the logger housing and connected via a three-way socket to the logger.

The Starlogger requires a single battery voltage of 6.5 to 10 V DC. Battery life varies anywhere from a few weeks up to 2 years depending on the logging project (see below).

4.1.1 Battery Life

The Data Logger battery life is influenced by five factors:

1. logger scan rate
2. logger program run time
3. external instrument power requirement
4. display usage
5. computer communication (RS-232)

Formula for Determining Battery Life

The following calculation will determine the battery life for Unidata battery packs (Model 6910A):

$$\text{Life (days)} = \left[\frac{\text{ST}}{\text{RT} + 35} \right] * 3300$$

ST = Scan Time (seconds)

RT = Run Time (milliseconds)

where external instrument load is not exceeding 20mA

Note: 6910A battery packs have a maximum life of 3 years.

Battery Life Estimation Tables

The following tables details the estimated battery life from data loggers with various scan rates and battery types. This table assumes a program run time of 12 milliseconds

Model 6910A	
Scan Rate	Life
0.25	12 days
1	30 days
5	40 days
10	40 days

Model 6910A – 10 Ah Alkaline Battery Pack

4.1.2 Battery Pack Connections

The Model 6910A battery packs are manufactured with a 3-way socket connector which plugs into the Model 6004D Starlogger PCB.

4.1.3 Replacing A Battery Pack

IMPORTANT - All recorded data will be lost when the battery pack is disconnected. Ensure the Starlogger has been unloaded before replacing the battery.

1. Remove Starlogger lid by unscrewing the six lid screws.
2. Depress the small retaining clip securing the battery plug and disconnect the battery cable.
3. Lift out the black metal battery retaining plate and remove the used battery pack.
4. Insert a new battery pack and replace the metal retaining plate making certain not to crush the battery wires.
5. Reconnect the new battery and the Starlogger automatically begins operating.
6. Replace lid into Data Logger base. Tighten six lid screws.

RECYCLE - Unidata uses only Mercury-free Alkaline cells in battery packs. Unidata or your battery manufacturer will accept battery packs returned for recycling.

IMPORTANT – Reverse Polarity Protected. The Starlogger is NOT damaged if battery wires are accidentally reversed.

4.2 External Power Supply

An external power source can be connected to the Data Logger. The external power may be used with an Alkaline battery pack as a backup power source or simply on its own.

A mains power pack and a solar power pack are available from Unidata.

IMPORTANT - The supply voltage to the Data Logger must be maintained at all times to ensure correct logger operation and data integrity

The voltage to the logger must be in the range of 9 V to 20 V and able to supply a load of 100 mA peak.

4.2.1 Connecting an External Power Supply

To install an external power supply:

1. Connect +ve to pin 16 of the **INPUT SIGNALS** socket (terminal 1 of the Field Termination Strip).
2. Connect -ve (common) to pin 23 of the **INPUT SIGNALS** socket (terminal 2 of the Field Termination Strip).

4.3 Battery Status Indicators

The Starlogger measures its internal battery voltage every scan. If the battery voltage falls below pre-set levels this is displayed on the Battery Status LED on the front panel.

GREEN	RED	BATTERY STATUS	ALKN	LCD DISPLAY
On	Off	Battery OK	>7.2V	Ok
On	On	Battery Low (Replace soon)	<7.2V	Low
Off	On	Battery Flat (Replace immediately)	<6.6V	Chg
Off	Off	Not Operating ("Sleep" or "Shutdown" Mode)	<6.2V	Bad

Note: Whenever an external power source greater than 11V DC is connected to the logger, the internal battery is bypassed. The logger operates from the external power, but will automatically use the internal battery if external power falls below 11V DC or fails altogether.

4.4 Flat Battery Shutdown

As a further protection, the logger continues to monitor the battery voltage whilst in "Sleep mode" and if the voltage falls to a level that may cause faulty operations, the logger enters "Shutdown" state and will not scan, communicate with a computer or activate the Display. In addition, all equipment power loads are disconnected (counter channels and pin 18 continuous power) to preserve memory.

The Flat Battery Shutdown voltage limit is 5.6V.

4.4.1 Saving Memory

A logger in "Shutdown" or "Sleep" mode will preserve its memory for many weeks. To recover information stored in the logger:

1. Connect a computer to the logger and attempt to "Unload" it.
2. If the logger was in:
 - a. "Sleep" mode it will "wake-up" and unload normally.
 - b. "Shutdown", connect an external power source to the logger (such as a new battery pack). The logger will then "wake-up" and unload normally.

Note: The external power must be connected without disconnecting the internal "Flat" battery. Follow the procedure in "Connecting an External Power Supply" above.

5.0 INSTALLATION & CONNECTION

This chapter provides information necessary to install a Starlogger. This includes:

- a list of the connections of the **INPUT SIGNALS** connector
- signal specifications for each connection
- how to initialise a Starlogger

For information about the connecting the Logger to a computer, see Chapter 7, Computer Communication.

5.1 Locating the Logger

The Starlogger may be installed in nearly any environment. The Data Logger should not be exposed directly to the weather and if it is to be used externally, it should be housed in a weatherproof enclosure. The Data Logger should be mounted away from electrical noise sources (such as electrical motors and radio transmitters) and in all cases signal leads should be shielded and kept as short as possible.

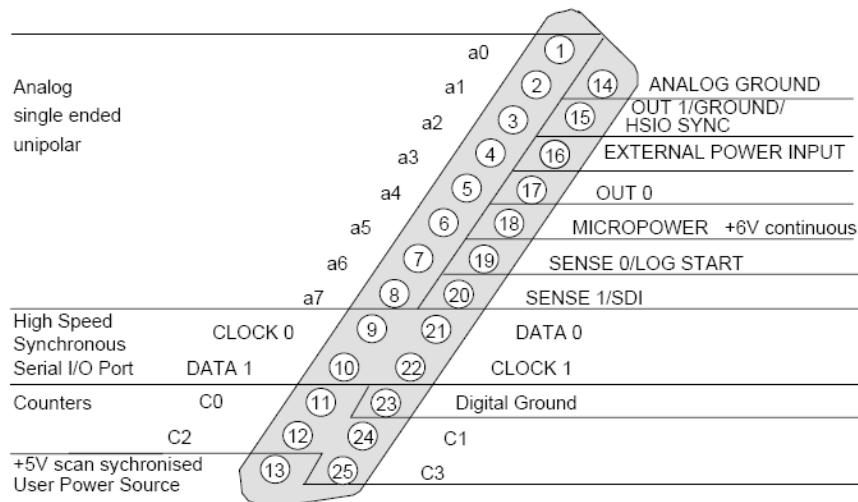
Wherever possible, install the Data Logger in a protected location exposed to the least temperature extremes. This will increase the battery life, and improve clock and signal measurement accuracy.

5.2 Instrument Connection

You connect instruments to the Starlogger via the 25-pin socket located on the Logger’s front panel and labelled **INPUT SIGNALS**. For ease of use you can plug a Field Termination Strip into this connector (see below). Each input is referred to as a channel in the Starlog V4 Software Package.

Field Termination Strip - This extends the **INPUT SIGNALS** connector to a row of numbered screw terminals. The Field Termination Strip (Model 6103E) and its manual are available from Unidata.

The following table lists each pin in the INPUT SIGNALS connector by number. Next to the pin number is a description of the signal for which this connection is designed. The last column lists the high resolution channel mnemonic used by Starlog V4 Software to refer to this connection.



Pin	Signal Description	Channel
1	Analog input A0	a0
2	Analog input A1	a1
3	Analog input A2	a2
4	Analog input A3	a3
5	Analog input A4	a4
6	Analog input A5	a5
7	Analog input A6	a6
8	Analog input A7	a7
9	High Speed Synchronous Serial Port 0 CMOS OUTPUT CLOCK 0	HSIO CLOCK 0
10	High Speed Synchronous Serial Port 1 CMOS BI-DIRECTIONAL DATA 1	HSIO DATA 1

11	16 bit counter input (20kHz)	C0
12	16 bit counter input (20kHz)	C2
13	+5V scan synchronised User Power Source	UPS
14	Analog Signal Ground	analog ground
15	CMOS Output, HSIO Sync/Ground (not to be used in new installations)	OUT 1/HSIO sync
16	Power input	power input
17	Control, Open Collector Output, 30V maximum, 100mA drive	OUT 0
18	+6V continuous power for external instruments (1mA max)	MICROPOWER
19	Sense input BIT 3 (Log Start, MASK 8)	SENSE 0
20	Sense input BIT 1 (MASK 2)	SENSE 1/SDI-12
21	High Speed Synchronous Serial Port 0	HSIO DATA 0
22	High Speed Synchronous Serial Port 1	HSIO CLOCK 1
23	Data Logger Power and logic ground	Digital Ground
24	16 bit counter input (3kHz)	C1
25	16 bit counter input (3kHz)	C3

5.2.1 Log Start Sense

Normally, the Data Logger only begins to record when an instrument is connected to the **INPUT SIGNALS**. To sense this condition, Pin 19 (Log Start Sense 0) of the **INPUT SIGNALS** socket is grounded (connected to Pin 23).

