

ML32 32-CHANNEL MODBUS LOGGER

INSTALLATION & OPERATION INSTRUCTIONS

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1. INTRODUCTION

This document describes the installation, commissioning, operation and maintenance of the ML32 32-channel logger. All hardware aspects are covered in detail but the software aspects of commissioning and operation are only covered as an overview.

1.1 Overview

The ML32 logger provides secure reliable logging of digital and analog inputs. It has 8 Universal Channels and 24 Modbus channels.

The logger acts as a Modbus Master and polls Modbus RTU Slave devices and stores the readings at regular intervals in non-volatile memory. Each of the 24 Modbus channels can be programmed with a different combination of Modbus slave address, register address and data format. Channels can either be

The logger is specifically designed to log data from Northern Design or Carlo Gavazzi electricity meters, but should be able to log data from most Modbus slaves.

Each Universal Input can be configured using a jumper link to suit the type of input to be measured (contact closure, voltage, current or thermistor). The logger channels can be programmed to interpret these inputs as analog or digital quantities. Alternatively the logger can monitor the state of a digital input and store the time and date of any changes of state (on-to-off or off-to-on).

Digital channels normally count pulses generated by volt-free contact closures and store the number of pulses recorded over a configurable time interval (typically every 30 minutes).

Analog channels measure the analog value of a current or voltage input by sampling it once per second and averaging it over 1 minute.

Temperature channels are a special type of analog channel that measure the resistance of a thermistor and convert it to an equivalent temperature using a linearization algorithm. Contact SHM for compatible thermistor sensor units.

The logger is mains powered but the logged data is kept in non-volatile (battery supported) storage so that logged readings are maintained while the mains power is off. The logger can be supplied with a UPS (Un-interruptible Power Supply) that allows data to be logged for several hours without mains power.

The logger can provide security of data with 4 levels of passwords, but for applications that do not require this, the logger can be programmed to operate without passwords.

The logger is fully configurable in terms of channel type, logging interval, channel size and security, and can also be configured to generate channel alarms.

The Universal Channels can be configured independently, but certain configuration parameters of the Modbus channels are common to all 24 of these channels (see section [3.2.1]).

The logger has a number of communications options, including an integral telephone modem and an RS485 network. The RS485 network allows a number of inter-linked loggers to be interrogated from a central point or via a single modem connection. The ML32 logger is fully compatible with other SHM loggers (eg. the UL8 Universal 8-channel logger and the DL4 Digital 4-channel logger) and these loggers can be networked in any combination.

All SHM loggers communicate using the same efficient reliable real-time protocol.

There are a number of software applications that can communicate with SHM loggers :-

- Stark RT. This is a full-function real time energy monitoring and reporting suite that will collect data automatically from SHM loggers and provide comprehensive analysis of the data.
- UREAD. This is a utility that can collect data locally from an SHM logger and store the data in a file for subsequent import into Stark RT. It is designed for use if the communications link to a logger is temporarily unavailable.
- UCSV. This utility collects data from an SHM logger and stores it as a Comma-Separated-Value (CSV) file that can be imported into database and spreadsheet programs (eg. Microsoft Excel).
- UCOMM. This utility is required to commission and configure an SHM logger. If SHM carry out the commissioning of the logger on site, the user may not need this utility, unless there is a requirement to alter the configuration subsequently.
- MLConfig. This utility is required to commission details of the Modbus slave devices that are to be logged. It requires a special programming adapter to connect the PC to the special Modbus programming connector on the logger.

1.2 Safety Warning

The installation of the Logger requires connection to hazardous voltages, and should only be undertaken by suitably qualified personnel. The main circuit board has exposed voltages at mains live potential.

An earth strap is supplied with every unit, connecting the three metal parts of the enclosure (base plate, lid and sub-chassis). A separate lead must be used to connect the enclosure to the supply earth. Spare M4 studs are provided on the base plate for this purpose.

The equipment should be connected to the supply earth at terminal E of terminal block TB1.

Always ensure that the equipment is installed with the above earthing arrangements in place.

1.3 Electromagnetic Compatibility (EMC)

To comply with EMC regulations, the ML32 should be installed with regard to minimizing interference to any sensitive equipment nearby.

The use of screened cables ensures minimal RF interference and also reduces the susceptibility of the system to external interference.

When using screened cable, the screen should be earthed at the logger end on one of the earthing studs provided, and with as short a tail as possible. The length of the un-screened conductors as they emerge from the screen to the terminal block should also be kept as short as possible.

In certain circumstances, un-screened cables (eg. multi-pair 'telephone' type cable) may work satisfactorily. In these cases the cable runs should be short, and should not run alongside high-current power supply cabling. However, if in doubt, screened cabling should be used.

1.4 Disposal (WEEE)



In the European Union, this symbol indicates that this product is not to be disposed of with household waste, according to the WEEE Directive (2002/96/EC). This product should be deposited at an appropriate facility to enable recovery and recycling. For more information about disposal of waste electronic equipment, contact your local waste authority, approved WEEE scheme or household waste disposal service.

1.4.1 Battery Disposal



Caution. Do not dispose of the batteries in a fire or with household waste. Contact your local waste disposal agency for the address of the nearest battery disposal site.

2. INSTALLATION

Because the electronics assembly is on a separate sub-chassis, and because all connections to it are pluggable, it is possible to install the enclosure and all the wiring first (without the electronics), and then fit the sub-chassis afterwards. This prevents damage to the electronics from dust, debris etc. A dummy sub-chassis, fitted only with the headers for the plug-in connectors, is available to facilitate this approach.

2.1 Siting

2.1.1 Logger

The logger should be sited with regard to the length of cabling required, the proximity to a telephone socket (if required) and the availability of a mains supply.

If the logger is monitoring pulse outputs from meters, quite long cable runs from logger to meter are permissible. Hence proximity to the meters need not be an issue, particularly if a site is already wired with a multi-pair cable network.

If the logger is monitoring analog or temperature inputs, it should ideally be mounted close to the sensors. However, if screened cables are used, runs of several hundred metres should be possible.

The optional integral modem is supplied with a 3 metre cable. If possible the logger should be sited within 2m of a BT telephone socket.

If the logger is to communicate directly with a PC (rather than via a modem) then the logger should ideally be sited less than 15m from the PC. In situations where this is not possible, an RS485 link (this is an option that must be ordered) can be used, allowing PC to logger distances of up to 1500m.

The logger should also be reasonably close to a mains supply, either a switched fused spur (preferable) or a 13A socket.

In addition, the minimum clearances specified in Figure [1] should be observed, otherwise access to the cable-entry glands and local interrogation socket will be difficult.

2.1.2 Modbus

A single Modbus communication cable runs from the logger to all the Modbus slave devices to be logged. Provided suitable good quality cable is used, and the cable is terminated with a 120 Ω resistor, a cable run of up to 1200 metres should be possible.

2.2 Fixing

The logger lid must first be removed before fixing the logger to the wall as follows :-

The first step is to release the knurled knob on the bottom face of the logger (NB. This is a captive fixing), as shown in Step 1 of Figure [2].

Next lift the lower edge of the lid until the flange **A** is clear of the bottom face of logger (about 20 mm), as shown in Step 2 of Figure [2].

Then pull the lid down until its upper edge is free of the top flange **C**, as shown in Step 3 of Figure [2]. It may be necessary to lift the lid further to allow it to disengage from the LED indicators.

NB. Keep hold of the lid, as it will still be connected to the rest of the logger by the earthing strap. Pull off the spade connector to disconnect the earth strap and finally free the lid.

Replacement is the reverse of the removal procedure. Ensure that the sides of the lid engage *inside* the flanges (marked **B** in Figure [2]) at each side of the base plate. The lid should be slid upwards until the LED indicators engage in their holes in the lid. Also ensure that the top flange **C** engages correctly with the metal strip on the underside of the lid. Remember to re-connect the earthing strap.

The logger base plate is fixed to the wall by three screws. The upper fixing hole is keyhole-shaped, so it is not necessary to remove the logger sub-chassis to fix the unit. The base plate can be hooked over this screw first, and then secured through the remaining two fixing holes.

The fixing holes can either be pre-drilled using the dimensions given in Figure [1], or the upper screw can be put in and the other two positions marked using the base plate as a template.

Fixing screws may be up to 5 mm diameter.

NB. Ensure sufficient clearance below the logger for cable entry via the conduit connectors, and for the RS232 connection.

