UGL REGIONAL LINX

CERBERUS LEVEL CROSSING MONITOR EQUIPMENT MANUAL

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LINKING COMMUNITIES. CONNECTING CUSTOMERS.

Table of Contents

Document Control

Function	Position	Name	Date
Approver	A&E Manager	Lucio Favotto	27.01.2022

Revision	Issue Date	Revision Description
1.1	24.01.2022	UGLRL Operational Standards Template applied
2.0	27.01.2022	First approved and issued UGLRL version

Summary of changes made from previous version

Section	Summary of change
All	This document is based on the previous rail infrastructure maintainer (RIM). Full revision history is available on request from UGLRL.

1 Introduction

1.1 Referenced and Associated Publications

The following RailCorp Signal Engineering Specifications provide additional information to this document.

Specification 1033   Vital Indication Optoisolator.

Specification 1068   Analogue to Digital Converter

Specification 1069   Current sensor.

Specification 1070   Level Crossing Monitor Requirements

Specification 1071   Level Crossing Monitor hardware

Specification 1072   Level Crossing Monitor - backplane.

Specification 1073   SCADA 2000 D12 - Individual Input Optoisolator

Specification 1074   8 way output optoisolator

The following Signal Engineering manuals provide additional information to this document.

Cerberus Control Centre users guide

SCADA 2000 A/2.0 Technical manual.

1.2 Definitions

The following mnemonics are used in this document.

ADC	Analogue to Digital Converter
IIO	Individual Input Optoisolator
PCB	Printed Circuit Board
SCADA	Supervisory Control And Data Acquisition
VIO	Vital Indication Optoisolator

2 Overview

2.1 Monitoring (How does it operate?)

Once every 0.25 seconds the Level Crossing monitor scans all of its inputs. It then checks the pre-programmed relationships between its analogue inputs, digital inputs and its digital outputs.

Through the use of the configuration data the level crossing monitor processes a number of mathematical expressions (known as 'Boolean Expressions') to examine the relationships. Each expression is the equivalent of a non-vital relay circuit. For more information on Boolean Expressions consult the section on configuration data.

The pre-programmed relationships are customised for each particular level crossing. However they are all based on a standard set of relationships that are discussed in this section. Any specific expressions for a level crossing are contained in the expression file for that particular level crossing.

The Level crossing monitor processes Boolean expressions with, internal intermediate states and timer facilities to one second accuracy. Appendix A contains a sample set of Boolean expressions that define the relationships for a standard level crossing.

The Level crossing monitor determines the number of lamps operating on each lamp circuit. It then checks the number of lamps operating against the number that should be operating as specified in the expression file. A lamp fault indication is provided when the number of lamps

detected is more than expected on any particular lamp circuit or 1 or more lamps has failed on any circuit.

In normal operation the level crossing monitor will display two green LEDs which indicate NO FAULT and NO WARNING. If a maintenance computer (either locally or remotely via modem) is connected these two indications are combined to give a status of NORMAL on the maintenance computer. If a FAULT occurs than the LED (on the level crossing monitor front panel) for NO FAULT will extinguish, indicating that a FAULT has occurred. If a WARNING occurs then the LED for NO WARNING will extinguish, indicating that a WARNING has occurred.

The NO FAULT status indicates that the battery voltage is not low, no more than 1 lamp is out, more lamps than expected have not been found, and no other fault detected by the level crossing monitor. The Fault indication is latched until the fault reset push button is pressed or the fault reset command with the appropriate pin number is received from a serial channel.

The NO WARNING status indicates that none of the warning conditions are present. The Warning indication is latched until the fault reset push button is pressed or the fault reset command with the appropriate pin number is received from a serial channel.

The list below indicates what could cause the status indications. This list is based on the standard set of GENERIC I/O and expression files dated 18/5/95.

A status indication of **WARNING** is indicated if one or more of the following has occurred:

- No remote or local test of the level crossing has occurred within the last 36 hours.

- The local test was not valid as it was not conducted for the 2 minute minimum period.

- No train has traversed the level crossing within the last 72 hours.

- The Emergency switches have been turned off for more than 10 minutes.

- There has been a failure of some signalling equipment near the level crossing which has caused a Interlocking failure. eg. points detection failure, signal lamps out or track failure.

A status indication of **WARNING & LAMP** is indicated if:

- One of the lamps is not working.

- A status indication of **WARNING & BATTERY** is indicated if:

- The AC Supply has been OFF for more than 6 hours 30 minutes.

- A status indication of **WARNING & SYS_FAULT** is indicated if:

- The Level Crossing Monitor itself has a internal fault. A possible internal fault could be due to failure of the A/D card, real time clock, CPU, memory, log data or EPROM.

A status indication of **FAULT & LOGIC** is indicated if the level crossing has:

- Not started operating 6 seconds after the time that it should start operating.

- Not stopped operating 6 seconds after it should have stopped operating.

- Not had a change of state on the flasher inputs within the last 5 seconds when the level crossing should be operating.

- Operated continuously for more than 20 minutes.

- Remote battery testing output on without a test being requested or the test runs for more than 5 minutes and 30 seconds.

- The Boom normal when it should not be, or not normal when it should be normal.

- Either direction stick is up and there is no train detected.

- Battery Test relay is faulty

A status indication of **FAULT & LAMP** is indicated if:

- Two or more of the lamps are not working.

- More lamps are operating than expected (possible short circuit).

A status indication of **FAULT & BATTERY** is indicated if the level crossing has:

- The battery voltage is below the alarm point configured in the expression file as measured by the level crossing monitor for more than 3 seconds.

- The Store 74 Low battery alarm card has tripped for more than 3 seconds.

- The remote testing of the level crossing battery has not produced the test current specified in the expression file.

It is possible to have multiple status indications which would indicate that more than one fault or warning has occurred. For example a failure of a flasher unit will give FAULT & LAMP & LOGIC.

A status indication with **LOGIC flashing** once per second indicates that the monitor has had its reporting of status changes disabled temporarily (called maintenance mode). When in this state the monitor will not report changes of status to the Control Centre via modem. This state is entered by holding the Fault Reset button pressed for 5 seconds. It is cancelled by a momentary push of the Fault Reset button or after a time delay of 45 minutes. This function is provided so that maintenance staff can conduct maintenance activities at the level crossing without causing unnecessary faults and warning to be reported back to the Control Centre. All Faults and Warnings must be cleared before cancelling this maintenance mode otherwise they will be reported to the Control Centre.

2.2   Control and Interrogation

The control, interrogation, and reporting facilities are provided via the RS232 serial ports labelled channel A, and channel B. Normally a dial-up modem is connected to channel A.

Maintenance staff may Control and interrogate the Monitor using a Personal Computer and one of two programs. Either the MS-DOS V6.2 based program named LX_MAINT.exe or the MS-WINDOWS 3.1/WIN95 based programme named 'Cerberus'.