WARNING - The Starlogger will not begin recording UNLESS the LOG START Sense is connected to ground (Pin 23).

Note: LOG START is automatically connected to ground when the Model 6103 Field Termination Strip is used.

5.2.2 Analog Inputs

All Analog channels are programmable to carry a signal: 0 to 2.550 V (2.5 mV per bit). Input impedance (when the logger is active) is greater than 1 MW. Load impedance (when the Logger is inactive) for signals less than 500 mV is greater than 1 MW, while for signals greater than 500 mV, it is 10 kW. The recommended source drive impedance is <10 kW.

5.2.3 Counters and Digital Inputs

Counters and Digital inputs are DC inputs, suitable for 20 kHz potential free contacts or 0–5V to 0–12V DC digital input.

Maximum pulse rate to the counters is 20 kHz. Pulse rates must also be related to scan rate, to ensure counters do not overflow before being scanned by the Data Logger.

5.2.4 User Power Sources (UPS)

The User Power Source (Pin 13) is intended to power instruments associated with the Data Logger. The full load output capability is 250mA in pulsed mode.

The UPS switches on and off (synchronised with the logger scan). Any loads connected to these outputs will contribute to the drain on the Data Logger battery (and reduce battery life).

5.2.5 High Speed Serial Ports

There are two serial ports:

- Port 0: Pin 9 (Clock 0)
Pin 21 (Data 0)
- Port 1: Pin 22 (Clock 1)
Pin 10 (Data 1)
Pin 13 +5V sync signal

Each logger scan, the High Speed Serial Ports are read. The Sync signal (Pin 13) is used to indicate to the remote equipment that a logger read scan is about to begin. This signal is usually used to load the serial shift register(s) in the remote equipment in preparation of being read.

Note: the first data bit LSB must be present on the Data (0/1) signal within 7ms after the Sync signal.

Serial transfer rate is 50 microseconds per bit with a 30 microsecond gap between each byte. Please see timing diagrams for Serial In and Serial Out overleaf.

Note: every 1 millisecond a logger interrupt sequence adds a 50 microsecond delay to the serial transfer sequence. Transfer starts with the least significant bit of the least significant byte and each clock reads the next most significant bit.

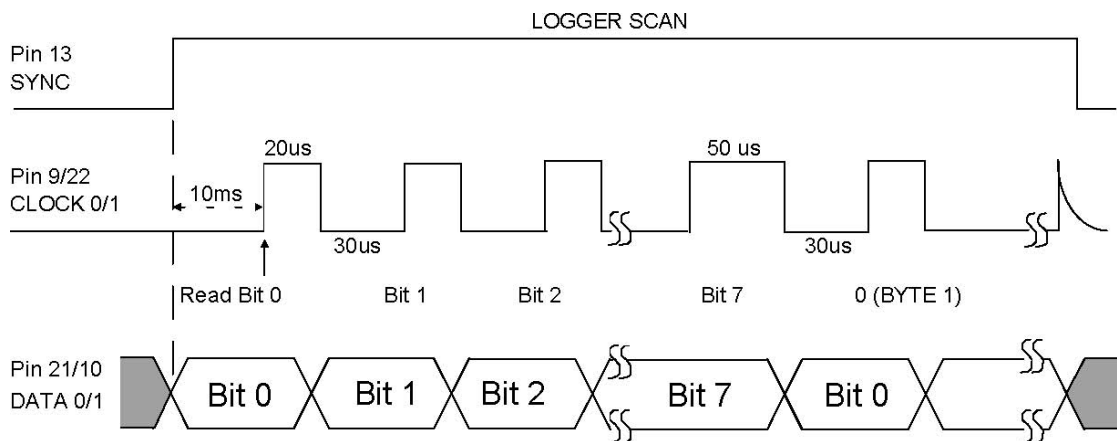


Figure 5.3 - Serial In Timina Diaaram

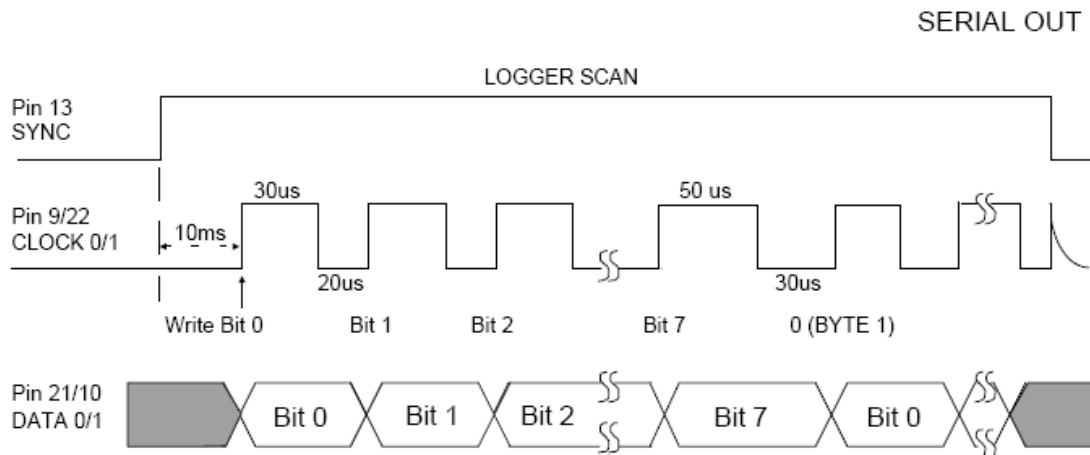


Figure 5.4 - Serial Out Timing Diagram

5.3 SDI-12 Serial Digital Interface

The Starloggers support the U.S. SDI-12 standard for serial data interchange between the logger and intelligent instruments.

SDI-12 is implemented as an alternate use of Sense 1 (Pin 20). Up to ten SDI-12 compatible instruments may be connected onto this bus. Programming the SDI-12 interface is supported in the Starlog V4 Software.

Appendix A - Using The Starlogger SDI-12 Interface for details on how to use the SDI-12 Interface.

5.4 Starlogger Initialisation

The Starlogger is normally stored and delivered to you in a "sleep" state to conserve batteries. You MUST LOAD A SCHEME into the logger before it can be used.

Any of the following actions will (re)initialise the logger:

- Load a Scheme into the logger.
- Execute the "RESET LOGGER" command in the Config List.
- Use the ALT-I command in Diagnostics. (See Starlog V4 Software Package.)
- Disconnect, then re-connect the battery after a ten second delay.

WARNING: Memory storage will be lost.

During initialization, the logger's firmware and Configuration Table is check summed to confirm its integrity. The Scan Counter is set to the Logger Scan Rate and other housekeeping functions performed.

6.0 INTERNAL CHANNELS

The Starlogger has two internal channels. These are presented as high resolution values (signed 16 bit) in Register Addresses 232 to 239 as detailed below:

Name	Description	Register Address
I0 (Temp)	Logger Temperature (0.1221 °C per bit)	232
I2 (Batt)	Logger battery (or supply) voltage (1.221 mV per bit)	236

The values of these internal channels are available for recording (logging) or use in computations in the User Log Program.

6.1 Battery Voltage Monitor (I2, "Batt")

Battery voltage is automatically monitored by the logger and recording will cease (the logger goes into a dormant "sleep" mode) if the battery falls below a defined threshold. The threshold is defined in the Configuration Table (see Chapter 9.0). The battery state is also displayed on the Battery Status LED's while the logger is operating (see section 4.3).

7.0 COMPUTER COMMUNICATIONS

The Starlogger communicates using standard asynchronous, RS-232 serial communication standards which allow it to communicate with an IBM PC or compatible computer using a direct 25 pin to 25 pin cable at 9600 baud. Model 6602A “25-to-25 pin” and Model 6602I “25-to-9 pin” cables are available from Unidata.