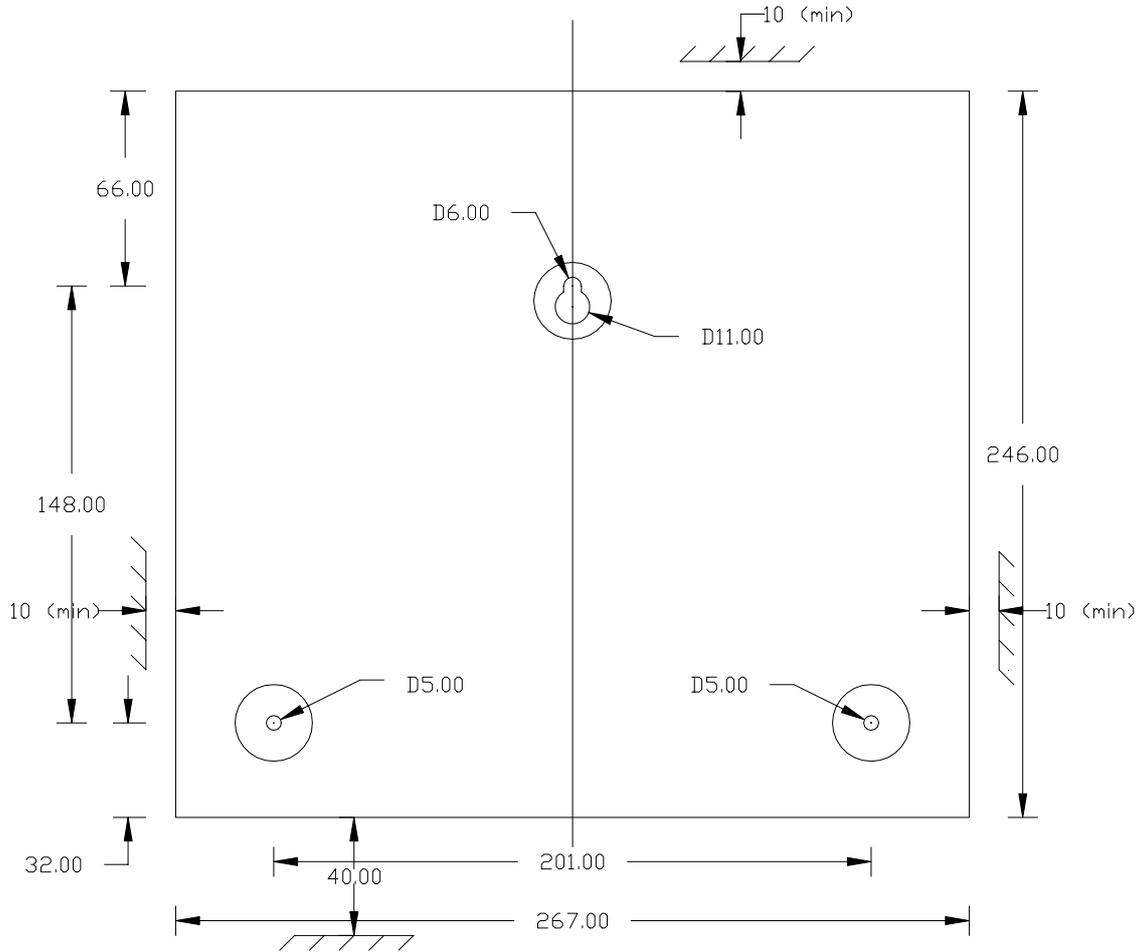


Figure 1 - Fixing Hole Dimensions

All dimensions in millimetres.

Ensure minimum clearances around enclosure are observed.

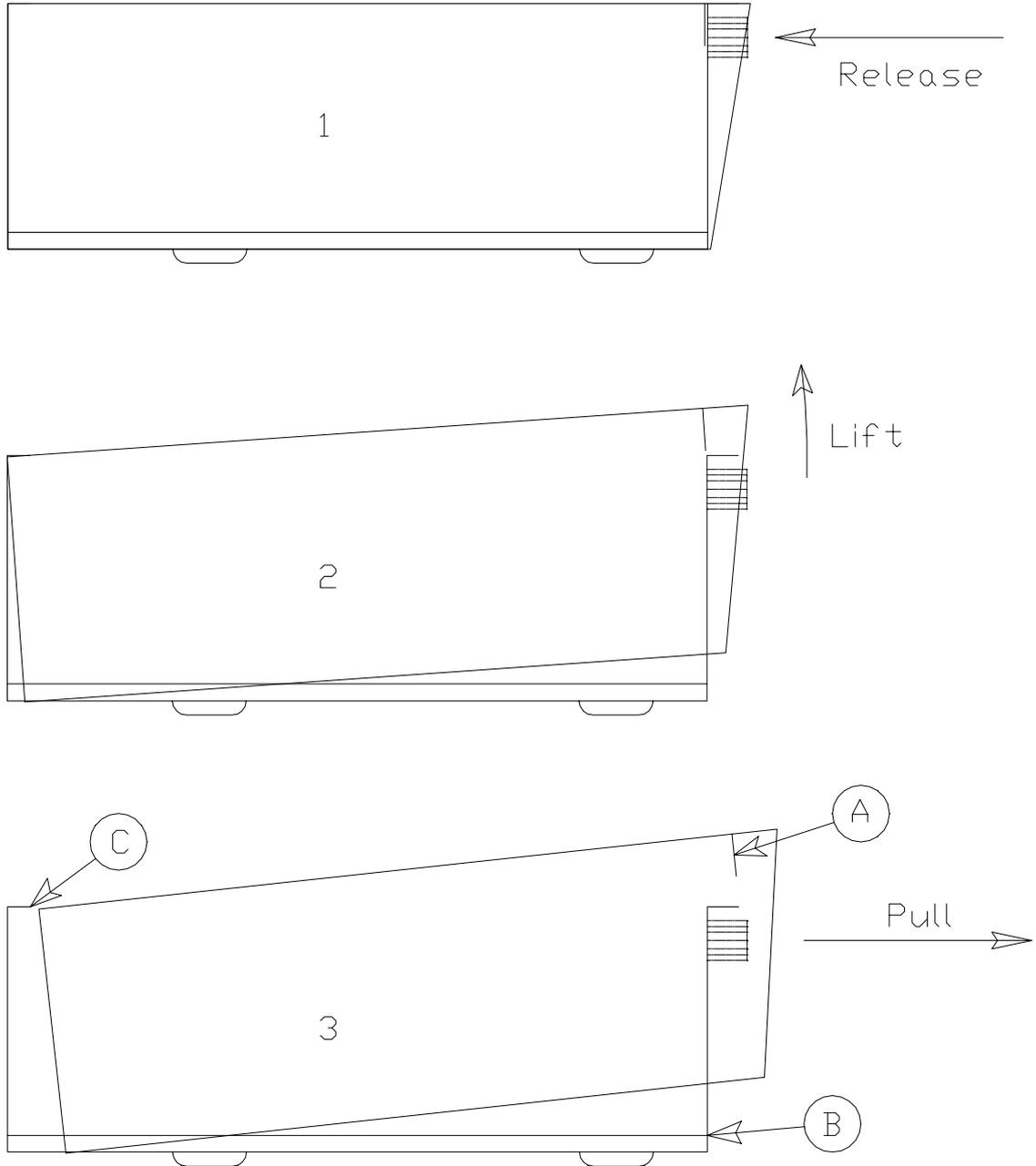


Figure 2 - Removing the Lid

2.3 Wiring

All cabling must enter the logger through the enclosure base via the bottom flange or the rear of the base-plate. Eight 20 mm diameter knock-outs are provided on the bottom flange and four on the rear. These are easily removed by using a screwdriver to lever them out. These holes are designed to take conduit fittings if required.

All connections to the logger circuitry are plug-in. The mains power and input connections use plug-in terminal blocks. These terminal blocks are normally of the screw-fixing type, but 'cage clamp' terminal blocks can be supplied as an option.

If the logger is to be commissioned at a later date, the mains and input connections can be left unplugged if desired.

NB. Refer to the safety warning in section [1.2]. It is important that the 'E' terminal of TB1 is earthed to both the supply earth and the enclosure.