The dial-up modem is connected to serial channel A. Serial channel B is available for on-site maintenance staff. The maintainers PC is directly connected to the Level Crossing Monitor serial channel B via a null modem serial cable. The cable must include loopbacks on the Level Crossing Monitor end. These are DTR to CD, and RTS to CTS. See section 4.2 for further details of the cable configuration. Normally the Laptop PC end of the cable is plugged into serial port 1.

The level crossing monitors have a default set-up of:

Serial Channel A	Serial Channel B
9600 bps	19200 bps
8 data bits	8 data bits
1 stop bit	1 stop bit
no parity	no parity

The functions available to a user are menu driven. These functions include obtaining the event log, IO states, configuration details, and status change times as well as conducting a remote battery test. Some menu items are protected by a PIN number.

The PIN numbers will be common for a Region and are available through the District Signal Engineer.

2.3   Logging

Once every 0.25 seconds the Level Crossing monitor checks its analogue inputs, digital inputs and its digital outputs for changes. If any changes are found then details of these changes are logged with their date and time (to the tenth of second) of occurrence.

The log contains the last 10,000 changes. The oldest event is automatically replaced by the next new event when the event log is full.

The log is maintained in a non volatile storage medium (battery backed memory). The log is still retrievable after the Level Crossing monitor has been without power and disconnected for at least 2 years.

Changes to the state of the flasher inputs are not logged. The VIOs used to monitor the flasher units are connected to the level crossing monitor directly via the flasher cable (4 wires - 2 Red, 1 Blue, and 1 Orange) to Input 4. This is solely to prevent wasting log space. (See standard circuits in Appendix C).

2.4   Status Reporting

2.4.1   General

The Level Crossing monitor indicates its status locally using No Warning and or No Fault indications on the front panel. If a warning or fault occurs, then the No Fault or No Warning outputs turn off as appropriate and the cause is indicated by turning on either system, lamp, battery, or logic output as appropriate. Details of the outputs are described in the section on digital outputs.

In the CRN the majority of level crossing locations are fitted with 3G wireless Cybertec modems and these have been converted to IP addressing, rather than the original 'dial up' configuration. In these locations where a status change is being reported to the control centre, no audible sounds will be heard.

2.4.2   Maintenance Disable of Status Reporting

The maintainer may temporarily disable Status Reporting by holding the Fault Reset button pressed for 5 seconds. The LOGIC led will flash once per second to indicate that the monitor has had its reporting of status changes disabled temporarily. When in this mode the monitor will not report changes of status to the Control Centre.

This mode is cancelled by a momentary push of the Fault Reset button or at pre-programmed interval after activation. Normally this time-out is set at 45 minutes. All Fault and Warning conditions must be cleared before cancelling this mode otherwise they will be reported to the Control Centre.

Note that the maintenance disable feature is a part of the expression file and can be disabled if required by modifying the expression file.

2.4.3   Codes Reported to Control Centre

The level crossing monitor will report a Fault or Warning and one of the following codes when it detects a change in the status of the crossing. These directly relate to the monitor front panel indications discussed previously. But also include some additional information by identifying some indications that are grouped on the front panel.

Code reported by Control Centre PC	Level Crossing Monitor, Status Codes
Code 1	LAMP
Code 2	LOGIC

Code 3	SYSTEM
Code 4	BATTERY
Code 5	TEST
Code 6	COMMUNICATIONS FAIL
Code 7	SECURITY ALARM
Code 8	EMERGENCY SWITCHES
Code 9	No Train for 72 hours
Code 10	No Test for 36 hours
Code 11	Operating Too long
TRAIN DRAGGING EQUIPMENT	DRAGGING EQUIPMENT

Note 1:Security Alarm is intended to be an alarm module installed at the level crossing. In the future a number of level crossing locations may have alarms fitted which can then report back via the level crossing monitor to the Control Centre.

Note 2:Train Dragging equipment is intended to be an alarm that is activated by Train Dragging detector equipment. It is a future option.

2.5   Digital Inputs

The Level Crossing monitor has 48 digital inputs that are logged and 8 digital inputs that are not logged. Digital inputs are conditioned through a 12 volt 32 way Input Optoisolator board. They are suitable for input voltages in the range of 9 volts to 20 volts DC. They require a positive voltage for each individual input and a common negative for the Input Optoisolator board.

The following digital inputs are normally connected to the Level Crossing monitor when available at the particular Level Crossing:

- All track circuits that qualify the operation of the level crossing.
- Direction stick relays.
- The level crossing control and repeat relays.
- Test switch.
- Boom 85-90 degree state.
- Lights, Bell and Boom emergency switches.
- AC supply state.
- Low battery voltage indication from charger.
- Any other function that qualifies the operation of the Level Crossing (for example approach signals HR and ALSR).
- Crossing normal relay.
- Reset fault or warning.
- Output state of each flasher.

Other relays/contacts of interest e.g. Signal control relays, releasing switches.

2.6   Digital Outputs

The level crossing monitor has 8 digital outputs. The current state of these outputs is indicated on the front panel of the level crossing monitor. These outputs are connected to the 8-way

Output Optoisolator which is used to drive the required external relays. This output optoisolator switches a common positive and are suitable for operating relays. In particular they are suitable to drive 12 volt BRB 930 series relays directly.

The Level Crossing monitor outputs are as follows:

1. Battery Test

Used to control battery test relay.

2. No Fault

This output is ON when no fault condition has been detected with either the level crossing monitor or the level crossing equipment. The fault indication remains until reset. This output may be used in the future to control an external flashing beacon which indicates healthy/faulty level crossing operation to the train driver or public road users.

3. No Warning

This output is ON when no warning condition has been detected with the level crossing equipment. The warning indication remains until reset.

4. System

This output operates in conjunction with the No Fault output. This output is ON when a fault has been detected internally with the level crossing monitor unit. The output remains on until the fault condition is fixed.

5. Battery

This output operates in conjunction with the No Fault and No Warning outputs. This output is ON when a fault or warning condition has been detected with the level crossing battery. The output remains on until the fault or warning condition has been reset.

6. Lamp

This output operates in conjunction with the No Fault and No Warning outputs. This output is ON when a fault or warning condition has been detected with the level crossing lamps. This output remains on until the correct number of working lamps is detected. It cannot be turned off until the correct number of lamps have been detected running for at least 10 seconds.

7. Logic

This output operates in conjunction with the No Fault and No Warning outputs. This output is ON when a fault or warning condition has been detected with the operation of the level crossing equipment. The output remains on until the fault or warning condition has been reset. If this output is flashing it indicates the maintenance disable state.

8. Timer test

Used to control both the non-vital battery test timer and the battery test relay.

2.7   Analogue Inputs

The level crossing monitor has 8 analogue inputs.