The communication format is:

- RS-232C compatible
- 300 to 76800 baud
- 8 data bits
- 1 stop/start bit
- no parity

You connect a computer to the Starlogger via the 25-pin socket (labelled **COMPUTER**) located on the Logger’s front panel. This allows you to load and unload schemes and data. About half of the pins in this plug are allocated a function. The rest are reserved for future use.

[If your computer does not have a serial port, you can make a connection using a USB to serial converter.](#)

This chapter:

- explains how to set the baud rate,
- describes the communications protocol for 512K Loggers,
- provides a sample communication program, and
- includes a table listing pin allocations.

7.1 Computer Connector Pin Designations

The following table lists each pin in the COMPUTER connector by number. Next to the pin number is a description of the signal for which this connection is designed. The last column explains how the pin is being used.

Pin	Signal Description	Usage
1	Data Logger signal & logic ground	Ground
2	Serial data signal to Data Logger	RxD*
3	Serial data signal from Data Logger	TxD*
4	RTS from computer (See Note 1.)	RTS*
6	DSR from Logger	DSR* to CPU
7	Signal Ground	GND
10	Mode	
15	Baud Rate Select (See section 7.2.)	
16	Baud Rate Select (See section 7.2.)	
17	Baud Rate Select (See section 7.2.)	
20	from computer (not used)	DTR
25	Remote Telemetry Control from Logger	OUT 0

* These are RS-232 signals.

All other pins are not connected and reserved for future use.

Notes:

1. RTS signal from the computer will activate the Logger even between scans. The Logger may respond with a prompt (*C/R) immediately the RTS becomes true or wait until the next scan (depending on communication mode settings). See section 7.1.
2. CTS signal is not used to synchronise communications between Logger and computer, this is achieved by the Logger prompt (*C/R). The DSR is true whenever the Logger scan is active.

7.2 Baud Rates

The communication baud rate is selected on the **COMPUTER** connector on the face of the Logger. Note that PC/XT and slow PC/AT computers can only communicate up to 9600 baud. 9600 Baud is the default baud rate for a Starlogger.

7.3 Communications (Starlog) Protocol

This section describes communications protocol. See section 8.5 for a complete list of Starlog Protocol commands.

7.3.1 Scan Synchronised RS-232 Communication (default)

At the end of every Data Logger scan (5 seconds usually) the logger will check to see if the Computer Interface is connected. If the interface is connected, the logger sends a prompt to the interface (host computer). This prompt is an ASCII asterisk followed by a carriage return (* C/R).

The Data Logger then waits 0.5 second for a request from the host computer. If no request is received by the logger, then the logger powers down (switches off) until the next scan (5 seconds usually).

Whilst the logger is communicating with the computer, it will remain active (in high power mode) however any logger Scans that are due will be processed "simultaneously" with ongoing communications.

7.3.2 Non-Synchronised RS-232 Communication

If the Starlogger is set to operate in non-synchronised mode the RS-232 communication protocol timing is slightly different.

The logger will immediately enter communications state (and send a prompt) whenever the Request To Send (RTS) line becomes true (ON/HIGH), it does not wait until the end of the next Logger Scan.

If a logger Scan occurs during RS-232 communications then the scan will be processed.

7.3.3 Data Logger Requests

The following are valid Data Logger requests (or Commands). If the logger receives an invalid command it will be ignored. Other commands are used to maintain and initialise the Configuration Table (see Chapter 8.0).

A Starlogger has three basic commands - GET, PUT & KILL. The (G)ET and (P)UT commands will access the first 64K of memory only. For memory sizes greater than 64K, a lowercase equivalent of the basic commands serves as an Extended Protocol Command (i.e., “g” command performs an extended “G” GET command). All Extended Protocol Commands require a checksum following the message.

See section 8.5 for a complete list of Starlog Protocol commands.

GET {and (g)et} Commands

GAAAASS where **G** is the GET command, **AAAA** is the 16 bit address (MSB/LSB) and **SS** is the number of bytes required.

Zero in the SS command corresponds to 256 bytes.

AAAA is the command for a 16 bit address in the first 64K memory storage of the Logger.

gaaaaaaaaasssscccc where **g** is the get command, **aaaaaaaa** is the 32 bit start memory address (MSB...LSB), **ssss** is the 16 bit number of bytes to transfer, and **cccc** is the 16 bit checksum.

To read 256 bytes from address 768 into the host computer the command is: **G030000**

PUT {and (p)ut} Commands

PAAAASS

paaaaaaaaassss...put data...cccc similar to the GET command except that data is sent to the logger immediately following the command string.

cccc the 16 bit checksum for the (p)ut command includes the address, size and data fields (i.e., everything except the "p" command and the checksum itself)and is sent MSB/LSB.

To reset the logger timer to zero, you will want to put zero into addresses 4,5,6 & 7. The command is:

P00040400000000

P is the put command
0004 is the offset address (in the registers)
04 is the put data count
00000000 is the data to put

The data format for the GET or PUT is a continuous string of hex characters. The first two characters correspond to the first byte requested or to be sent, the next two characters is the second byte, etc. The data string is terminated by a carriage return.

A command to retrieve 16 bytes may appear as - **G000010**

the returned data may appear as -

00112233445566778899AABBCCDDEEFFmmllc/r

Where **mmll** = Get Data checksum consisting of a 16 bit binary addition of all binary data (not HEX representation) within the retrieved information (excluding the checksum and c/r).

The checksum is sent as four HEX characters; mm = Most Significant Byte and ll = Least Significant Byte.

Note: Two hex characters are always received or transmitted (most significant digit then least significant digit) even though the number is smaller than 16. E.g., 10 decimal is sent or received as 0A.

Note: GET or PUT may address any continuous segment of the memory.

(K)ILL command

K is the KILL command which directs the Data Logger to switch OFF until the next scan cycle (usually 5 seconds). a command to load location 2 with 0 then exit, would be:

P00020100K

Note: After a GET command, the computer must wait until the Data Logger has sent the GET data before a KILL is issued.

7.4 Sample Program

The following program written in Microsoft QBASIC communicates between the Data Logger and an IBM PC or compatible computer.

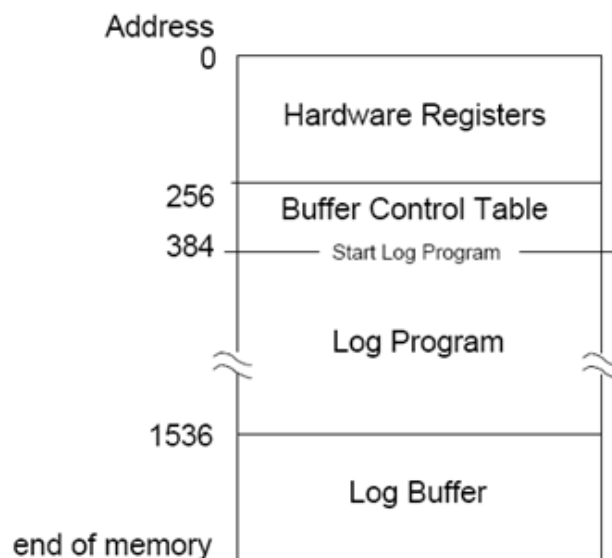


Figure 8.1 – Memory Map

7.4.1 Simple Interrogation Example

This sample program will issue a command to the Data Logger and display then response from the logger. The commands must be valid commands (see above).

The "ON ERROR GOTO 140" statement is needed to trap (and ignore via RESUME statement) any I/O errors that may occur as the Data Logger powers up and the RS-232 signals lines change states.

The statement 70, sends the command to the logger. Notice that a "K" command (kill) is appended to the operator request. This shuts the Data Logger down, immediately after the request has been completed (to save logger battery power).