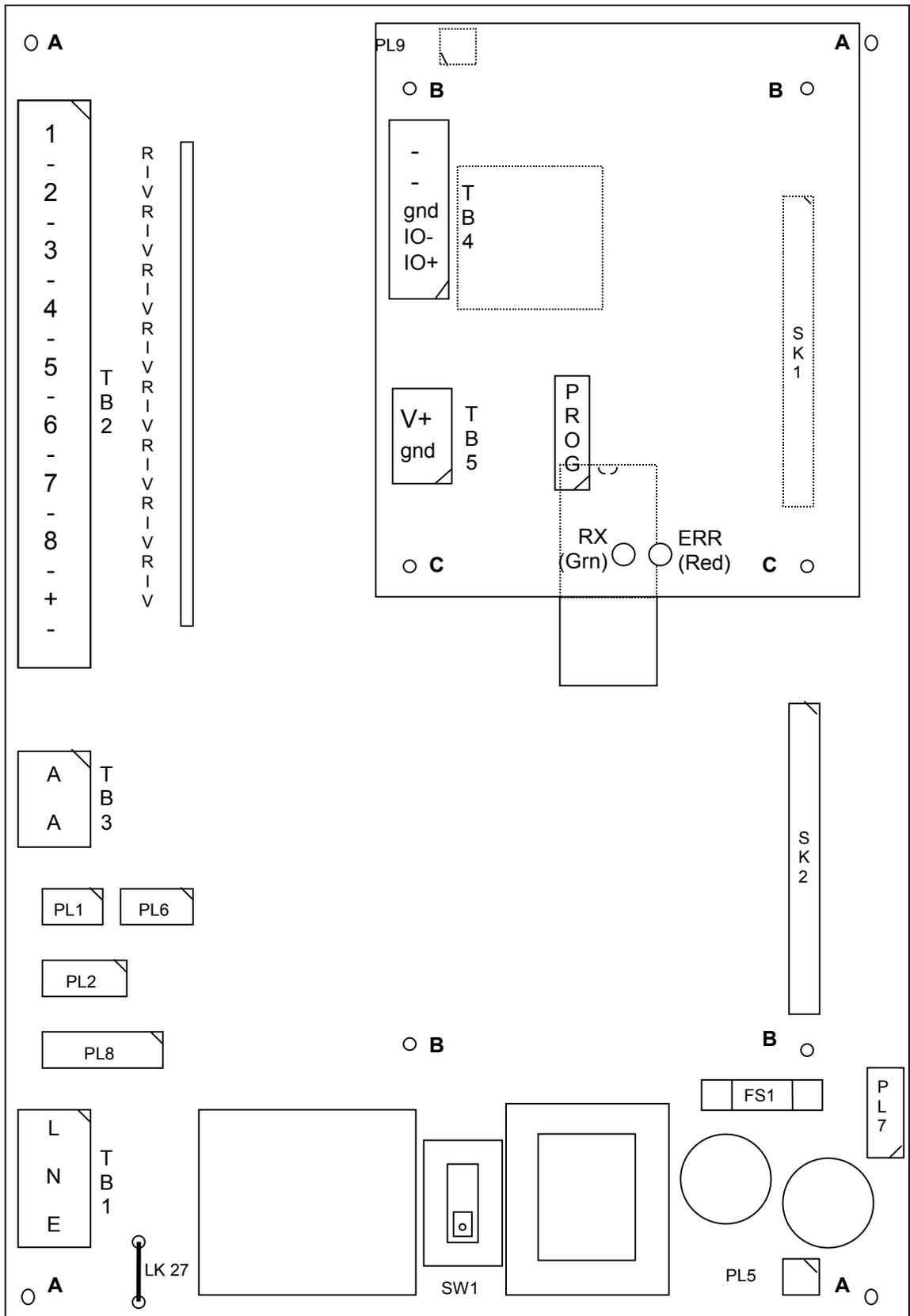


Figure 3 - PCB and Connector Layout

NB. In the above figure, holes marked 'A' are for the screws that fix the PCB to the sub-chassis. Holes marked 'B' are for the pillars that are used to mount the Modbus Interface Module. Holes marked 'C' are used for both purposes.

2.3.1 Mains

This connects via the 3-way terminal block TB1. The mains Live, Neutral and Earth connections are labelled **L**, **N** and **E** respectively. TB1 is a 2-part plug-in terminal block.

Typical power taken will not exceed 3 Watts and a supply spur fused at 3A is recommended.

SW1 is the Mains Voltage Selector. This is marked 240 and 120. Ensure that its setting matches the nominal mains input voltage at TB1.

Screened mains cable is recommended. Both the screen and the earth wire should be wired to the **E** terminal of the terminal block.

The screened mains cable should be passed through the ferrite ring supplied with each logger to provide additional RF filtering.

2.3.2 Inputs

The 8 Universal Inputs connect via the 18-way terminal block TB2. The inputs are marked **1** to **8**, and the common earth terminals are marked '-'. The right-hand 2 terminals (marked **+** and **-**) provide an unregulated DC voltage supply. TB2 is a 2-part plug-in terminal block.

The Modbus Interface Module interfaces with the Modbus slaves via TB4 (RS485 2-wire). This module provides data for up to 24 additional logger channels.

Screened "Twisted Pair" cables are preferred for wiring up the inputs. A screened multi-core cable is a suitable alternative. Unscreened cable may be suitable for some installations.

It is not necessary to use large-diameter cables, as the current taken by the inputs is very small.

The screen or screens of the input cables should be wired to one of the earth posts on the baseplate. The length of the tail from the screen to the earth tag should be kept as short as possible (less than 5 cm).

Cable runs of up to 1000m should be possible. With long runs, thicker cable may be needed to minimize the cable resistance.

The following diagram shows how to connect various devices to the logger. Note that for the volt-free contact and thermistor, the polarity of the connection does not matter. However, for all other input sources, the correct polarity must be observed.

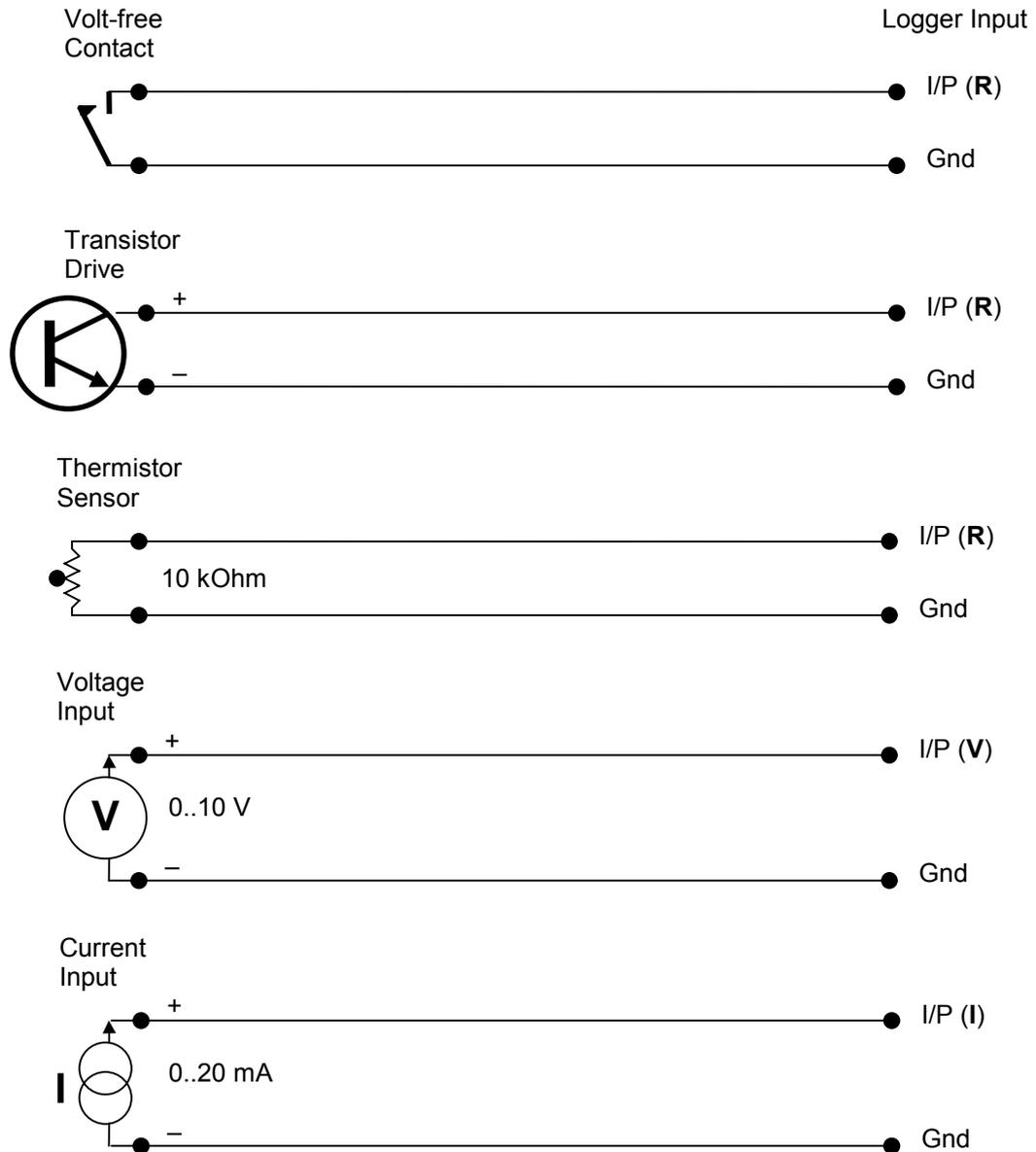


Figure 4 - Input Connection Circuit

2.3.3 Telephone

If the optional integral modem is fitted, it will be located on the underside of the sub-chassis. The modem has an RJ12 socket on the front for connection to the telephone line. A 3m lead with an RJ12 plug on one end and a standard BT 431A plug on the other is provided with the modem. If a longer lead is required, the one provided can be extended with a normal telephone extension lead.

2.3.4 Network (RS485 Option)

This is a card that plugs into one of the option positions (left or right - usually right). It allows a number of loggers to be connected up in a chain, using a 2-wire plus earth cable between each logger.

The Network connects via the 6-way 2-part plug-in terminal block on the card. The inputs are marked **RX +** and **-**, the outputs are marked **TX +** and **-** and the common earth terminals are marked **TX 0** and **RX 0**.

The network uses RS485 signalling, which is a physical link standard for communicating serial data over long distances ('long range RS232').

Screened "Twisted Pair" cables are strongly recommended for wiring up the RS485 network. The RS485 network is actually a chain, with the **TX+** and **TX-** of one logger connected to the **RX+** and **RX-** inputs respectively of the next logger in the chain.