Analogue input number 1 is used to monitor the Level Crossing battery voltage. No connection is required from the level crossing battery to analogue input 1 as the battery voltage is measured through the power supply input wires used to power the monitor. This input is electrically conditioned for a 0 to 20 volts DC input voltage. The Battery voltage is be considered to have changed when the voltage is more than 0.95 volt different than the last logged value.

Analogue inputs 2 to 5 are electrically conditioned for a 0 to 5 volts DC input voltage. These are normally used to monitor the Level Crossing lamp currents in the range of 0 to 20 amps DC via the Current Sensor units. The Current Sensor that has a linear output voltage of 0 to 5 volts in response to a lamp current of 0 to 20 amps.

For a standard level crossing two sets of lamps are connected to each flasher unit (PTF3B or Safeflash). An electronic flasher (PTF3B or Safeflash) flashes between the two sets of lamps at about 43 times per minute. The Current Sensors are connected to the common leg of the two sets of lamps. The two sets of lamps are identified as Flasher Up and Flasher Down. While the lamps are flashing the Current Sensor is measuring the current both sets of lamps. To allow the level crossing monitor to know which set of lamps relates to the current being measured a digital input (via a VIO) is used to monitor the state of the flasher (Flasher Up or Flasher Down or in the case of Safeflash - Bank 1 or Bank 2). This digital input tells the level crossing monitor which set of lamps is currently lit and the monitor than knows the current reading for each set of lamps.

A change is considered to have occurred on a lamp analogue channel when a different number of lamps are determined to be operating.

Analogue inputs 6 to 7 are electrically conditioned for a 0 to 5 volts DC input voltage. They are normally spare and may be used with other sensors to monitor additional flashing lamps OR log voltage, current or temperature. A possible use for the spare inputs is to use a Vital Analogue Interface module to directly monitor DC track relay voltages. Another useful application is the monitoring of the location hut temperature and even monitoring of the rail temperature.

Analogue input 8 is electrically conditioned for a 0 to 5 volts DC input voltage. It is normally used to monitor the Level Crossing battery test current in the range of 0 to 20 amps DC. To monitor the battery test current it uses a Current Sensor (same unit as used for the lamps) that has a linear output voltage of 0 to 5 volts in response to a lamp current of 0 to 20 amps. A change is considered to have occurred when the current is more than 1.6 ampere different than the last logged value.

2.8   Battery Testing

The level crossing monitor has a facility for testing the capacity and terminal voltage of the level crossing battery and reporting the results to a remote location or Control Centre via a theCybertec modem.

The level crossing monitor uses outputs 1 and 8 (that is Battery Test, and Timer Test) to control the battery test circuitry. These outputs control the 120 V AC supply to the level crossing battery charger, and a test load for the level crossing battery.

The process of testing the level crossing battery after a request is received from a Control Centre or maintainer takes approximately 8 minutes to complete.

The details of the test are as follows.

- Perform a thorough check of the operation of the Level Crossing monitor which includes processor test, event log integrity check, EPROM checksum, RAM test. If all checks do not pass then the battery test does not commence and a system fault is indicated and reported.

- Check battery voltage to determine if it is within limits. If it is too low, then abort the battery test, indicate a battery Fault and report it.

- Check that the battery test current is less than 1.0 ampere and the Battery test cut-off indication is ON. (this is to check the operation of the current sensor and the battery test cut-off relay.

- Report that the test has commenced.

- Turn on output 8 (that is Timer test). Check that the Battery test cut-off indication turns OFF between 4 minutes 30 seconds and 5 minutes 30 seconds later. If it does not, then abort the battery test, indicate a Fault and report it. (This tests that the timer relay is working correctly and that it is set for the correct time.)

- Turn OFF timer test output.

- Check that the battery test current is less than 0.5 amps and the Battery test cut-off indication is ON.

- Turn ON both timer test output and Battery test output at the same time.

- Monitor that the Battery test current is greater than 6 amps and battery voltage remains greater than alarm voltage for 3 minutes. If battery voltage drops below the alarm voltage, stop test and indicate a battery fault; otherwise terminate the test at the end of 4 minutes and indicate and report the current state of the level crossing.

Note: The battery test is stopped automatically if the crossing starts operating (train is approaching). The battery test is automatically recommenced 30 seconds after the crossing stops operating.

2.9   Configuration

There are two types of configurable items. One set may be changed during normal operation. The other set cannot. Both are stored in non-volatile memory.

Configurable items that cannot be changed during normal operation are:

- Name and date of the permanent configuration data.

- For each digital input, its name.

- For each digital output, and intermediate state, their name and controlling Boolean expression.

- For each Timer its name, controlling Boolean expression, and duration in hours, minutes, and seconds.

- For the battery analogue input, its name, fail voltage, and bus voltage correction.

- For each lamp analogue input, its name, analogue channel number, number of lamps expected on flasher up, number of lamps expected on flasher down, flasher input.

- For the battery test current analogue input, its name, and analogue channel number, on current in amperes, off current in amperes.

Configurable items that can be changed during normal operation are:

- Name of crossing

- Phone numbers to report too

- Serial port set-up

- Reporting state. That is report changes, dial-up on status change, or do not report changes or dial-up on status change.

- Current date and time

- Battery bus offset from measured value

- Lamp offsets for each particular lamp set. This may be required to allow for variations in level crossing installations. This information can be manually entered but is normally set during the lamp learn function (described later).

3 Operation and Functional Checks

3.1 General

The front panel layout of the level crossing monitor is detailed in drawing M08-865A. The No Fault, No Warning, +5V, +12V, -12V, and Led 2 are green in colour. All other LEDs are red.

In the normal state all the green LEDs should be on. That is the +5, +12, -12 power supply indications, the No Fault, No Warning, should all have their green LEDs lit.

Led 2 (green) on the SCADA 2000 A I/O board should be lit continuously.

Led 4 (red) on the SCADA 2000A I/O board should be flashing once every 0.25 seconds, Led 3 (red) may be on or off, and Led 14 (red) should be on. All other LEDs should be off.

The SCADA 2000 A I/O Boards front panel LEDs have the following meaning:

- LED 1: Normally off, flashing or permanently ON means a Board Error on start-up or too many resets in the last 5 minutes.

- LED 2: Normally on, means board successfully passed start-up tests

- LED 3: On when a command is being processed either locally or remotely.

- LED 4: Normally flashing, means that logging and monitoring is occurring.

- LED 5: Should be off, flashes for when a character is received on a serial port

- LED 6: Should be off, flashes for each Carrier Detect change on a serial port

- LED 7-13: Should be Off, Means that Bits 1 to 56 are configured as inputs.

- LED 14: Should be On, Means that Bits 57 to 64 are configured as outputs.

The Level Crossing monitor is comprised of the following components.