Try entering these commands:

```
G000008          (get 8 bytes from location 0)
G000502          (get 2 bytes from location 5)
G010010          (get 16 bytes (10 hex) from location 256 (Block 1, Location 0))
P00020188G000201 (put 88 into location 2 and immediately gets the data)
```

Note: the maximum G (get) size is 127 (7F hex). This is limited by BASIC string length maximum of 255 characters.

```
10  REM Starlogger - data transfer example
20  INPUT "Enter data logger command-",A$ 'Get Command from
    operator
30  IF A$="" THEN END 'Finish on c/r
40  OPEN "COM1:9600,N,8,1,CS0,DS0,CD0" FOR RANDOM AS #1
    'Open RS-232 to logger
50  ON ERROR GOTO 140 'Trap I/O errors
60  INPUT #1,L$:IF INSTR(L$"*")=0 THEN 60 'Wait for logger
    prompt
70  PRINT #1,A$; 'Send command to logger
80  INPUT #1,L$ 'Get response from logger
90  PRINT #1,"K"; 'Send KILL to save battery
100 ON ERROR GOTO 0 'Reset error trapping
110 CLOSE #1 'Close RS-232 file (channel)
120 PRINT "Data Logger Response =";L$ 'Print result on
    terminal
130 GOTO 20 'Go back to beginning
140 RESUME 'Ignore I/O error
```

8.0 STARLOGGER PROGRAMMING

This chapter describes programming techniques for the Starlogger including memory layout. The information included here is especially useful to those who program and test the Logger with the **Test Mode** screens provided with a Starlog V4 Software Package. For those who use this Software Package, this chapter provides important details on Data Logger instructions used by the assembler. For complete programming information, a programmer should consult the Programmer's Supplement (Model 6201).

8.1 Memory Layout

The Starlogger uses its data CMOS memory for:

- Hardware Registers - Storage of housekeeping registers
- Logger Program - Storage of user scheme definition
- Buffer Control Table - Storage of pointers controlling Log Buffer
- Log Buffer - 1536 to end of memory for recording measured data

8.2 Hardware Register Information

The information contained in the header may be viewed in **Test Mode** or used by programmers wishing to write their own unload and analysis programs. The table below gives a description of each register numbered 0 to 255. For multiple byte registers the convention used is – least significant byte to most significant byte. A byte may contain a number from 0 to 255 (8 bits) and for calculating multiple byte numbers the first byte is added to the second byte times 256 plus the third byte times 256 times 256, etc.

eg. The four byte number 1,2,3 and 4 would give

$$1+(2*256)+(3*256*256)+(4*256*256*256) = 67305985$$

Arithmetic instructions using 32-bit unsigned integers can represent values from 0 to 4294967295.

8.2.1 Model 6004, V2.00 Memory Assignments

The Model 6004 Starlogger, operating the standard instruction set, has the following fixed memory assignments in the Hardware Register: (Pin xx) refers to a pin of the **INPUT SIGNALS** connector.

* Active in Standard (6004) Mode (See Chapter 9)

† Active in Compatibility (6003) Mode

Address	Size	Description
0	1	Software Revision Number (20 onwards)
1	2	Logger runtime in milliseconds (16 bit integer)
3	1	Error flags (see section 10.1.110.2)
4	4	Logger scan counter (32 bit integer)
8	1	Reserved
†9	1	HSIO MASK (128=Serial 0, 16=Serial 1)
10	1	Reserved
11	2	msb of address (bits 8-23) used in LDBLK and MVBLK instructions
13	2	Reserved
14	1	Binary states of analog channels
16	8	Eight analog channels (a0 to a7) unsigned low resolution representation (8 bit) of the 16 bit channel (h0 to h7) measurement
24	8	Counter channels (see section 8.2.2)
*32	1	Digital input values (normally high) Bit 0...2 Baud Rate: 000=9600; 101=300; 010=1200 011=2400; 110=4800; 001=19200; 100=38400; 111=76800 Bit 3=0 Log Start (SENSE 0) connected to GND Bit 4=0 Memory Card inserted Bit 5=0 SDI-12 (SENSE 1) not active Bit 6 High speed serial DATA 1 Bit 7 High speed serial DATA 0
†32	1	Digital input values (normally high) Bit 0 = 0 "Pin 7, C=GND" 9600 baud select Bit 1 = 0 "Pin 20, S=GND" SENSE 1 Bit 2 = 0 "Pin 20, C=GND" 300 baud select Bit 3 = 0 "Pin 19, S+GND" Log Start Detect Bits 4...7 Not available

Address	Size	Description
*33	1	User Power Supply status register Bit 0 = 1 UPS will be ON next scan Bit 1 = 1 UPS was ON this scan Bit 2 = 1 UPS is currently ON Bit 3 unused Bit 4 = 1 RTS is not active Bit 5 unused Bit 6 = 1 Memory Backup Battery OK Bit 7 = 1 unused
34	1	Arithmetic status register set by ADD, SUB, MUL, DIV instructions. Bit 2 = Arithmetic overflow Bit 7 = Arithmetic carry Logic status register set by CMP (compare) instruct. Bit 4 set Operand 1 = Operand 2 Bit 5 set Operand 1 < Operand 2 (unsigned) Bit 6 set Operand 1 < Operand 2 (signed)
35	1	Reserved
80	6	Software stores Scheme Name here.
*200	16	8 x analog channel h0 (Pin 1) signed 16 bit channel
*232	2	Starlogger internal temperature signal $\pm 500^{\circ}\text{C}$ range (0.1221 $^{\circ}\text{C}$ resolution/bit)
*236	2	Supply (Battery) voltage scaled 1.221 millivolt/bit
*238	7	Reserved

8.2.2 Counter Register Assignments

In Standard (6004) Mode the use of a prescale setting enables a 1 byte counter result to be recorded. The mnemonic in brackets indicates how this channel is referred to in Software.

Note: The Counter channels' mnemonic changes in Compatibility (6003) Mode to maintain compatibility with PDL documentation. Prescale is available for all four counters. (See section **Error! Reference source not found.**)

Address	Standard (6004) Mode		
	Prescale = 1...15	Prescale = 0	Pin Assignment
24	Counter 0 remainder	Counter 0 [C0] 16 bit difference LSB/MSB	Pin 11
25	8 bit difference [c0]		
26	Counter 1 remainder	Counter 1 [C1] 16 bit difference LSB/MSB	Pin 24
27	8 bit difference [c0u]		
28	Counter 2 remainder	Counter 2 [C2] 16 bit difference LSB/MSB	Pin 12
29	8 bit difference [c1]		
30	Counter 3 remainder	Counter 3 [C3] 16 bit difference LSB/MSB	Pin 25
31	8 bit difference [c1u]		

8.2.3 Logger Scan Counter

This is incremented every scan and when loaded with a scheme represents the number of scan intervals past 1/1/1980 at 00:00:00.

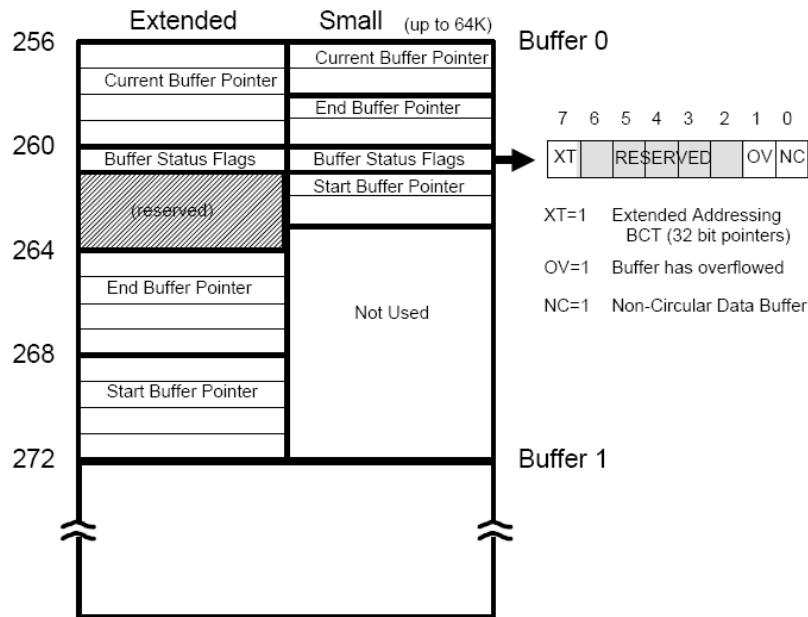


Figure 8.2 – Buffer Control Table

8.3 Starlogger - Program

The Starlogger is a programmable data recording unit programmed using a computer. Its program resides in the first part of the logger's main memory (after the Hardware Registers and Buffer Control Table). It is defined by a user and loaded into logger memory from the host computer.

The logger program is executed every logger scan (from 0.125 of a second to 5 minutes). The first instruction in the logger program is at Address 384. The Data Logger executes this program until an EXIT instruction is encountered (opcode = 0), then the Logger proceeds to service the Computer RS-232 port.