The screen of the network cables should be wired to the common earth terminals on the connector. The length of the tail from the screen should be kept as short as possible (less than 5 cm). Cable runs of up to 1500m should be possible.

The following diagrams show the different ways of connecting up loggers using the RS485 interface. Note that in all cases, the correct polarity of the Receive and Transmit signals **must** be observed.

NB If connecting to the logger network at RS232 levels (eg. PC or external modem), then connection should be via the 6-way plug on the RS485 network card (see section [4.5.2]). The set-up is then similar to Figure [5].

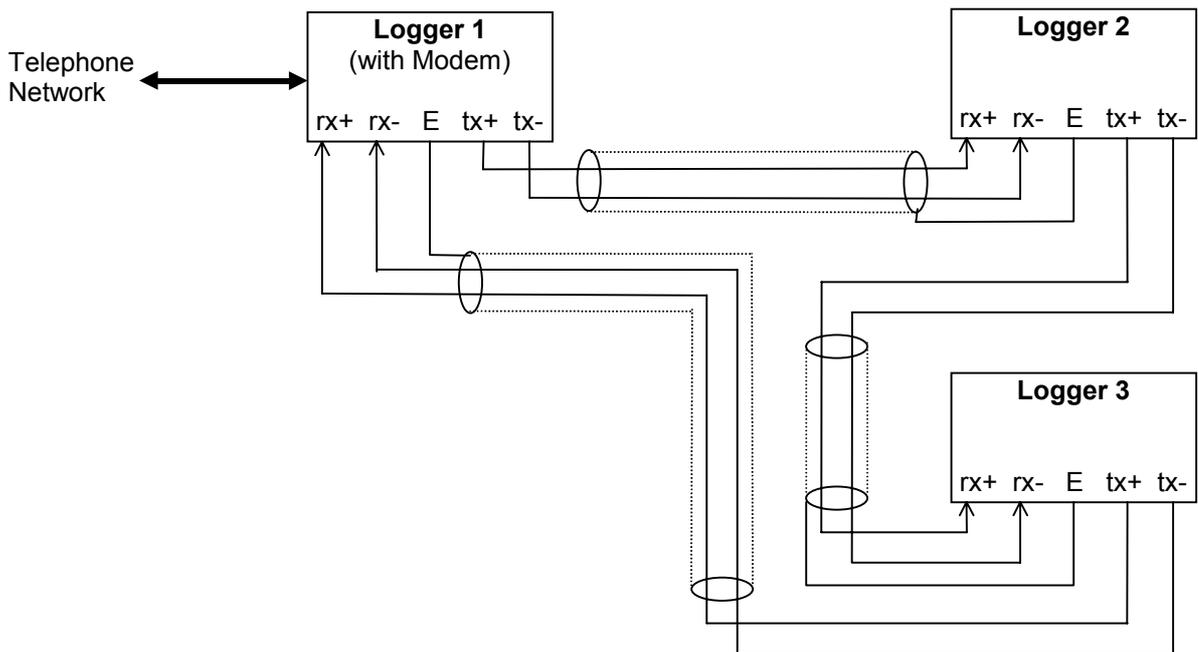


Figure 5 - RS485 Network interrogated via a modem

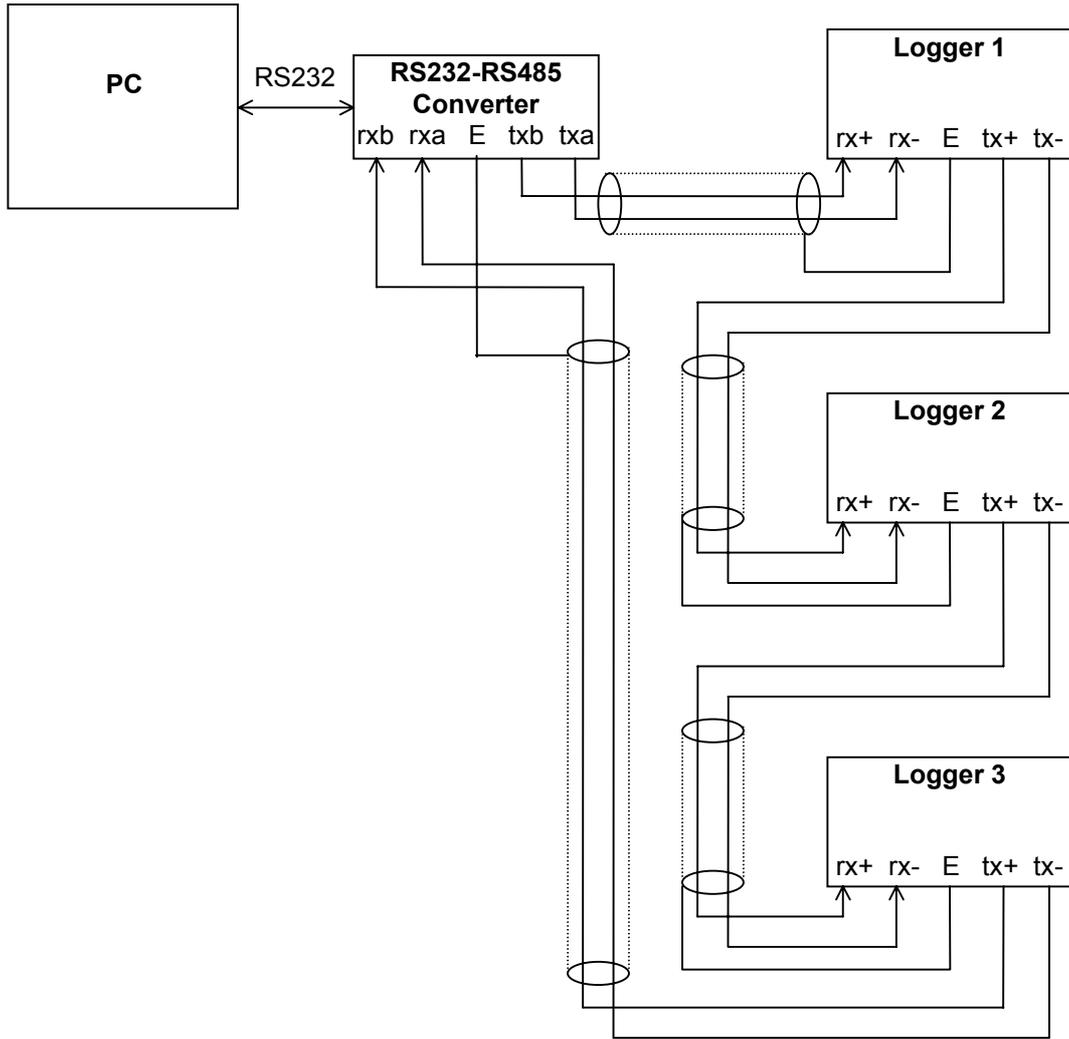


Figure 6 - RS485 Network directly connected to PC

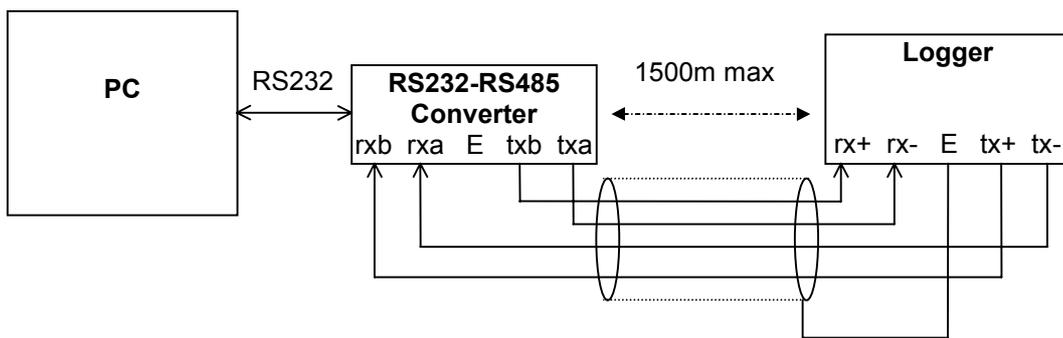


Figure 7 - Single Logger - Direct (long distance) connection to PC

2.3.5 Cable Types

Screened cables are recommended for all external connections for the logger. Apart from that, the type of cable used is not critical for the logger inputs and the terminal blocks will accept a wide range of types and sizes.

Cables for RS485 and Modbus must be of an approved type if communication errors are to be avoided.

Users requiring examples of suitable cables should refer to the SHM website for the latest list of recommended cables. Application Note AN011 can be found at :-

http://www.shmcomms.co.uk/tech_support/application_notes.htm

3. COMMISSIONING

The commissioning process consists of :-

- Inspecting the installation
- Powering up the logger and checking basic functionality
- Programming the logger configuration using **UCOMM**
- Programming the logger Modbus configuration using the special programming adapter and **MLConfig**.
- Verifying that all sensors / transducers are working, connected and being recorded
- Verifying satisfactory RF reception from all transmitters.
- Generating an electronic configuration certificate
- Completing a Logger Commissioning Record

Use of the UCOMM and MLConfig commissioning utilities requires specialist knowledge of the logger and its operation.