  – Main Box
  – Current sensors
  – Vital Indication Optoisolators (VIO)
  – Input Optoisolator
  – Output Optoisolator
  – Cables
  – Interface relays
  – Battery test load resistor
  – 3G Cybertec Modem

Telephone line surge protection unit (where a landline is utilised)

  – Telephone line

The level crossing monitor - Hardware Block Diagram shows how all components of the Level Crossing monitor are connected together. (Appendix D)

Signal Engineering, Standard circuits sheets X14 to X26 & X49, X 50 details the normal method of connecting the level crossing monitor to the level crossing signalling equipment. X50 Part 2/2 shows the normal method for connecting the level crossing monitor with the Westinghouse SAFEFLASH unit. (See Appendix C).

3.2   Main Box

3.2.1   General

Check that the correct EPROM is inserted. EPROMs are labelled with LXMON R3.7 (or later), and a date. The software in the EPROM should be version R3.7 or later. The EPROM is fitted in U5.

Note: The EPROMs have to be inserted in the correct orientation. The notch on the EPROM socket should match the notch on the EPROM. If power is applied to a board with the EPROM incorrectly inserted, it may damage the EPROM or the I/O Board.

The following drawings detail the main box:

- M08-865A   Front Panel layout
- M08-865B   Rear Panel layout
- M08-866   Surge circuit drawing
- M08-864A   Wiring
- M08-864B   Wiring.
- M08-851/1   ADC circuit,
- M08-851/2   ADC physical.
- M08-862   Flasher interface Cables
- CSSC SRA1016   Level Crossing Monitor unit assembly. Sheet 4
- CSSC SRA1016   Level Crossing Monitor unit assembly. Sheet 5
- CSSC SRA1022   V/Suppress PCB for SRA1016.

3.2.2   SCADA 2000 A I/O Board

S-2000 A/2.0 I/O Board is a general purpose micro controller board with 64 digital inputs and/or outputs. These 64 I/O can be configured as either Inputs or Output in groups of 8. These are configured as 56 Inputs and 8 Outputs for the level crossing monitor.

The I/O Board also has two serial communications ports at the front, and a Bitbus communications port which is connected to the Backplane.

Dimensions of the I/O Board are 261 mm (length of face plate) x 220 mm (d) x 20 mm (width of face plate). These are the standard dimensions for a 6U high x 220 mm deep extended Eurocard.

The major features of the I/O Board are:

- The 8044 BitBus Enhanced Micro controller (BEM) which is the heart of the I/O Board, controlling all its functions.

- EPROM socket (U5) which allows a 64 KByte (27512) EPROM containing the software to be installed.

- RAM sockets (U6 & U7) which each contain a 32 Kbyte SRAM chip.

- Two D9 Male serial ports (Channel A & Channel B) which are controlled by the 82530 serial communications chip.

- 14 x Indication LEDs on the front of the board (LEDs 1 - 2 are for the micro controller status, LEDs 3 - 6 are general purpose LEDs, and LEDs 7 - 14 show the I/O Port Configuration).

- Two 64 way IEC Male connectors mounted on the rear of the board. These connectors contain the power supply pins, BitBus pins, I/O pins and Address pins. The top connector is known as 'IOJ1' (it has I/O Bit Nos. 1 to 32) and the bottom connector is known as 'IOJ2' (it has I/O Bit Nos. from 33 to 64).

Drawing M08-723 shows the physical dimensions and component layout of the I/O Board. Drawing M08-724 shows a block diagram of the I/O Board.

3.2.2.1 Function

The I/O Board is responsible for controlling the functions of the Level Crossing Monitor and storing the logged information.

3.2.2.2 Operation

The microprocessor on the I/O Board executes a software program which resides in the EPROM plugged into the I/O board. The program determines the functionality and configuration of the Level Crossing Monitor.

If the program is not executed correctly then a Watch Dog IC will reset the board. The Watch Dog IC also monitors the 5 volt power supply and will reset the microprocessor and hold it reset while the 5 volts bus is not greater than 4.7 volts. There have been some cases where a slightly high resistance connection between the power supply and the I/O board supply pins has resulted in the Watch Dog resetting the microprocessor and stopping the monitor from operating.

For complete details on the operation of the SCADA 2000 board refer to the source code of the level crossing monitor and the SCADA 2000 A/2.0 Technical manual.

3.2.2.3 Software Description

The level crossing monitor software consists of 3 separate tasks. A task is essentially an independent piece of software that fulfils an element of functionality.

Task 1 is the command task which:

- Initialises the hardware and software.
- Responds to commands received by either serial port.
- Reports status changes assuming a Hayes Compatible modem is connected to serial port A.

Task 2 is the scan task which:

- Flash Led 4 each time it runs.
- Reads and check the real time clock.
- Toggles watch dog.
- Scans digital inputs and logs changes.
- Scans analogue inputs and logs changes.
- Scans timers, updates timer status, and logs changes.
- Evaluates logic expressions.
- Scans intermediate states and logs changes.
- Scans output states, sets outputs accordingly, and logs changes.
- Update status, and flag status changes.
- Checks serial port A modem is not off-hook and idle for too long.

- Scans and logs serial port connection changes.

Task 3 is the serial communications task which:

- Receives characters from either serial port.

- Assembles the received characters into messages.

- Acknowledges messages which comply which the protocol.

- Passes valid messages to Task 1.

- Transmits messages passed from Task 1.

Command Task Description

Execution of this task is commenced by a hardware reset. It proceeds in the following manner:

Initialise and clean variables

If there has been more than 3 resets in the last 12 seconds then stop and blink led 1 continuously.

If the EPROM checksum is not correct then stop and blink led 1 continuously.

Create task 2.

If task 2 did not start properly then turn on led 1.

Create task 3.

If task 3 did not start properly then turn on led 1.

Record the start time.

Initialise the serial ports.

Send modem configuration string to port A.

Continuously repeat the following:

Turn led 3 off.

If a valid command has been received on serial port A then turn on led 3, process the command and respond.

If a valid command has been received on serial port B then turn on led 3, process the command and respond.

Report changes to serial port A if requested.

If required hang-up the modem on port A.

Report changes to serial port B if requested.

Send lamp diagnostic information to serial port if requested.

Report any outstanding status changes.

Check remote test outputs and indicate problems.

Scan Task Description

Execution of this task is commenced by task 1. It then proceeds in the following manner:

Initialise variables.

Configure level crossing monitor.

Log stop date from non-volatile memory.

Log start date from Real Time Clock.

Continuously repeat the following at 0.25 second intervals:

Turn led 4 on.

Check Real Time Clock.

Kick over watch dog.

Scan inputs, update state, and log changes.

Scan timers, update state, log changes, and every fourth time update run time.

As necessary and every fourth time:

Evaluate expressions.

Scan outputs, log changes, and write outputs.

Scan analogue inputs, update status, and log changes.

Every fourth time.

If not maintenance disabled and there has been a status change then store the time of the change and set the status to report flag for task 1.