8.3.1 Data Logger - Operation Sequence

Every logger scan cycle, the logger hardware performs the following sequence:

1. Read all channels and store their values in the Hardware Register area (Address 0 to 255).
2. Execute the logger program (until EXIT detected).
3. If an RS-232 connection is sensed, send * c/r prompt to Computer Port and wait 0.5 second for a response.
4. Shut down Data Logger and await next scan time.

8.3.2 Data Logger - Program Instructions

A logger program starts at Address 384 and consists of one or more instructions. Each instruction is four bytes long (even though some instruction do not use all four bytes). An instruction takes about 0.5 millisecond to interpret and execute.

Typical instructions include:

TIMED GOTO	Timer controlled logging sequences
CONDITIONAL GOTO	Event controlled logging sequences
LOG DATA	Flexible data storage command
(BLOCK) MOVE	Block, Word and Byte move
ACCUMULATE	Block summation for averaging
OUTPUT	Control output sequences
BLOCK CLEAR	Storage initialization
ADDITION	2 & 4 byte operands, 4 byte result
SUBTRACTION	2 & 4 byte operands, 4 byte result
MULTIPLICATION	2 & 4 byte operands, 4 byte result
DIVISION	2 & 4 byte operands, 4 byte result or 2 byte result & remainder
SERIAL INPUT/OUTPUT	Bi-directional Data Bus read/write

8.4 Buffer Control Table

Information to be recorded by the Data Logger is stored in one of eight memory areas. Normally only one memory area is used and this occupies all free external memory, starting at Address 1536 and ending at the limit of the Data Logger’s CMOS memory.

Note: For some log programs requiring lookup tables the storage starting address may be different.

The storage of channel data in these memory areas (buffers) is controlled by pointer registers held in the Buffer Control Table. Both standard (16 bit pointers) and extended (32 bit pointers) are supported by Revision #32 firmware. There is one table entry for each buffer (memory area) used by the Data Logger program “LOG” instructions.

An extended (32 bit, 4 byte pointers) Buffer Control Table is indicated by setting bit 7 of the “flag” byte (BFLO) in the Buffer Control Table entry for the appropriate buffer(s). (See Figure 7.2) Standard and extended buffers can be intermixed, but only extended buffers can log data past the 64K memory limit.

Address	Size	Label	Description
256	1	BCL0	Buffer 0 LSB of current log pointer
257	1	BCH0	Buffer 0 MSB of current log pointer
258	1	BEL0	Buffer 0 LSB of buffer end (last used +1)
259	1	BEH0	Buffer 0 MSB of buffer end

The small Buffer Control Table entry format is:

Address	Size	Label	Description
260	1	BFL0	Buffer 0 Status Flags Bit 0 = 1 non-circular, stop when full Bit 1 = 1 buffer has overflowed once Bit 5 = 1 MC first time through Bit 6 = 1 Log to memory card (6004-3 only) Bit 7 = 0 Extended Address (32 bit pointers)
261	1	BSL0	Buffer 0 LSB of buffer start address
262	1	BSH0	Buffer 0 MSB of buffer start address
263	1	BPL0	Buffer 0 LSB of current printer pointer

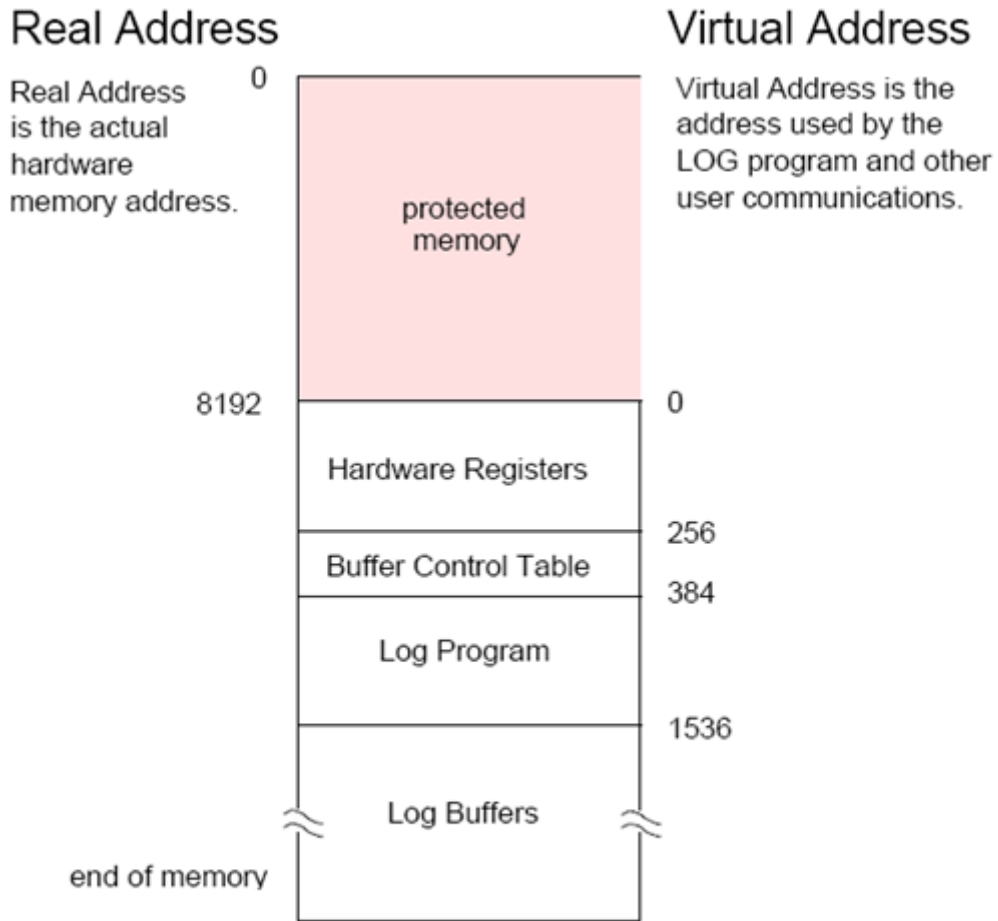


Figure 9.1 – Memory Map of Real and Virtual Addresses

Address	Size	Label	Description
264	1	BPH0	Buffer 0 MSB of current printer pointer
265	1	BTL0	Buffer 0 LSB of current telemetry pointer
266	1	BTH0	Buffer 0 MSB of current telemetry pointer
267	5		Reserved
272 383			Buffer 1 to Buffer 7 pointers (as above)

The extended Buffer Control Table entry format is:

Address	Size	Label	Description
256	4	EBC0	Current log pointer (LSB...MSB)
260	1	EBF0	Buffer 0 Status Flags Bit 0 = 1 non-circular, stop when full Bit 1 = 1 Buffer has overflowed once Bit 7 = 1 Extended Buffer pointers
261	3		Reserved
264	4	EBE0	Buffer End Pointer (LSB...MSB)
268	4	EBE0	Buffer Start Pointer (LSB...MSB)
272			Buffer #1 Definition, etc...

8.4.1 Buffer Format Convention

Information is stored in the data buffers as a sequence of one or more data bytes. Each sequence is called a 'log entry'. There may be many log entries in each buffer.

There are two log entry types:

Fixed TIME & SIZE

This is the most common form of log entry. Each entry is a fixed number of bytes long and is stored at a fixed interval. For example, recording the wind speed and ambient temperature every hour would produce fixed TIME & SIZE log entries.

Variable TIME & Fixed SIZE

This form is used with event-initiated log entries. The first 4 bytes of the entry is the time that the event occurred {the time bytes come from Register Address 4 to 7 followed by the log entry (if any)}. For example, if an event initiated log entry stored the instantaneous value channel 1, the entry would be: time (4 bytes), channel 1 (1 byte).

8.5 Starlog Protocol – Command List

There is no response if a GET or READ request has a bad checksum.