3.1 Initial Checks

Check that the links on the PCB are correctly installed for each universal input. If an RS485 option board is fitted, its links should also be checked. Refer to section [4.5] for details.

Ensure all connectors are properly plugged in.

If the logger is supplied with a UPS, plug in the main battery (connector PL5 - if it is not already connected). Switch on the mains supply and check that the upper two yellow indicators (Mains & Charge) are lit and that the yellow Heartbeat indicator is flashing. If the UPS option has not been ordered, there will be no main battery and the yellow "Charge" indicator should be off.

3.2 Configuring using UCOMM

UCOMM is a special configuration software utility available separately from SHM. The logger can be pre-configured prior to installation, or it can be configured after installation.

The use of UCOMM is covered in a separate manual.

The logger has a software-programmable configuration that is stored in non-volatile EEPROM memory. This means that it is retained even when all mains and battery power is disconnected. UCOMM is used to read, display, edit and store this configuration information.

The following parameters should be set or checked using UCOMM :-

1. The Logical Logger Number. For a single-logger installation, the default of 1 can be used. However for an RS485 network of loggers, each must have a unique

Logical Logger Number. It is most convenient to program this to 11, 12, 13 etc. in order round the network.

2. The option codes "Option A" and "Option B". These ensure that the logger firmware recognises the options fitted. Refer to the UCOMM manual or the table in section 5.1.
3. If any special firmware features, such as "Dial In", "Modem Answer Window" or "Alarms" are required, these must be suitably configured.
4. Channel configuration for each channel. For Digital (Pulse) channels, this comprises :-
 - Logging Interval
 - Physical Input number
 - Channel Size (memory allocation)
 - Pulse pre-scaler value
 - Initial count

For Analog or Temperature channels, this comprises :-

- Logging Interval
- Physical Input number
- Channel Size (memory allocation)

For Modbus channels, this comprises :-

- Logging Interval

5. If alarms are required, they should be enabled for the alarm channels and the high and low thresholds set.
6. The logger time. NB. It is normal for the logger to use the same time reference all year (eg. Greenwich Mean Time) rather than re-program it for daylight saving times.

It is advisable to check the configuration data after installation, even if the logger has been pre-configured. In particular, if the Memory battery has been disconnected at any time or become discharged, then the logger's clock / calendar will not have a valid time, and the correct time will need to be commissioned before the logger begins logging.

3.2.1 Configuring Modbus Channels

3.2.1.1 Using UCOMM

Channels 1 to 8 are Universal, and can be configured independently of each other.

Channels 9 to 32 are Modbus channels, and have certain restrictions as to how they can be configured from UCOMM. In practice you the only parameter you might want to change is the logging interval. Modbus channels must additionally be configured using MLConfig, as explained in the next section.

The following parameters **cannot** be changed for Modbus channels :-

Channel Type	This will depend on how the channel is configured using MLConfig, and will either be Digital or Analog.
Input Line	Always the same as the channel number.
Alarm Settings	Alarms are not supported. NB. An alarm exception is logged alongside the data whenever an internal communications error occurs while reading the

channel counts (this implies a hardware problem). An alarm exception is also generated if the Modbus Slave device fails to respond when polled. However, this does not generate any external alarm notification.

The following parameters are common to all Modbus channels 9 to 32. These parameters can be set for any channel, but the value set will apply to all channels 9 to 32 :-

Log Interval	NB. The log interval can be based on time-of-day or triggered by a pulse on one of the 8 Universal Inputs.
Channel Size	Since there are 24 Modbus channels and 40 memory blocks, the channel size can only be set to 0 or 1 blocks.
Pre-scaler	This parameter is ignored for Modbus channels.
'Read Data' password	
'Configure' password	

The following parameter can be set uniquely for each Modbus channel 9 to 32 :-

Initial register count	NB. Although this value can be set, it is not relevant to Modbus channels.
------------------------	----------------------------------------------------------------------------

3.2.1.2 Using MLConfig

It is necessary to program in the Slave parameters for each Modbus channel (9 to 32). This is carried out using a special software utility **MLConfig**, available from SHM.

All Modbus slave devices connected to the logger must be configured with the following communication settings :-

9600 baud, 8 data bits, no parity.

Each slave must have a unique address in the range 1 to 239. Note that slave address 240 is reserved for the programmer.

The utility **MLConf** programs the logger via the programming connector on the upper PCB on the logger (marked **PROG** in Figure 3). A special programming adapter is required, available from SHM. It consists of a USB to RS485 serial interface with a special cable.

MLConfig is simple and self-explanatory to use. A single button click reads in the existing configuration, which can then be modified as required and written back to the logger. It is possible to load and save the configuration to a file.

Initially, MLConfig will show **Logger Not Detected** in red. It may take up to 30 seconds for the logger to detect the presence of the programmer, at which point MLConfig will show **Logger Present** in green.

For each channel, the following parameters need to be specified :-

- Modbus Slave Address (0..239)
- Register address (0..65535)

- Divisor (1, 10, 100, 1000, 10000, 16, 1024, 16384)
- Signed/unsigned data
- 16-bit or 32-bit data
- Scrambled (least significant word first)/normal for 32-bit data
- Analog/Digital. Analog channels may need to use the divisor to ensure the result is in the range -32767 to +32767.

Programming a Slave Address of zero means that the channel is not used.

To avoid having to look up the manufacturer's datasheet to find appropriate Modbus register addresses etc, MLConfig comes with predefined sets of parameters for common meters, eg. Multicube kWh, Multicube KVAh, EM24 kWh which specify everything but the Slave Address. These predefined sets are loaded from a configuration file, and SHM can provide customer-specific files if necessary.

Each Modbus channel is shown in MLConfig with a traffic light symbol next to it, indicating its status as follows :-

Purple	Unknown. The channel configuration has not been read yet.
Green	OK. The current logger channel configuration is being shown. Ie. it has been read, or written and read back.
Yellow	Modified. The channel configuration has been changed (or a configuration file has been loaded) and is different to the logger configuration. The new configuration needs to be written to the logger.
Red	Error. A communication error occurred while reading or writing the logger channel configuration.

The left-hand pane of the MLConfig window shows the transmission and reception of Modbus messages. This may be a useful diagnostic tool if you understand the Modbus protocol.

The ML32 polls all the configured Modbus slaves in turn. The diagnostic LEDs on the upper PCB (see section 4.1.1) can be used to diagnose Modbus communication problems.

Once all the Modbus channels have been configured using MLConfig, it is a good idea to run UCOMM again, read in the logger configuration and then write the channel configuration back again. This action clears all the logged data from the channels, and eliminates spurious data which will have been stored before the Modbus parameters were properly configured.

3.3 Verification

Connect a portable PC to the 9-way D connector on the bottom face of the logger and run the configuration utility UCOMM on the PC.

Check that the configuration can be read and is correct.

Check that the logger's time and date are correct.

Use the 'Monitor Channels' function to display all the channel inputs. Where possible, check that each input is operating correctly as follows :-

- For Pulse inputs, the advance in the count can be compared to the advance on the meter registers, or pulses can be artificially induced by shorting the cable at the far end.
- For Analog inputs, verify the readings using a DVM.
- For Temperature inputs, verify the readings using a thermometer.
- Status inputs can be tested by changing the state of the device being monitored.
- Modbus inputs can be cross-checked with the actual value on the meter.

For Modbus channels, use UCOMM to read in the entire logger personality and display it. On Page 4 of the display (Warnings), check that all Modbus channels in use are showing "OK". Other warning codes are as follows :-

80H	Internal communications error (resetting the logger may clear this).
44H	Modbus timeout. The last poll of the slave device failed.
42H	Slave Rejected. The slave device rejected the last poll command. This probably indicates that the Register Address configured for this channel is invalid.
41H	CRC Error. The last poll response from the slave device had an invalid CRC code.

If all Modbus channels are working correctly, the green LED on the upper PCB should flash regularly, and the red LED should remain off. If the red LED flashes occasionally, then there is a Modbus problem.

If the logger is fitted with a modem, check by dialling from another location that the logger answers the line and that data can be read.

In normal every day use, the logger will be interrogated by a specialist software application, such as SHM's XLeMs or Stark Reality Energy Monitoring Software. The final step is to configure the application with details of the logger, and check that it will interrogate the logger correctly, via modem, LAN or whatever communications medium is being used.

4. DESCRIPTION

4.1 Indicators

4.1.1 Logger Unit

The ML32 Logger Unit has three external indicator LEDs. The LED functions are as follows :-

- **AC Mains** - Yellow (Upper). Indicates presence of the mains supply when lit.
- **Battery Charge** - Yellow (2nd from top). Indicates that the main battery is connected and is being charged when lit.
- **Heartbeat** - Yellow (Middle). Flashes briefly once per second showing that the main processor is properly functioning.
- **Receive Data** - Red. Flashes briefly as serial data is received by the logger from one of the communications ports.
- **Transmit Data** - Green (Lower). Flashes briefly as serial data is transmitted by the logger.

If the Heartbeat flashes are so brief as to be barely visible it may indicate that the clock / calendar does not have a valid time and date. The logger will not log anything in this state, but all that is required to restore normal operation is to set the logger to the correct time.