If there is a communications link on serial port A and there has not been a valid message sent or received for the last 10 minutes then force the modem to be hung-up.

Log changes in serial port connections.

Turn led 4 off.

Serial Communications Task Description

Execution of this task is commenced by task 1. It then proceeds in the following manner:

Initialise variables.

Continuously repeat the following:

1. If a serial port interrupt has occurred then

2. Acknowledge the interrupt to the Serial Controller Chip.

3. Read the Serial Controller Chip interrupt status register.

4. Repeat the following until there are no more interrupts to be processed.

5. If serial ports A receive interrupt occurred then turn led 5 on, check for and processes any reception errors, and process the received character.

6. If serial port A transmits interrupt then if there are characters to transmit, send the next one, otherwise clear the interrupt.

7. If serial port A external status interrupt then turn on led 6 and check the state of carrier detect. If it is on, set the port A communications link flag, and enable RTS, CTS flow control. If it is off, clear the port A communications link flag, store the connection lost time, and disable RTS, CTS flow control. Reset the external status interrupt.

8. If serial ports B receive interrupt occurred then turns led 5 on, check for and process any reception errors, and process the received character.

9. If serial ports B transmit interrupt then if there are characters to transmit, send the next one, otherwise clear the interrupt.

10. If serial port B external status interrupt then turn on led 6 and check the state of carrier detect. If it is on, set the port B communications link flag, and enable RTS, CTS flow control. If it is off, clear the port B communications link flag, store the connection lost time, and disable RTS, CTS flow control. Reset the external status interrupt.

Else if there has been no serial port interrupt for 1 second, then check the transmission/reception state for each serial port and if they are not idle take the necessary corrective action.

3.2.2.4 Configuration & Set-Up

A specific EPROM is prepared and labelled for the particular level crossing. The EPROM is inserted in U5. The EPROM must be type 27512 running at 200nS or better.

A DALLAS DS1235YWL 200nS or better is inserted in U6.

A DALLAS DS1244Y 200nS or better is inserted in U7.

The links for the board must as follows (all others shall be open circuit, that is removed):

1-2	3-4	5-6	7-8	10-11	12-13	17-18
19-20	25-26	27-28	29-30	31-32	33-34	37-38
39-40	43-44	47-48	49-50	51-52	53-54	55-56
59-60	85-86	87-88	89-90	95-96	105-106	107-108

Drawing M08-781 SCADA-2000 A/2.0 I/O Board jumper allocations (marked up for LX monitor) shows the location and setting of the links.

3.2.2.5 Troubleshooting

Check the LED indications on the I/O Board for correct operation (see section above).

Check 5 volt supply is greater than 4.75 volts and less than 5.25 volts. It is easiest to check this on the input or output Optoisolator board test pins.

If the Board Error LED (LED1) is 'ON' or flashing than the monitor has been reset too many times in the last five minutes (indicating a possible fault). Press the reset pushbutton once to see if the I/O Board comes good. If the error LED1 remains 'ON' then replace the board with a spare.

Suspect boards may be swapped with another board (preferably a spare). Make sure it is correctly configured before installation. Normally the EPROM from the faulty board is moved to the replacement board as it is unusual for these to fail. Note that the configuration information for the monitor is contained in the DALLAS 1235 SRAM and 1244Y SRAM and clock chips. If a new I/O board is installed without swapping over the old DALLAS chips than the configuration file will have to be uploaded and a lamp learn will be have to be completed.

Make sure the I/O Board is fully seated in its connectors.

Make sure the current version EPROM (R3.7 or later) is installed.

Make sure all the jumpers are installed in their correct positions and that the correct ICs are installed.

3.2.2.6 Replacement Procedure

The monitor should be turned off.

The ADC board mounted on top of the I/O board must be removed first by undoing the retaining screw and lifting the board off the connector.

Remove any connectors plugged into the front of the I/O Board and eject the board from its slot position by using the front panel card ejectors (push outwards). Make sure front panel retaining screws are first unscrewed. In some cases the bottom of the board may foul against the bottom of the front panel cut-out. It may be necessary to slightly flex the card to allow it to clear the slot as the card is removed.

Insert an I/O Board into the slot, ensuring that it is pushed all the way in to get a good connection with all pins in the rear connectors. Replace any connectors that were plugged into the front of the I/O Board.

The I/O Board may be difficult to slide in because of the anti-vibration card guides. If this is the case, wiggle the board as you push it in. Once pushed in reset the board.

Replace the ADC board and the retaining screw and ensure the ribbon cable is properly connected to the board.

3.2.3 Power Supply Units (PSU)

The power supply is a DC to DC switch mode power supply which operates from 10 to 30 volts. It has triple outputs. Output Voltage one is +5 VDC @ 6.0 A maximum. Output voltage two is

+12 VDC @ 3 A maximum. Output voltage 3 is -12 VDC @ 0.5 A maximum. Maximum total output power is 65 Watts.

Other features of the PSU are:

- Overcurrent protection

- Overvoltage protection on the 5 volt output.

3.2.3.1 Function

The Power Supply Units function is to a supply a regulated and stable DC voltage (+5, +12, -12 VDC) for the I/O Boards, a 5 VDC supply for the Optoisolators, +12 VDC for the current sensor, and a +12 VDC supply for the non-vital timer.

3.2.3.2 Operation

The PSU is based on a high frequency DC-DC switch mode operation. The DC input supply from the Level Crossing Battery is first converted to a high frequency AC voltage and then converted to a DC rectified voltage. The DC voltage is then 'chopped' to form a pulsed DC voltage. The pulsed DC is then transformed to different voltages and the output rectified and regulated to provide the correct DC output voltages.

Switch mode DC-DC converters are small, light and consume less power than conventional linear supplies. They provide very accurate and stable outputs and are thus favoured for electronic applications.

3.2.3.3 Configuration and Set-Up

There is no configuration and set-up for the power supply.

3.2.3.4 Troubleshooting

This section is aimed at identifying a failed power supply unit.

- Check the status of the three indicating LEDs and the power switch lamp. This should indicate if the problem is with the input supply voltage or the output voltage.

- If the power switch lamp is 'off', measure the input voltage. It should be between 12 and 18 volts.

Also check the supply fuses.

- If there are no LEDs alight on the I/O Boards or Opto Boards, the +5V has most likely failed. If the maintenance terminal fails to respond when plugged into the diagnostic port, the +12V and -12V may have failed.

- If any of the indicating LEDs are 'off', the PSU has most-likely failed and thus the main box requires replacement. However, to confirm that the PSU has failed, remove the top cover and measure the output voltages. They should be (+5, +12, -12 VDC). The pin-outs for the PSU are either on the top or the sides of the PSU.

- To test remove the power supply connector from the rear of the backplane and test the power supply using a voltmeter between 0V and +5V, +12V and -12V. If the +5V rail is less than 4.7V the system will not work.