	Command	Format	Response
G	G/get data block from PDL	GAAAASS	dd--ddcccc(c/r)
g		gaaaaaaaaasssscccc	
P	P/put data block to PDL	PAAAASSdd--dd	eecccc(c/r)
p		paaaaaaaaassssdd--ddcccc	
W	W/write protected mode	WnnnnAAAASSdd--dd	eecccc(c/r)
w		wnnnnaaaaaaaaassssdd--d dcccc	
R	R/read protected mode	RnnnnAAAASS/r	dd--ddcccc(c/r)
r		rnnnnaaaaaaaaasssscccc	
T	T/test mode (Diagnostics)	Tnnnnzz	
t		tnnnnzz	
I	Initialise CDT/Firmware	Innnnzz	ee(c/r)
S	Unload CDT from PROM	S	dd--ddcccc(c/r)
s	Partial Unload of CDT from PROM*	sss	dd--ddcccc(c/r)
N	N/number (serial#) of Logger	N	nnnncccc(c/r)
n		n	
K	K/kill (power down logger)	K	
k		k	

* where the last ss is the size of unload.

8.5.1 Standard/Extended Command Differences

Standard (UPPER CASE) supports 64K (16 bit) address and 256 byte (8 bit) data transfers.

Extended (lower case) supports 4G (32 bit) address and 16K (16 bit) data transfers except the (p)ut/(w)rite commands which are limited to 1024 byte (10 bit) data transfers.

8.5.2 Definitions

AAAA	=	4 Hex memory address (16 bit) MSB/LSB
aaaaaaaa	=	8 Hex memory address (32 bit) MSB...LSB
SS	=	2 Hex size in bytes of transfer (8 bit 00=256)
ssss	=	4 Hex size in bytes of transfer (16 bit 0000=65536) MSB/LSB
zz	=	2 Hex parameter (8 bit)
dd	=	2 Hex data per byte transferred (if applicable)
cccc	=	4 Hex data binary addition checksum (16 bit) MSB/LSB excluding the C/c and the cccc fields.
nnnn	=	4 Hex Logger serial # (16 bit) password LSB/MSB
ee	=	2 Hex error code (00=OK)

8.5.3 (i)nit Parameters

0	=	Init USER CDT
1	=	Load Firmware from RAM
2	=	Load USER CDT from RAM (then init00)
3	=	Load FACTORY CDT from RAM (then init02)
4	=	Copy FACTORY CDT to USER CDT (then init02)

Error Code

00 = OK, 01 = Bad checksum in ROM, 02 = PROM/Verify Fail,
03 = Mirror Fail, 04 = Bad checksum in RAM firmware.

9.0 STARLOGGER CONFIGURATION TABLE

The Starlogger has a number of operating modes for its analog inputs. During factory calibration and testing a standard setup and some calibration factors are permanently written into the Logger's firmware (in ROM). This part of the firmware is referred to as the Configuration Table and a copy of it is also located in protected memory. If a different configuration is required, you may alter parts of the table.

This chapter describes the Configuration Table and its operation.

9.1 Default Configuration Table

The Starlogger has a permanent (default) copy of the Configuration Table in a ROM (Read Only Memory) chip. This default version instructs the logger to operate with commonly used settings. A user may alter some (or all) of these default settings to instruct the logger in another manner.

9.2 Memory Layout and Protected Memory

A small portion of the Starlogger memory is set aside for housekeeping functions such as I/O buffers and the LCD Scheme Display List. This portion of memory is protected (hidden) from normal logger operations and cannot be read or written by the Log Program or normal GET/PUT commands.

9.3 Configuration Table Layout

The Configuration Table is stored in ROM and may be read by the computer using the "S/s" commands. The CDT contains an array of 16 bit (LSB/MSB) variables which control many aspects of the Starlogger's operation (such as Scan Rate). The (i)nt command is used to permanently alter settings in the CDT. Some settings may be viewed and adjusted from the Display/Keyboard (Model 6004–2/3).

A copy of the Configuration Table is also stored at Real Address 0 and may be read using the protected (R)ead command (see section **Error! Reference source not found.**). This copy is not used for Starlogger control, it is available for reference only (see 12.0 Appendix B - Starlogger Configuration Table).

9.4 Starlogger Linear Calibration Correction

The Starlogger uses the following linear correction formula:-

$$y = gx + o, \text{ where}$$

y = corrected value

x = raw value (from A/D converter)

g = gain coefficient

o = offset coefficient

The gain coefficient (g) is made up of the gain coefficients from the appropriate Gain Drive Table gain stage entry.

The same applies to the offset coefficient (o).

These coefficients represent decimal numbers (e.g. 0.15) which are stored in the Starlogger in a normalised 16 bit form as follows:

GAIN the decimal gain coefficient is multiplied by 8192 to form the Starlogger gain coefficient entry.

That is, each bit is $1/8192$ or $1.2207E-4$.

For example, $g = 0.00610 = 0.00610 * 8192 = 50$ (or 32 HEX)

Note: Gain coefficients must be POSITIVE.

OFFSET Decimal offset coefficient is multiplied by 8 to form the Starlogger offset coefficient entry IN BITS. This offset must take into account the 10 bit A/D conversion as each offset bit has a magnitude of $1/4096$ of the input signal range.

For example:

Gain stage = 1, input range 0 – 2550 mV (2.55V)

each bit = $5000/4096 = 1.221\text{mV}$

Gain stage = 100, input range 0 – 255 mV

each bit = $50000/4096 = 122.1\mu\text{V}$

therefore, if $O = 12.21\text{mV}$ on a gain stage of 1

= $12.21/1.221 = 10$. (A HEX)

Note: Offset coefficients may be POSITIVE or NEGATIVE.

9.5 Initialising via the RS-232

Before the Starlogger can be used it must be initialised. In some cases, the Logger may have stopped scanning to conserve its battery. Normally this initialisation occurs automatically when the logger is loaded with a Scheme.

The command to initialise (or re-initialise) the logger is:

`I ssss` where ssss is a 4 HEX ASCII number equal to the logger serial number.

The response from the logger following the initialisation is:

`CC c/r` where CC is the checksum error in the Configuration Table.

if $CC = 00$, then the resident Configuration Table is valid and the logger has been initialised to use its configuration.

if $CC = 01$, then the resident Configuration Table is corrupted and the logger must be returned to Unidata for service.

9.6 Read/Write Protected Memory

There are five new RS-232 commands used with the Starlogger. They relate to the maintenance and initialization of the Configuration Table. For a complete list of Starlog Protocol commands see section 8.5.

Command	Description
S	Read the Default copy of the Configuration Table from ROM
N	Read the Logger's serial number.
Issss	Initialize the logger with the Configuration Table.
RssssBLLCC	Read from or write to real memory Wssss BLLCCddddcccc {same construct as GET/PUT but with checksum of configuration table (cccc = MSB/LSB)}
Tssss	Activate diagnostic firmware (see Chapter 9)

Note:

ssss in these instructions relates to the 16 bit serial number of the Starlogger and acts as a password for protected commands.

cccc checksum for the (W)rite command includes serial# (password), address, size and data fields (i.e., everything except the "W" command and the checksum itself).

S The 'S' command does not require the serial number password as it only reads the Configuration Table.

9.6.1 Computer Communication

RS-232 Communication with a computer only occurs at the end of the scan (if RTS is present). If RTS is presented between scans, the Starlogger switches ON but immediately switches OFF again until the next scan time.

9.6.2 Analog Channels

Register addresses 16 to 23 contain the 8 bit (low resolution) equivalent of the input signals present on Analog channels h0 to h7 scaled as a 0 to 2.55V value.

Note: If a gain of 10 is configured these 8 bit values represent 0 – 255 mV.

High resolution values h0 to h7 and internal channels are not stored.

9.6.3 Counter Channels

16 Bit counters are configured similar to the Model 6003 Portable Data Logger.

10.0 TEST DIAGNOSTICS

The Starlogger has inbuilt diagnostic firmware activated by the protected command:

```
Tssss ssss = serial number*
```

WARNING: Once the diagnostic mode has been selected, information stored in the logger may be lost. Always unload the logger before performing test diagnostic requests and also reload the logger after diagnostics.

10.1 Diagnostic

This diagnostic offers several tasks used to test and calibrate the Starlogger during manufacture. Each task corresponds to a single character sent to the logger via the RS-232 Computer Interface. After receiving the Protected Command... Tssss, the logger enters Diagnostic Mode and sends the message:

```
"Starlogger Diagnostics 6004B V22.1"
```

...followed by a menu of diagnostic commands

The diagnostic then awaits the entry of a Task Command from the host computer. When a Task Command is received, the logger executes the Task then awaits another Task Command (unless the previous task exited the logger from the Diagnostic Mode).

The serial number must be in hex format and entered Least Significant Byte to Most Significant Byte; i.e., the serial number 4001 is hex number 0FA7, or, (as it should be entered in the Tssss command), TA70F.