In addition, there are two internal LEDs on the upper expansion board of the logger, whose functions are as follows :-

- **Received OK** – (LED1 - Green). This is lit while reception of Modbus response from the slave device is in progress. It normally flashes briefly for every message received.
- **Error** – (LED2 - Red). This is lit if there is a communications error (eg. CRC error or timeout) for the Modbus response message. The red LED also flashes while the programmer is writing configuration data. In this case the red LED does not indicate an error.

4.2 Connectors

4.2.1 Logger Unit

Refer to Figure [3] which shows the position of the connectors on the logger main PCB. Pin 1 on each connector is indicated on the figure by a diagonal line.

TB1 - Mains Supply

This 3-way terminal block provides the mains Live, Neutral and Earth connections (labelled **L**, **N** and **E** respectively).

1	Earth
2	Neutral
3	Live

TB2 - Univ Channel Inputs This 18-way terminal block connector provides connections for the first bank of 8 (Universal) logger inputs.

Each logger input consists of two terminals, the Input itself and the Common (ground). The numbered terminals refer to the Input Number. Terminals marked with a dash are commoned together to the ground of the logger circuitry.

1	Input 1	10	Ground
2	Ground	11	Input 6
3	Input 2	12	Ground
4	Ground	13	Input 7
5	Input 3	14	Ground
6	Ground	15	Input 8
7	Input 4	16	Ground
8	Ground	17	DC o/p (+)
9	Input 5	18	Ground

TB3 - Pulse Output

This is a 2-way terminal block connected to a volt-free electromechanical relay.

1	Normally Open
2	Common

TB4 – Modbus Serial Data

This 5-way terminal block connector provides RS485 data connections to the Modbus slaves. It is fitted on the upper expansion board inside the ML32. Modbus 2-wire mode is used.

The terminals 4 & 5 must be left open circuit.

1	Modbus I/O+ (I+)
2	Modbus I/O- (I-)
3	Ground
4	<i>Do not use</i> (O+)
5	<i>Do not use</i> (O-)

NB. *Pin 1 on this terminal blocks is on the right-hand side as viewed looking into the logger the normal way up.*

TB5- Auxiliary Power This 2-way terminal block connector provides auxiliary power and is fitted on the upper expansion board inside the ML32. **Consult SHM before making use of this supply.**

1	Ground
2	DC o/p (V+)

NB. *Pin 1 on this terminal blocks is on the right-hand side as viewed looking into the logger the normal way up.*

PL1 - Local Communications Port This is a polarized 4-way plug. This connector is normally wired to the 9-way D-type socket on the bottom face of the logger. This port is opto-isolated, and requires a steady positive voltage on pin 1 to operate. The connections below are labelled as a DCE.

1	DTR (+5v input)
2	RXD (output)
3	TXD (input)
4	Ground

PL2 - Remote Communications Port This is a polarized 6-way plug. It is intended for connection to a BT modem or radio modem where remote interrogation of the logger is required. This port is opto-isolated, and requires a steady positive voltage on pin 1 to operate.

The signals supported are RXD, TXD, RTS, CTS and DSR, and the connections below are labelled as a DTE. Connection to a modem requires a special cable which should be ordered separately.

1	DSR (+5v input)
2	TXD (output)
3	RXD (input)
4	Ground
5	CTS (input)
6	RTS (output)

PL5 - Main Battery This is a polarized 2-way plug. It connects to the 8.4V main battery pack which is secured under the sub-chassis.

1	Battery +
2	Battery -

PL6 - LED Connector

This is a polarized 5-way plug. It connects to two LEDs on the sub-chassis.

1	TXD LED - (ground)
2	TXD LED +
3	RXD LED - (ground)
4	RXD LED +
5	Ground

PL7 - LED Connector

This is a polarized 6-way plug. It connects to three LEDs on the sub-chassis.

1	Mains LED - (ground)
2	Mains LED +
3	Charge LED -
4	Charge LED +
5	Heartbeat LED -
6	Heartbeat LED +

PL8 - Modem Connector This is a polarized 8-way plug. It connects to the integral modem, or to some Option Boards.

1	RTS/ (output)
2	TXD (output)
3	CTS (input)
4	RXD (input)
5	V _{aa} power (unregulated)
6	V _{ur} power (unregulated)
7	Ground
8	PON (output)

PL9- Memory Battery This is a polarized 2-way plug. It connects to the 3.6V memory battery pack which is secured under the sub-chassis.

1	Battery -
2	Battery +

Local Communications Port This is a 9-way D-type socket mounted on the bottom face of the logger enclosure, that is connected to PL1 by a short flying lead. This connector can be used as a V24/V28 (RS232-C) connection to an adjacent PC using a straight-through lead.

The signals supported are RXD and TXD. The connector is wired as a DCE, so it can be connected directly to a PC serial port (which is wired as a DTE).

2	RXD (output)
3	TXD (input)
5	Ground
4	DTR (+5v input)

TB3 - RS485 Network *This is either a 5-way or a 6-way terminal block on the RS485 Option Board. There are 2 terminals for the receiver input, 2 terminals for the transmitter output and 1 or 2 common earth terminals. Note that the transmitter and receiver connections are polarity-sensitive.*

The later RS485 board, with 5-way connector is as follows :-

1	Receive Data + (I+)
2	Receive Data – (I–)
3	Ground
4	Transmit Data + (O+)
5	Transmit Data – (O–)

The earlier RS485 board, with 6-way connector is as follows :-

1	Receive Data + (I+)
2	Receive Data – (I–)
3	Ground (Rx)
4	Transmit Data + (O+)
5	Transmit Data – (O–)
6	Ground (Tx)

NB. Pin 1 on these terminal blocks is on the right-hand side as viewed looking into the logger the normal way up.

4.3 Fuse

The supply from the battery is fitted with a 20mm 500mA quick-blow fuse **FS1**.

4.4 Batteries

Two batteries are normally provided in the standard unit.

4.4.1 Main Battery

The operating main battery is a 8.4V Nickel-Cadmium 7-cell battery pack and forms part of the logger UPS. This is maintained on constant trickle charge and provides approximately 15 hours of continuous logging (including Modbus channels) after the mains supply fails. Full recharge takes approximately 24 hours, though the logger will function normally as soon as mains is re-applied. The main battery pack lead is normally NOT plugged in to the logger as shipped.

4.4.2 Memory Battery

The memory battery is a 3.6V Nickel-Cadmium battery which is also maintained on trickle charge. This provides memory retention of the logged data for 1 month in battery-supported RAM (random access memory). The memory battery also powers the crystal controlled clock/calendar circuit. It is connected to the PCB via a flying lead and 2-pin polarized connector.

4.5 Configuration Links

The logger PCBs have jumper links which are used to further configure the operation of the unit. These links are 0.1" pitch shorting jumpers which plug into arrays of 0.1" spaced pins.

4.5.1 Input Configuration

Each logger Universal Input has its own configuration link. These are all in a row above TB2.

Each input jumper can be placed in one of three positions. These are marked **R**, **I** and **V** on the PCB. These should be set as follows :-

- I** Current Input. Used when connecting to a 4 to 20 mA current transducer.
- V** Voltage Input. Used when connecting to a 0 to 10 Volt voltage transducer.
- R** Temperature Input. Used when connecting to a 10 kOhm thermistor sensor. Also used when connecting to volt-free contacts for logging Pulse Counts or Status (On/Off).

4.5.2 RS485 Option Board Configuration

There are two versions of the RS485 option board, which can be identified as follows :-

- Later type Fitted with 5-way terminal block and has links LK5 and LK6 on the board
- Earlier type Fitted with 6-way terminal block and does not have links LK5 or LK6

The tables below show the links present on the RS485 Options Board. Various pre-configured options boards are available, as indicated by the part number in the right-hand column. Note that the different types of board have different components fitted, so it is not usually possible to re-configure a unit in the field. Any option combinations not shown are not permitted.

Later type board :-

Option	LK1	LK2	LK3	LK4	LK5	LK6	Part No.
RS485 Loop	Out	Out	In	Out	Out	Out	LAN-485N
Integral Modem	Out	In	Out	In	Out	Out	LAN-485M
External Modem	Out	In	Out	Out	In	In	LAN-485A
RS485 Direct	Out	Out	In	Out	Out	Out	LAN-485W
Modem Serial Sw.	In	Out	In	Out	Out	Out	LAN-485S

Earlier type board :-

Option	LK1	LK2	LK3	LK4	Part No.
RS485 Loop	Out	Out	In	Out	LAN-485N
Integral Modem	Out	In	Out	In	LAN-485M
External Modem	Out	In	Out	In	LAN-485A
RS485 Direct	Out	Out	In	Out	LAN-485W
Modem Serial Sw.	In	Out	In	Out	LAN-485S

NB When connecting to the network via an external modem (or directly to a PC) at RS232, use the 6-way connector on the LAN-485A card. A lead for this purpose can be ordered from SHM.