- The +5V may be tested in circuit using the test points on the Input or Output Optoisolator Boards.

3.2.3.5 Replacement Procedure

For the main box, if the PSU has failed, remove and replace the whole main box. The PSU can be replaced in the workshop.

The power supply is a PD65-31LC from PowerBox for a V1.0/V2.0 monitor or a NFC25-12T05-12 from Computer Products - Power Conversion for a V3.0 monitor.

3.2.4   Analogue to Digital Converter (ADC)

3.2.4.1 Function

The analogue to digital converter provides 8 analogue inputs the level crossing monitor can monitor and log. They are used to measure the Battery voltage, Lamp currents and Battery Test currents. It is mounted on a connector on top of the I/O board.

3.2.4.2 Operation

This board is connected to the rear panel 8-way connector via a ribbon cable.

Pin 1 of the 8-way connector is internally wired to the incoming +'ve supply. This connects the Level crossing battery to analogue channel number 1 on the ADC. Analogue inputs 2-8 are available on the rear panel for connection to the lamp and battery current sensors.

Due to the voltage drop of approximately 0.16V DC between the level crossing battery bus and analogue input number 1 of the ADC board the measured voltage will be 0.16V DC less than the bus voltage. To compensate for this the level crossing monitor software through the expression file automatically adds 0.16V DC to the displayed voltage so that the bus voltage and the voltage detected by the monitor are within 0.1V DC of each other.

The ADC is a 8 bit Analogue to Digital converter. The board has an onboard voltage reference to provide greater accuracy. The ADC converts the incoming voltage to a 8-bit digital signal which is then used by the SCADA I/O microprocessor to detect the battery voltage and the number of operating lamps.

3.2.4.3 Configuration and Set-up

There is no configuration or set-up required for the ADC.

3.2.4.4 Troubleshooting

The Version 1.0 ADC board will fail if reverse polarity is applied to the level crossing monitor input terminals. The failure will be indicated by the level crossing monitor giving a system fault and battery low indication. The application of reverse polarity will cause one of the PC tracks to burn open circuit. If a jumper wire is soldered in place of the burnt out track it is most likely that the board will be useable. This problem was rectified for the ADC boards V2.0 or later which are supplied with the Version 3.0 level crossing monitors.

By looking at the analogue inputs it is possible to see if the ADC board is supplying valid readings. If the all of the inputs read zero then maybe the ribbon cable is not connected or the board has failed. The board is susceptible to lightning damage and should be checked carefully if the level crossing monitor has failed after a lightning strike or surge. If the inputs read full voltage with no current sensors connected then the ADC board is faulty and should be replaced.

Failure of the ADC board is indicated by the battery voltage to analogue input 1 reading zero. This will result in a system fault being displayed. Individual failures of the other inputs 2-8 is rare but each input can be checked by monitoring the analogue inputs (by viewing I/O inputs) and connecting 5 volts to each input and confirming that the A/D reading is close to 255.

The ADC board will also fail if the internal +12V rail fails or goes low voltage. The ADC board uses this +12VDC rail to generate a voltage reference. If the +12V rail fails than the ADC will read zero on all of its inputs. (Note: it is possible for a failed current sensor or faulty wiring to the sensor supply terminals 1-11 to fail the internal +12V rail and therefore fail the ADC board.

3.2.4.5 Replacement Procedure

Open lid of the Level Crossing Monitor. Turn off the power. Unplug the cable. Remove the screw and unplug the ADC module from the SCADA 2000 A I/O board.

Plug in the new module. Re-install the screw and plug in the cable ensuring that the cable captive clips are engaged.

3.2.5 Backplane

3.2.5.1 Function

The backplane provides the interconnections for the power, digital, and other wiring.

3.2.5.2 Operation

The backplane is a passive device which provides various connectors and interconnections between them via Printed Circuit Board (PCB) tracks. The backplane does have a 5.1V DC Transorb and a diode which is designed to suppress voltage spikes from the +5V DC supply and protect against reverse polarity.

3.2.5.3 Configuration and Set-up

The configuration links on the backplane are not used by the level crossing monitor. They should however be set to the following:

375kbps link set (link between the two bottom pins)

The node address connections should be left as set by the factory.

3.2.5.4 Troubleshooting

If the backplane is suspected then it is best to test it by continuity testing the relevant circuits on the backplane. If this is okay test for shorts to test circuits. Close inspection can only be done by removing the backplane PCB as there are printed circuit board tracks on both sides of the PCB.

It has been discovered that the 5.1V Transorb designed to protect the 5V supply is susceptible to failing short circuit after a power surge or lightning strike hits the level crossing location. If this transorb has failed short circuit than the level crossing monitor will draw excessive current blowing the 4A supply fuse. As a temporary measure you can disconnect the failed transorb with a pair of side cutters. The level crossing monitor may then function correctly, although other components on the surge protection and power supply board may have failed open circuit or PCB tracks may be damaged.

3.2.5.5 Replacement Procedure

Remove the I/O board, ADC board and the DC/DC converter power supply to allow access to the backplane PCB. Removal is done by removing all of the mounting screws disconnecting the 10-way ribbon cable, disconnecting the 4 power supply wires and lifting the board out.

On replacement of the backplane PCB ensure that the power supply wires are connected to their proper terminals. Incorrect wire placement will cause extensive damage to most components. See Specification 1072 if you are unsure of the proper connections for the power supply to backplane connections.

3.3 Current Sensor

3.3.1 Description

The current sensor is a Klippon rail mounted device. The module has an identification label of "LXMON/2.0 CSN". Refer to drawing M08-854 for details of its physical aspects.

Refer to drawing M08-855 in Appendix D for circuit drawing.

3.3.2   Function

The current sensor uses a Hall Effect device to monitor the current in the wire that is threaded through its aperture. It does not affect the circuit in which the current is being measured. The Hall Effect device measures the magnetic field created by current flowing in the wire. Tong and clamp meters also use Hall Effect devices for measuring DC currents.

3.3.3   Operation

Power is connected to the current on terminals 1 and 2. Terminal 1 is 0 volts and terminal 2 is +12 VDC.

The output is a voltage between terminals 1 and 4. Terminal 4 being positive in respect to terminal 1. The output voltage is linear in respect to the current in the circuit being measured.

Output Voltage = Current (A) / 4.

UGL FL03 Level Crossing LED road traffic lamp units can draw between 0.6 and 1.5 amps each. Therefore the output voltage of the current sensor for a 2 lamp a side level crossing (crossing without gates) while lamps are flashing is between 1.2 and 3.0 amps / 4 which is between 0.3 and 0.75 volts. In some cases the Hall Effect senor will require multiple turns of the conductor being monitored to achieve a reliable level of operation.

The current sensor can measure currents in the range of 0.28 amps to 20 amps. Note that because of characteristics of the Hall Effect device the current sensor typically has an output voltage of about 70 millivolts when there is no current following in the circuit being measured.