WARNING: Diagnostic Mode is intended for technical maintenance and certain protection features are disabled. TAKE CARE.

10.1.1 Task Command List

Analog

- E Continuously convert and display channels a0...a7
- H Select High level signals GAIN = 1 (0–2.55V)
- I Continuously convert and display temperature and battery readings
- L Select Low level signals GAIN = 10 (0–255mV)

Control

- K Kill (exit from) Diagnostic Mode. Resets logger
- S Sleep. Shut down logger to conserve batteries when the logger is left unused for long periods.

WARNING: The logger will be left in an uninitialized state and will not scan. The User must reset the logger using the lssss command (or reload the logger with a valid Scheme).

Counter

- Y Continuously read and display four Counter channels in hertz (frequency mode.)
- T Continuously read and display four Counter channels in binary. Type any character to stop continuous conversion mode.

Inputs/Outputs

- J Display Binary inputs UIN0/UIN1
- C Set Binary output UOT0/(CNTL)
- O Set Binary output UOT1/(LEDs)
- V Test HSIO Ports and UPS (User Power Source)

Keyboard/Display

- B Test beeper and Vlc
- D Test LCD display
- M Play tune on beeper
- P Test keyboard

Memory

- X Test memory circuit
- Z Write/Read cycle through 256 data values on RAM address 0
- R Test RAM/ROM shadow

Memory Card

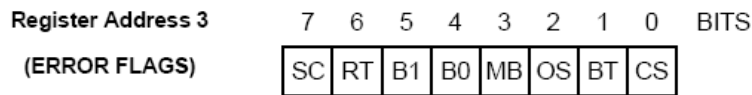
- A Read/Write memory card
- W Display Memory Card status and test Memory Card memory

Miscellaneous

- C/R Pressing the Enter key will end the current command (if any) and display the Command Menu.
- Esc End the current command

10.2 Error Conditions During Logger Operation

The Starlogger may detect certain error conditions and an indication of these errors is presented in Register Address 3.



Flag	Meaning	Result
CS	Checksum error or other inconsistency found in the STARLOGGER's Configuration Table or firmware	fatal
BT	Battery is too low for safe operation.	fatal
OS	Operator Stop. Logger entered "Sleep" mode by command (not due to detected error.)	fatal
MB	Lithium memory backup battery needs replacement or is not installed (default).	warning
B1 B0	00 – Battery OK, 01 – Battery Low, 10 – Battery Flat, 11 – Battery Dead	warning
RT	User Log Program exceeded maximum runtime and was prematurely terminated (no EXIT instruction or corrupted/incorrect Log Program.	warning
SC	Scan counter fault detected.	warning

Error flags are divided into WARNING and FATAL errors. FATAL errors cause the Starlogger to stop operation and become dormant ("sleep mode").

WARNING errors are informative only.

» NOTE 1: To "wake" a logger from "sleep mode" the logger must be connected to a computer and the RTS signal presented. This powers on the logger but does not allow signal scanning or Log programs to run, however normal RS-232 communications can occur after the prompt (* C/R).

» NOTE 2: A logger RESET will also set the logger from "sleep" to operating state.

The ERROR FLAGS are READ ONLY and cannot be reset by the Log Program or a (P)ut command. These flags are only cleared when the logger is RESET (using the I command or Keyboard RESET).

11.0 APPENDIX A - USING THE STARLOGGER SDI-12 INTERFACE

11.1 Introduction

SDI-12 is an industry-originated, serial digital interface bus designed to allow an operator to connect a wide variety of transducers (such as, meteorological, hydrological, water quality, etc.) to a single SDI-12 Data Recorder, such as a Starlogger, with a single cable bus. This means that you could, for instance, connect several SDI-12 sensors to a Starlogger and not have to worry about combinations of RS-232, parallel analog, BCD, serial analog, RS-422, etc., signal types.

A unique feature of the Starlogger is its ability to operate as an SDI-12 Data Recorder or an SDI-12 Sensor.

This appendix assumes that the reader is familiar with the operation of the SDI-12 Sensor (the Sensor) and the Starlogger (the Recorder). For more information see the Starlogger Programmer's Manual, #6201.

11.2 Theory Of Operation

When the Starlogger sends a "break signal", the Sensor awakens and captures the SDI-12 command following the break signal. If the command is valid, the Sensor reads its address setting to see whether or not its address is in fact being called, or if the address of some other device (at another location) is being sought. If the Starlogger is looking for a different address, the Sensor will go back to sleep until another break signal is received.

If the address being sent belongs to the Sensor, it will scan the instructions coming from the Starlogger to see what action is required. The two most important commands at this time are:

Measure: If the Sensor receives the START MEASUREMENT command, it will report back to the Starlogger the number of parameters enabled for measurement, and that these parameters are available to be sent to the Starlogger immediately.

Data: If the Sensor receives the SEND DATA command, it will send the last parameter readings measured to the Starlogger for storage.

11.3 Master Mode (SDI-12 Data Recorder)

Using the Starlogger as an SDI-12 Data Recorder allows several Starloggers to be connected together.

11.3.1 SDI-12 Data Recorder Commands

Two Scheme Program instructions are used to control the SDI-12 Master operation:

SDIGET which collects measurements from the nominated SDI-12 sensor, and

SDICONV which converts the collected data for use by the Log Program.

Measurements may be converted into fixed point Short Integers (for manipulation by the Scheme), Floating Point Numbers (for logging by the Scheme) or an ASCII string.

- Integers are two bytes.
- Floating Point numbers are 4 bytes.
- An ASCII string is zero byte terminated.

11.3.2 Data Recorder Coordination

Once an SDI-12 communication has commenced (SDIGET instruction executed) the SDI-12 Bus is busy and will ignore any subsequent SDIGET commands until the active measurement transfer is complete. The measurements are stored in memory, to be converted by a SDICONV instruction. Converted measurements (stored on Starlogger channels) may be further processed by the Scheme program and Logged.

Because most SDI-12 sensors require considerable time to make their measurements (typically 60 seconds), the Starlogger remains powered up awaiting a response from the sensor. This mode of operation usually requires the Scheme Program to initiate SDI-12 Measurements (SDIGETs) prior to the desired Log Interval.

The sequencing of the SDI-12 measurements is under the control of the Scheme Program, which is defined during Scheme Editing

11.3.3 Measurement Errors

If during a data collection sequence (SDIGET) an error occurs, the sequence is retried a total of 10 times (configurable). A non-recoverable error causes the SDIGET instruction to report a "null" result and a subsequent SDICONV will not return any data (the channel readings remain unchanged from their last good reading).

11.3.4 Transparent Mode (Extended Commands)

Starlogger supports a transparent mode of operation that allows "ad-hoc" commands from an external computer (or modem) to be sent to SDI-12 Sensors connected to the SDI-12 bus.

This mode is entered using the Starlog protected command:

```
tssss01
```

Extended commands may be issued whilst the Scheme Program is operating, but remember that the extended commands may disrupt the Scheme Program data collection timing. Type Alt - T from within the **Communications** window to enter this mode.

11.3.5 SDI-12 Test

To check the operation of the SDI-12 system the following sequence can be tested:

1. Configure the Starlogger as SDI-12 Data Recorder to enable SDI-12 operation.
2. At address 384 (Log Program) insert these instructions:

```
128 0 255 4 SDIGET BUSY
129 1 100 0 SDICONV INTEGER,100
128 0 0 0 SDIGET ADDR0
0 BUSY: EXIT
```

This sequence will branch to "BUSY" whilst SDI-12 bus is busy – then convert the previous measurement to 16 bit integers stored into addr 100 – then issue an SDI-12 measurement sequence to the Sensor at SDI-12 address 0.

11.4 Interrogation Mode (SDI-12 Sensor)

Using the Starlogger as an SDI-12 Sensor enables it to be interrogated by another Starlogger or any SDI-12 Recorder. The SLAVE Starloggers do not record their measurements (although they could do so) but instead, send the computed results to the MASTER Starlogger for logging. The Starlogger will continue to operate at its pre-set scan rate and will perform all the normal logging functions.

Starlog measurements, RS-232 communications and data logging, co-exist with SDI-12 interrogation.

Whenever an SDI-12 Data Recorder issues a START MEASUREMENT/ SEND DATA sequence, the Starlogger immediately responds with the latest parameter readings.

Note: In this mode, the SDI-12 command START MEASUREMENT does not initiate a new measurement cycle and the data is always valid and available for immediate retrieval by the Data Recorder.