4.5.3 Expansion Board Configuration

The links on the expansion board (the PCB with Modbus I/O terminal block) should be set as follows :-

LK1	In
LK2	Out
LK3	In
LK4	Out

5. OPTIONS

5.1 Hardware Options

The functionality of the basic logger can be extended by fitting expansion cards. These option boards are normally fitted on the underside of the sub-chassis. Certain hardware options require the software option codes to be programmed appropriately using UCOMM, although this will normally have been set up at the factory. For reference, the relevant option codes are listed in the table below :-

Hardware Option	Option A Code	Option B Code
Integral Modem	16	0
Eternal Modem	48	0
RS485 Network Interface	n/a	n/a
Modem Serial Switch (applicable to DL4 only)	128	0
Integral Ethernet	32	0

5.1.1 Modems

5.1.1.1 Integral BT Modem

A special BT modem can be fitted on the underside of the sub-chassis. It has a socket on the front for the line connection and is supplied with a cable that plugs into a standard BT line socket.

The board is supplied with its own cable that plugs into PL8.

The modem is supplied programmed with a profile to suit the operation of the logger. It is usually factory-programmed using the following AT commands :-

1	AT&F0E0	Set factory profile zero WITHOUT echo
2	AT&K4	Software flow control
3	ATS0=1	Auto-answer after 1 ring
4	AT&Z0=01962...	If dial-in required, telephone number that logger is to dial.
5	AT&W0	Store as power-up profile

5.1.1.2 External Modems

External modems are connected via a special cable (which must be ordered separately) connected to PL2.

To operate correctly (particularly with the Modem Answer Window and Dial-In software options, the modem profile must be set for the following :-

1. **NO** local echo

2. XON/XOFF flow control
3. Answer after 1 ring
4. Disable answer if DTR off
5. Ensure DSR is always on
6. If dial-in required, the number to dial

For a US Robotics 14400 modem, these settings correspond to the following AT commands :-

1	AT&F2E0	Set software flow-control factory profile WITHOUT echo (also sets DTR & DSR modes)
2	ATS0=1	Auto-answer after 1 ring
3	AT&Z0=01962...	If dial-in required, telephone number that logger is to dial.
4	AT&W0	Store as power-up profile

5.1.2 RS485 Option Board

This option allows a number of loggers to be connected up in a chain network, using a 2-wire plus earth cable between each logger. The maximum distance between each link in the chain is 1500m.

The two ends of the chain are connected to the PC that is to interrogate all the loggers. This PC requires an RS232 to RS485 adapter to be fitted. Alternatively, one of the loggers can be fitted with an integral or external modem, to act as the common access point. Access from PC to any of the loggers is then via dial-up modem.

This option can also be used for direct connection to a PC where the distance involved means that RS232 would not work. The PC requires an RS232 to RS485 adapter to be fitted.

The various ways of connecting up loggers using an RS485 network are illustrated by Figures [5], [6] and [7] (see Section [2.3.4]).

The board is supplied with its own cable that plugs into PL8.

The RS232 to RS485 adapter can be ordered from SHM, and comes with its own instructions. It is connected up as described in Section [2.3.4]. The separate power supply must be wired into the terminal block (observe correct polarity).

5.1.3 Modem Serial Switch Option Board

This option allows the logger to share an external modem with another device.

A special 'T' cable is supplied with this option that is interposed between the modem and the other device and also connects to the logger. Serial communications are normally directed to the other device, but when a special command is received, serial communications are switched over to the logger.

The board is supplied with its own cable that plugs into PL8.

This option can also be used with a network of loggers connected via RS485.

5.1.4 Integral Ethernet Interface

A special Ethernet terminal server or EGU (Ethernet Gateway Unit) can be fitted on the underside of the sub-chassis. It has an RJ45 socket on the front for the Ethernet connection. An Ethernet patch lead is not normally supplied with this option.

The board is supplied with its own cable that plugs into PL8.

Setup instructions for the EGU are normally supplied with this option, but the latest application note (AN024) is also available on the SHM Website :-

http://www.shmcomms.co.uk/tech_support/application_notes.htm

5.2 Software Options

The following software options are available on all loggers and can be enabled as part of the configuration process.

5.2.1 Modem Answer Window

The Modem Answer Window option allows a logger to share a telephone line with another device. If enabled, the logger only answers calls during a pre-programmed time window. The logger's modem is programmed to answer after only one ring. If the line is shared with a FAX or other modem or answering machine, this must be programmed to answer after more than one ring to prevent conflict.

The window start and end time are programmed into the logger as times of day (hh:mm). The window is at the same time every day. If the start and end times are programmed with identical times, the logger will answer a call at any time of day. If the start and end times are programmed with the special dummy times 24:00 and 24:01, the logger will never answer calls.

Note that for testing purposes it is possible to get the logger to answer the calls outside the normal window if a special ring sequence is used.

5.2.2 Dial In

This is another function that allows a logger to share a telephone line with another device. With Dial-In, the logger (or network of loggers connected via RS485 links) is programmed to dial the number of the controlling PC at a specific time every day. The actual time of first dial-in is randomized with a delay of up to 10 minutes, and the logger will keep trying for up to one hour if it cannot get through. A Dial-In logger can share the line with any device without restriction.

The dial-in start time is programmed into the logger as a time of day (hh:mm). If this dial-in time is programmed with the special dummy time 24:00, then dial-in will be disabled. The telephone number dialled is stored in the modem profile rather than the logger.

Where an RS485 network is used, the dial-in start time is programmed into the logger that is connected to the modem.

5.2.3 Alarms

A logger can be programmed to check its Universal Inputs for alarm conditions and notify the user if any parameter goes out of limits.

Each Universal Channel in the logger can be programmed with two alarm thresholds (High and Low). The channel can be programmed to generate an alarm if its reading is between the two threshold values or outside the two values. Each channel alarm can also be individually enabled or disabled.

When an alarm condition is detected on a Universal Channel, an Alarm Flag is logged alongside the historical data.

For the Modbus Channels (9 to 32), threshold alarms are not supported. However, if a channel's transmitter unit reports "low battery" or if transmissions have not been detected for over 3 minutes, then an Alarm Flag is logged alongside the historical data for as long as the alarm condition persists.

The logger can be programmed to use latching or non-latching alarms.

Non-latching alarms are simplest - when the channel reading changes to a non-alarm value, the channel alarm ceases.

Latched alarms are used if the alarm state is to persist until acknowledged by the user, even if the original alarm condition ceases. The alarm is acknowledged by sending a special message to the logger. Acknowledging the alarm will clear the alarm state even if the channel reading is still at an alarm value. The channel alarm will only be re-activated if the reading subsequently changes from a non-alarm value to an alarm value.

The way an alarm is detected depends on the type of channel as follows :-

- Digital channels are checked once per minute (at 00 seconds) using the increase in count since the start of the whole logging period. Note that if the alarm becomes active during one logging period, it will stay on at least until the end of the next logging period (as it is only at this time that it is clear that the channel is not going to generate an alarm again).
- Status channels are checked once per second.
- Analog and Temperature channels are checked once per minute (at 00 seconds).

When alarms occur, the logger can be programmed to notify the user using the pulse output relay and/or by dialling in to a PC. The telephone number dialled is stored in the modem profile rather than the logger.

The relay is provided with contacts that are closed for the non-alarm condition and open for the alarm condition. This means that if the logger power fails or if the cable is cut, an alarm will be raised.

If notification is via the on-board relay, it is possible to program one of the logger inputs to be used for a reset button or remote contact that will cancel the relay alarm. Once the alarm relay has been reset, it will only be re-activated if a new channel alarm occurs.

For each channel, the alarm type can be configured to :-

- Disabled Channel does not generate alarms
- Inside Window Alarm if channel reading \geq Low and \leq High
- Outside Window Alarm if channel reading $<$ Low or $>$ High

The High and Low thresholds can be programmed, but the Low threshold cannot be greater than the High threshold (although they can be the same).

Alarm notification is a separate process that can depend on the alarm state of one or more channels. The following parameters configure the notification process :-

- Latched Mode Enables / Disables latched alarms for all channels
- Alarm Mask Determines which channel(s) generate alarm notifications
- Relay Notif. Enables / Disables notification via relay
- Dial-in Notif. Enables / Disables notification via dial-in. If enabled, the logger should either be fitted with a modem or be on an RS485 network accessed via a modem.
- Reset Input Determines which logger input (if any) is used to cancel notification via the relay

Operation of alarm notification is explained below.

5.2.3.1 Non-Latched Alarms

In this mode, if the alarm notification is not cancelled, the notification simply follows the alarm condition. However if required, the alarm notification (relay and / or dial-in) can be cancelled. The occurrence of a new alarm will re-trigger notification.

The alarm relay will be activated :-

1. When any un-masked channel alarm in this logger changes from off to on

The alarm relay will be de-activated :-

1. When all un-masked channels' alarms in this logger are off.
2. When the alarm reset input (if configured) is shorted to ground.

The logger will begin dialling in :-

1. When any un-masked channel alarm changes from off to on. If the logger and its modem control access to an RS485 network, this applies to any un-masked channel in any logger on the network.

The logger will stop dialling in :-

1. When all un-masked channels' alarms are off. If the logger and its modem control access to an RS485 network, this means all un-masked channels in every logger on the network.
2. When the logger receives a "Stop Dialling In" message.