3.3.4   Configuration and Set-up

Normally the link on the current sensor PCB is in the DC position (LK1 on some units). It may be necessary to move the link to the AC position (LK2 on some units) if there are 12 Volt DC Signal lamps fed from the location. When the Signal changes aspect there may be considerable induction into other circuits which the current sensor is sensitive enough to pick up. The monitor will then alarm because it detected lamp current when the crossing lamps should have no current. The current sensors are susceptible to electrical noise including radio frequency interference which causes the sensors to indicate a false higher current reading. If interference does occur than it will be required to move the link to the AC position. The sensor wiring may have to be moved and it may be necessary to move the whole sensor to another position to reduce the interference.

The current sensors are calibrated by the manufacturer but occasionally there is one that has been set wrong or missed. This will mean that field checks and possible re-calibration may be required.

Each current sensor should have between 50mV and 80mV DC between terminals 1 (C) and 4 (OUT). If the voltage is outside these levels than field calibration is required.

Field calibration is by the following process:

- If the output is less than 500mVolts. Turn the multi-turn trimpot until the output voltage is at least 500mVolts.

- Turn the trim-pot until the output voltage just reaches a minimum value.

- Now turn the trimpot the other direction until the output voltage is between 5 to 10 mV higher than the minimum.

Note: Although most current sensor trimpots require anti-clockwise turning to lower the output voltage some require the trimpot to turn clockwise to lower the output voltage.

The resultant output voltage is typically between 50 and 80 mV when no current is flowing through the circuit being measured.

Workshop calibration is done by passing 5.0 amps through the current sensor and adjusting the trim-pot until the output voltage is 1.25 volts.

When installing the current sensor ensure that the sense wire is passed through the sensor in the correct direction. The current sensor has a arrow on it clearly indicating the direction of positive current flow for the sense wire.

3.3.5   Troubleshooting

It the current sensor is suspected. Then first check the 12 volt supply to it. If this is okay. Check that when no current is following in the circuit being measured that the output voltage is about 70 millivolts. If it is significantly more the unit has either failed or needs to be re-calibrated. Refer to the previous section for details on calibration. If adjustment of the trimpot from minimum to maximum does not result in the output voltage (terminals 1 and 4) varying than the current sensor is faulty and should be replaced.

If the unit is correctly calibrated, then check the output voltage when the circuit being measured is drawing current. If the output voltage is as expected, then check the connections to the level crossing monitor or the Analogue to Digital Converter within the level crossing monitor.

If it is significantly different to expected then the check that the circuit being measured does not have any problems. If it does not then replace the current sensor.

If lamps are sometimes detected when the crossing is not operating then change the link on the current sensors from the DC position to the AC position. This link change will reduce the Current Sensor's sensitivity to induction from adjacent circuits. See section 3.3.4 above for details on interference with the current sensor.

Note that if it is a new installation you must ensure that the wire is threaded through the measurement aperture in the correct direction otherwise the sensor will not operate. It is sensitive to the direction of current flow. Refer to drawing M08-854.

3.3.6   Replacement

Disconnect the wiring from terminals 1 to 4. Make sure these are identified and will not be shorted out.

Unclip the current sensor from the Klippon rail. Confirm that there will be no trains approaching and that it is safe to disconnect the wire through the current sensor if it is on a lamp circuit. Disconnect the wire threaded through the current sensor measurement aperture.

Thread the wire through the measurement aperture for the new current sensor. Ensure that the wire is securely attached and that the lamp resistor has not been damaged or interfered with.

Make sure the link on the replacement unit is set the same as the original current sensor.

NOTE: Ensure that the wire is threaded through the measurement aperture in the same direction otherwise the sensor will not operate. It is sensitive to the direction of the current.

3.4   VIO

3.4.1   Description

The VIO is a Vital Indication Optoisolator. It is a Klippon rail mounted device. The module has an identification label of "S-2000 J 1.1 xxV VITAL INDICATION OPTOISOLATOR". Refer to drawing 1033-4 for details of its physical aspects. xxV is either 12V for monitoring 12 volt circuits or 50V for monitoring 50 volt circuits. Refer to drawing 1033-3 Circuit details.

<div style="border:2px solid red;">

CAUTION

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A 12V VIO must never be used on 50 volt Vital Signalling Circuits.

Although a 12V VIO will work on a 50V DC circuit a failure of the 12V unit could result in excessive current being drawn from the 50V circuit it is connected to.

All VIOs are clearly labelled with their working voltages on the main label of the unit and on the left edge of the unit when viewed from the side.

3.4.2 Function

The VIO is used to monitor the state of an intermediate point in a Vital Signalling circuit when it is not practical to do so by other means.

The VIO provides an isolation of greater than 10 KV between the indication circuit and the Vital Signalling circuit. It is also designed so that the current drawn is less than half that required to hold a BRB 930 series Safety Relay energised.

3.4.3 Operation

Terminals 1 and 2 monitor the Vital Signalling circuit. Terminal 1 is connected to the more positive voltage than terminal 2.

Terminals 3 and 4 provide the indication of the state of the Vital Signalling circuit. Terminal 3 is connected to the more positive voltage than terminal 4.

For a 50 volt VIO terminals 3 and 4 conduct when the voltage across terminals 1 and 2 is greater than 25 volts. Terminals 3 and 4 are high resistance when the voltage across terminals 1 and 2 is less than 20 volts.

For a 12 volt VIO terminals 3 and 4 conduct when the voltage across terminals 1 and 2 is greater than 8 volts. Terminals 3 and 4 are high resistance when the voltage across terminals 1 and 2 is less than 6 volts.

3.4.4 Configuration and Set-up

There is no configuration or set-up except the appropriate volt unit is installed to the voltage signalling circuit being monitored.

<div style="border: 2px solid red; text-align: center; color: red; font-weight: bold;">CAUTION</div>

A 12V VIO must never be used on 50 volt Vital Signalling Circuits.

3.4.5 Troubleshooting

When the voltage across terminals 1 and 2 is less than 2 volts then the voltage across terminals 3 and 4 should be equal to the voltage being switched on the indication circuit. The indication circuit should be in the off state.

When the voltage across terminals 1 and 2 is close to the rated operating voltage (12V or 50V) the voltage across terminals 3 and 4 should be about 1.3 volts. The indication circuit should be in the ON state.

In the case of the Flasher VIOs the circuit for terminals 3 and 4 is a 5 volt circuit (supplied by the special flasher cable from Input 4 of the level crossing monitor). When the level crossing lamps are off the voltage across 3, and 4 should be 5 volts. When the lights are flashing the voltage across 3 and 4 should vary between 1 volt and 5 volts in sequence with the flashing lamps.

If either of these cases is not correct then replace the unit.

Note: Terminals 1 and 3 should always be more positive than terminals 2 and 4.