11.5 Changing the Starlog Address

Address 0 is the default address setting for SDI-12; each Starlog is shipped set to address 0. You can change the address in the Configuration Editor (see 11.0 Appendix A - Using The Starlogger SDI-12 Interface).

11.6 Starlog SDI-12 Implementation

Command	Description	Sensor	Data Recorder
a!	acknowledge	√	×
al!	send identification	√	ö
aV!	start verification	√	ö
aM!	start measurement	√	À
aD0!	send data	√	ö

Commands not used:

aM1...9!	start additional Measurement	×	À
aD1...9!	send additional Data	×	ö
	extended commands	×	À

11.6.1 Default Settings

address	=	0
retry	=	10
# of channels	=	2
SDI0 channel 1 address	=	200 A0
SDI1 channel 2 address	=	202 A1
SDI2 channel 3 address	=	204 A2
SDI3 channel 4 address	=	206 A3
SDI4 channel 5 address	=	208 A4
ID string	=	011Unidata 6004B 2200000<C/R><L/F>
VERIFY string	=	00000<C/R><L/F>
START string	=	00002<C/R><L/F>

11.6.2 Altering SDI-12 Settings

Change the Starlogger Configuration to adjust SDI-12 settings in the Starlogger's Configuration Table. Adjustments are:

address	=	0...9
retry count	=	1...25
# of channels	=	0...5
channel 0¼4addr	=	n (location of 16 bit channel in the Starlogger Register Block)

12.0 APPENDIX B - STARLOGGER CONFIGURATION TABLE

WARNING: This section is for the expert user only. The Starlogger may be configured into an inoperable state and then must be returned to the factory for service. PLEASE TAKE CARE.

WARNING: Once a Starlogger has been re-configured it remains set to that configuration until explicitly changed again. For example, once a Starlogger has been loaded with a scheme configured for a 1 minute scan rate, it will remain as such, until re-configured to another scan rate. In Scheme Test Mode, use the .FTU Test Screen to carefully examine settings that need altering.

Starlogger configuration is adjusted during Scheme loading to conform to Scheme requirements. There are three ways of altering the configuration during loading.

Globally – by editing the file "PDL6004.CDT" which effects all future schemes or schemes that are altered.

Locally – by editing the file "scheme.CDT" which only effects the scheme "schemename". (In this case, a future edit of this scheme will regenerate the file "scheme.CDT" and your special configuration requirements will be lost. Consider using the "ATTRIB +R scheme.CDT" DOS command to set this file as Read Only so it cannot be overwritten.

New Product Type – Define a new Starlogger product type that has its own "PDLxxxx.CDT" definition file. This will allow you to select the standard Model 6004 setting or your own modified Model xxxx settings whenever you create a new scheme.

12.1 Configuration File Format (.CDT)

These files are ASCII Text files with a single configuration entry per line. Each entry contains three fields separated by a space and may be specified as decimal or hexadecimal numbers:

Address	Mask	Value
---------	------	-------

- The "Address" field contains the address of the configuration parameter to be altered (headed ADDR in Table A).
- The "Mask" field indicates whether one or two bytes (or part of a byte) need to be altered [logical AND].
- The "Value" field contains the new configuration setting.

Example: To set the RS-232 communications timeout to 1.5 seconds, the .CDT entry would be:

164	0xFFFF	384
-----	--------	-----

Example: To set the Starlogger to Compatibility Mode, the .CDT entries would be:

10	255	0
11	255	61

Note: 0x prefixes a hexadecimal number.

Note: The Starlogger only changes those configuration settings that are different to its existing configuration. If no changes are required, the configuration is not performed (although the Starlogger is re-initialized).

12.2 Configuration Table

STARLOGGER DEFAULT ROM CONTROL & DEFINITION TABLE	
;	Firmware File Naming convention:-
;	pppMvR_V.opt (eg. stl2v2_9.red, mlg6v1_1.ata)
;	ppp=Product Prefix (stl/udi/mlg/fec/obs)
;	M=(M)odel #
;	R=Hardware (R)evision
;	V=Software (V)ersion
;	opt=Option/Variant (red/blu/yel/ata/sdi)
;	REV=2 PCB 6078DF Model B. Yellow, SDI & EEPROM Prot.
;	REV=3 PCB 6078G.. Model C. UPS Control, Sonalert, LM34
;	; STARLOGGER Type 1=RED, ATA
;	; STARLOGGER Type 2=BLUE, SDI+ATA
;	; STARLOGGER Type 3=YELLOW, SDI+ATA
;	Timebases = *7.8125ms (1/128th sec), **3.90625ms (1/256th sec)
;	***1.628us (614/ms), **** 0.125sec, ***** 1sec
0000	DCDT:
0000	DSIZ:WORDDEND-DSIZ; Size of CDT LDB/MSB
0002	DSEr:WORD1d; Data Logger Serial
0004	DVER:DBREV,VER; Data Logger Microcode Rev #.sub
0006	DTYP:DB2d,OPT; CDT Type 2=1/256th sec. Firmware Options
0008	DSCN:WORD128d; 128 * 1/128ths (1 sec) PDL Scan Rate
0010	DMCF:WORDH,0000H; STL Configuration FLAGS (32 bits)
;	0 = Sync RS-232 Comms to Scan 8 = No A/D Hi-Res stored
;	1 = Extned Protocl ONLY 9 = A6 LORES = Battery 0 to 14.14V
;	2 = NO HALT on FATAL errors10 = No Internal Channels stored

STARLOGGER CONFIGURATION TABLE (part 1 of 3)

```

; 3 = 1/UPS is Programmable11 = PDL status combatibility
; 4 = 1/Enable SDI-12 System12 = PDL Cntr C0..3 - C0..1 U/L 4/8 Bit
; 5 = 1/Enable SDI-12 as MASTER13 = No A/D Binary state
; 6 =14 =
; 7 =15 =
;COUNTER Channel Settings (Prescale 0..15)
0014DCTR:DB0; CTR0 = 16 Bit
0015DB0; CTR1 = 16 Bit
0016DB0; CTR2 = 16 Bit
0017DB0; CTR3 = 16 Bit
;ANALOG Channel Type Table
; 0 = ADHG 0=2.55V, 1=255mV range 8 =
; 1 = ADAU 1=AUTO-ranging ON 9 =
; 2 =10 =
0018DADT:WORD0000H; Chan 0 (Type)
WORD0000H; Chan 1 (Type)
WORD0000H; Chan 2 (Type)
WORD0000H; Chan 3 (Type)
WORD0000H; Chan 4 (Type)
WORD0000H; Chan 5 (Type)
WORD0000H; Chan 6 (Type)
WORD0000H; Chan 7 (Type)
;ANALOG GAIN Drive table. Offset Gain and Temp Coefficient for each
gain
0034DGNT:WORD,8581d,0; 2.55V ... O=0, G=2.0475, T=0
0040DB8d,3+6; Averaging & Divide (incl. 6 bit shift)
WORD,8581d,0; 255mV ... O=0, G=2.0475, T=0
0048DB32d,5+6; Averaging & Divide

```

STARLOGGER CONFIGURATION TABLE (part 2 of 3)

```

$if(rev=3)
0050DATM:WORD1164d,1530d      ; TEMP. ... O=-17.8, G=1.187 T=0
(##.# degC)
0054DB0,0;      ... TO=0, TG=0
0056DB32d,5+6
$else
0050DATM:WORD17897d,18441d,0  ; Temp (deg C) gain=10, O=-2733,
G=3.251, T=0
DB32d,5+6; Averaging & Divide
$endif
0058DABT:WORD,39657d,0; Batt (V) gain = 1 ... O=0, G=5.841, T=0
0064DB8d,1+6; Averaging & Divide (NOTE: Effective *4)
WORD,0,0,0; **RESERVED**
;A/D Settings
0074DACT:WORD0; AC volts max period
0077DMUX:WORD200d; 800usec (4us)
WORD,0,0,0; **RESERVED**
;VM register address assignments
0086DCAD:WORD24d; VM addr of Counter registers
0088DALR:WORD16d; VM addr Lo-res registers
0090DAST:WORD14d; VM addr for Binary status registers
0092DAHR:WORD200d; VM addr Hi-res registers
0094DAIN:WORD232d; VM addr Internal chans, Temp & Batt

```

STARLOGGER CONFIGURATION TABLE (part 3 of 3)