5.2.3.2 Latched Alarms

In this mode, if alarm notification is not cancelled, the notification can only be de-activated by sending messages to acknowledge all channels generating alarms. However if required, the alarm notification (relay and / or dial-in) can be cancelled. The occurrence of a new latched alarm will re-trigger notification.

The alarm relay will be activated :-

1. When any un-masked channel latched alarm in this logger changes from off to on.

The alarm relay will be de-activated :-

1. When all un-masked channels' latched alarms in this logger are off. This can only happen if all active alarms are acknowledged by messages from the PC.
2. When the alarm reset input (if configured) is shorted to ground.

The logger will begin dialling in :-

1. When any un-masked channel latched alarm changes from off to on. If the logger and its modem control access to an RS485 network, this applies to any un-masked channel in any logger on the network.

The logger will stop dialling in :-

1. When all un-masked channels' latched alarms are off. This can only happen if all active alarms are acknowledged by messages from the PC. If the logger and its modem control access to an RS485 network, this means all un-masked channels in every logger on the network.
2. When the logger receives a "Stop Dialling In" message.

6. MAINTENANCE

In the unlikely event of failure, the entire electronics sub-assembly can be unplugged and removed very easily to be returned to SHM for repair or exchange.

6.1 Removing the Sub-Chassis

If you need to remove the sub-chassis, first unplug any connectors that are wired up (TB1, TB2, TB3, PL1, PL2, TB4, TB5).

The earth strap that connects to the base plate must also be unplugged.

The sub-chassis is fixed to the base plate by two M4 screws. These screws locate in two keyhole-shaped slots in the bottom flange of the sub-chassis.

To remove the sub-chassis, these two screws are slackened by approximately one turn, and the sub-chassis is then slid upwards to release it.

Replacement is the reverse of the removal procedure. When sliding down into position, ensure that the upper flange of the sub-chassis engages behind the metal strip on the base plate.

6.2 Battery Life

The batteries are maintained on low trickle charge with complete discharge occurring only rarely when there are extended power cuts. Under these conditions the batteries can be expected to last for a period in excess of 5 years.

6.3 Battery Replacement

When the main battery requires changing the sub-chassis must be removed from the main enclosure to release the battery. Removal of mains supply and main battery will cause the logger to stop logging. When the main battery is replaced the logger should not lose data or time since these are maintained by the memory battery.

The main battery will support time and data retention while the memory battery is changed.

If both the main battery and the memory battery are disconnected in the absence of mains power, then the logger will lose memory of its logged data and the clock will stop. However, it will not lose its personality profile which is maintained permanently in EEPROM memory.

NB. If the clock stops because of removal of the battery, then the logger will need to have the time and date re-commissioned before it will start logging again.

When changing one or both batteries the personality profile should be checked with a local portable PC first, and confirmed to be the same after the installation is complete. The calendar clock setting should also be checked and reset if necessary.

7. TECHNICAL SPECIFICATION

7.1 Logging Unit

7.1.1 Inputs

Quantity		8 Universal inputs 24 inputs via Modbus.
Pulse Counting Inputs		Volt-free contact closure input, 10k pull-up to +5V.
	Minimum pulse width	20ms
	Maximum pulse rate	20Hz
Status Inputs		Binary status input, 10k pull-up to +5V.
	Glitches recorded	20ms (minimum)
Current Inputs	Range	0 to 20 mA
	Input Impedance	250 ohms
	Resolution	10-bit ADC, $\pm 2\%$
Voltage Inputs	Range	0 to 10 volts
	Input Impedance	200 kOhm
	Resolution	10-bit ADC, $\pm 2\%$
Temperature Inputs	Type	Thermistor sensor, 10k nominal at 25°C. Built-in linearizer.
	Range	-80 to +150°C
	Input Impedance	10k pull-up to +5V.
	Resolution	0.1°C, $\pm 0.5^\circ\text{C}$ at +25°C
Protection	Series protection	100 mA PTC thermistor (80 - 100 ohms).
	Shunt protection	12 volt TranZorb™ type transient suppressor.

7.1.2 Channels

Quantity		8 Universal data logging channels 24 Modbus logging channels
Input		Each Universal Channel can be configured to monitor any of the 8 physical Universal Inputs.
Configuration		Each Universal Channel can be independently configured for channel capacity and logging interval.
Data integrity		Logging interval can be dynamically changed without losing historic data.
Immediate values		All channel inputs can be read as immediate values.
Types		Each Universal Channel can be configured to log data as pulse totalization, status change, analog value or temperature.
		Each Modbus channel can be digital (32-bit incrementing register) or analog (-32767 to +32767), depending on how the channel has been configured using MLConfig.
Pulse Counting Channels	Configurable pre-scaler	1 to 255
	32-bit pulse count register	Pre-settable 9-digit start value.
Status Channels	Event logging	Time and date of every change of state logged.
	Resolution	1 second
Analog Channels	Format	Readings logged as 15 bits plus sign (-32767 to +32767).
	Resolution	Zero reading corresponds to zero input. Maximum reading (+32767) corresponds to maximum input (10 volts or 20 mA).
Temperature Channels	Format	Readings logged as 15 bits plus sign.
	Resolution	Zero corresponds to 0 degrees centigrade. 1 bit corresponds to 0.1 degrees centigrade.
Logging capacity		512 Kbytes of RAM memory provides storage for up to 103,000 readings. See table below.

7.1.3 Isolation

Sensor Inputs		Sensor input common is normally grounded. For isolated sensors, common input can be made to float by removing LK27.
	Voltage	250V rms. max. common input to chassis with LK27 removed.
RS232		Opto-isolated
	Voltage	110V rms. max. common input to chassis.

7.1.4 Communications

Format	Character Set	7-bit printable ASCII characters and carriage-return.
	Data Format	Asynchronous 7 data bits, 1 stop bit.
	Parity	Even, Odd, Mark (1) or Space (0).
	Baud Rate	1200, 2400, 4800 or 9600
Flow control		XON / XOFF in both directions.
Local access		RS232 port (9-way D-type).
Remote access		Separate RS232 port for connection of external BT modem or PAKNET radio modem.
Modems		Integral BT modem option available.
Ethernet	10/100BaseT	Dual-rate auto-sensing

7.1.5 Time/Date

Source		Quartz calendar clock oscillator synchronized by host when reading.
Accuracy		Accuracy \pm 1 second per day
External Synch.		Volt-free relay contact provides 1-sec time synchronization pulse every 1/2 hour.

7.1.6 Security

Passwords		4-level security system with 32-bit numeric passwords.
	Disabling	Programming null (zero) as the password disables it.
	Level 1	Read data - each channel has its own unique password.
	Level 2	Configure channel – each channel has its own unique password.
	Level 3	Time Control - a single password controls access to regulate the time.
	Level 4	Logger Commissioning - a single password controls access for overall commissioning at installation.
Authentication		Logger readings are protected by an authentication algorithm (based on a 32-bit key) which appends a 16-bit validator to each block of readings.
Comms.		Data transmission is verified by a longitudinal parity check code on each packet (maximum 250 characters).

7.1.7 Electrical

External supply		240V AC or 110V AC \pm 15%
	Power consumption	3VA (maximum)
Main Battery		8.4V NiCad (if UPS option fitted).
	Endurance	15 hours sustained logging operation in the absence of external power.
Memory Battery		3.6V NiCad
	Endurance	60 days of retention for logged data and calendar clock.

7.1.8 Wiring

Connectors	Terminal Blocks	Two-part terminal blocks allow pre-wiring of enclosure prior to fitting of electronic sub-chassis, and easy maintenance.
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7.1.9 Enclosure

Construction		Three parts. Base-plate, Sub-chassis and cover.
		Internal sub-chassis slides into wall-mounted base plate. Sub-chassis available separately as OEM unit.
	Material	Mild Steel, powder-coated.
	Fastening	Single thumb screw. Single hole to fit a seal.
	Mounting	3-hole wall mounting. Top mounting has key-hole slot. 6mm stand-off dimples.
Cable entry		Eight 20mm conduit knock-outs for bottom entry of cables. Four 20mm conduit knock-outs for rear entry of cables.
Dimensions	Width	265 mm
	Height	262 mm
	Depth	95 mm
Weight		4 kg.
Environmental		IP 41

Logging memory is allocated on a per-channel basis in blocks of 2500 readings. There are 40 blocks, and the default configuration is 2 blocks per Universal Channel and 1 block per Modbus Channel

Data logging times for standard 512k logger with the default memory configuration is:-

Logging Interval (mins)	1	2	5	10	15	20	30	60
Channels 1-8 Duration (days)	3.5	7	17.5	35.5	53.5	71.5	107	214
Channels 9-32 Duration (days)	1.75	3.5	8.5	17.5	26.5	35.5	53.5	107

7.2 Modbus

7.2.1 Communications

Protocol	Modbus RTU	All slave devices must support this protocol
Physical	RS485, 2-wire	4-wire slaves can be accommodated by commoning their Rx and Tx signal pairs.
Baud rate	9600	All slave devices must be programmed to this baud rate.
Data bits	8	
Parity	None	
Read command	03h	Read Holding Registers
Data Formats	Integer	16-bit and 32-bit, signed and unsigned. Either word order for 32-bit