3.4.6   Replacement

Disconnect the wiring from terminals 1 to 4. The wires connected to terminals 1 & 2 are connected to vital signalling circuits and the appropriate procedures must be followed for modifications to vital signalling circuits. Make sure these wires are identified and will not be shorted out. Unclip the VIO from the Klippon rail. Clip the replacement to the Klippon rail. Terminate the wiring back on to terminals 1 to 4.

CAUTION

Ensure that the replacement unit is same voltage as the unit being replaced. Ensure that a 12V VIO is not being used on 50 volt Vital Signalling Circuit.

3.5   Input Optoisolator

3.5.1   Description

S-2000 D12/2.0 IIO. Dimensions are 315 mm (l) x 76 mm (w). The PCB is held in a green plastic circuit board module with mounting feet which clip on to TS32 (Klippon) rail or TS35 (DIN) rail. Identifying features of the board are:

- 4 x 8 way (Green) connectors
- 2 x 2 way (Green) connectors
- Integrated circuits have a white coloured casing (4N35)
- Row of 32 indicating LEDs
- 2 x D25 female connectors (labelled 'O/P 1' and 'O/P 2')

Refer to Drawing M08-731 for physical aspects, drawing M08-732 for the schematic diagram of the input optoisolator, drawing M08-733 for circuit diagram of the input optoisolator.

Refer to drawing M08-782 for an example of the input optoisolator circuit in operation.

Refer to drawing M08-861 for details of the cable between the main box and the input optoisolator. Note that the resistor values have been changed for 12-15V DC volt operation.

3.5.2   Function

The 12 volt Input Opto Board allows connection for up to 32 signalling inputs. The inputs can be from 9 VDC to 20 VDC.

3.5.3   Operation

Inputs 1 to 16 from the signalling side (green 8-way connector side) are connected (via the optoisolator circuits) to output pins 1 to 16 on the D25 connector labelled 'O/P 1'. A cable plugs into this D25 connector to connect 16 inputs into the level crossing monitor on Input 1. Similarly, inputs 17 to 32 are connected to output pins 1 to 16 of the D25 connector, labelled 'O/P 2'. A cable plugs into this D25 connector to connect 16 inputs into the level crossing monitor on Input 2.

All 32 circuits are identical and have consecutive component numbering. Referring to Drawing M08-782, the circuit operation is as follows:

When a voltage of between 9 - 20 VDC is applied to input 1 on the 8-way connector, a current flows across pins 1 & 2 of the 4N35 optoisolator (U1) and illuminates the internal LED which turns on the internal phototransistor. This causes the LED (LD1) to illuminate and pin 1 of 'O/P1' to be high (+5 VDC).

Similarly, when the voltage at the input is less than 3 VDC, no current flows across pins 1 & 2 of the 4N35 optoisolator (U1), the internal LED is extinguished and hence the internal

phototransistor is turned off. This causes the LED (LD1) to turn off and the voltage at pin 1 of 'O/P1' will be low (0 VDC).

A +5 VDC voltage is fed to the Optoisolator Board from the level crossing monitor via the Cables. The Cable that is connected to 'O/P1' connector feeds +5 VDC to circuits 1 to 16 only. The Cable that is connected to 'O/P2' connector feeds +5 VDC to circuits 17 to 32. Test points next to each O/P connector are used to verify that +5 VDC is present for each group of 16 circuits.

Wires from the signalling circuits are terminated on the 8-way (green) connectors. A positive voltage is switched onto a terminal via a relay contact, push-button or switch. The terminal on the Input Optoisolator Board can be likened to the positive terminal of a non-vital relay coil. The return path for the signalling voltage is via the bottom 2-way (green) connector (labelled 'N24'). This is a common return for all 32 inputs.

The 2-way (green) connector at the top of the board (labelled 'B24') is a test point for fault finding. It does not perform any function in the optoisolator circuit operation. B12 is only wired to that point to give quick and handy access to a B12 test point to allow false feeding of inputs during troubleshooting. If B12 is readily available elsewhere in the location then this connection point does not need to be wired.

3.5.4   Troubleshooting

If there is no power supplied to the Input Optoisolator Board then all inputs are read by the level crossing monitor as being 'off' (i.e. open contact).

Two categories of failures are examined, multiple failures on one board and single input failures. The 'Multiple Failure' section identifies failure points that will most likely affect more than one circuit. The 'Single Input Failure' section provides a comprehensive fault finding procedure of one input circuit.

In the event that a multiple input failure is rectified by following the multiple input failure procedure, the technician should then refer to the single input failure section.

3.5.4.1 Multiple Input Failures on One Board

If the all of the inputs are permanently OFF then the fault is most likely to be a power supply or connector problem. Check that:

- The B12 fuse for the indications is intact and the LXMON B12 bus has the correct pins in place.

- The N12 connection to the Input Optoisolator board is intact.

- The cables from the level crossing monitor to the Input Optoisolator board are intact and securely connected.

- The 5 VDC to GND test points both have 5 volts.

Multiple permanently ON failures are not likely to be a fault with the Input Optoisolator board. Check the cables for damage, and loose or damaged connections. Check Level crossing monitor for correct operation and configuration.

If none of the above find the problem double check then replace the Input Optoisolator board. If the problem persists then the level crossing monitor is at fault and needs to be repaired or replaced.

3.5.4.2 Testing a Single Input

Each input may be corresponded into the level crossing monitor by connecting a PC (with software) to channel B of the monitor and ensuring that the reporting of changes mode is enabled. Now when any input changes state it will be immediately reported to the PC.

Function test the inputs by forcing them on and off. If an input remains OFF when it should be ON go to 1. If an input remains ON when it should be OFF go to 2.

1. The input remains OFF when it should be ON

If the LED lights:

The fault is not likely to be in the Input Optoisolator board. Check in the following order until the problem is rectified:

Signalling side to ensure B12 is being switched to the input.

Possible faulty cable connection. Check connection at Input Opto board and level crossing monitor case.

Possible damaged cable. Check cable.

Possible faulty input on level crossing monitor. Replace level crossing monitor.

If the LED remains extinguished:

The fault is in the Input Optoisolator Board. Check in the following order until the problem is rectified:

Possible Input Optoisolator circuit fault. Replace the Input Optoisolator Board or the individual IC. A replacement IC may be taken from an unused input.

Possible connection fault on the signalling side of the Optoisolator. Check the voltage across the large 1 watt resistor (large brown component between the 4N35 and green 8-way connector labelled R1 to R32). If the voltage is less than 8 VDC, then the problem is in the N24 connector. If voltage is present re-check Optoisolator Board.

2. The input remains ON when it should be OFF

Re-check by removing the corresponding 8-way connector.

If the LED remains illuminated. Check in the following order until problem is rectified.

Possible short on output of 4N35. Replace the Input Optoisolator Board or the individual IC. A replacement IC may be taken from an unused input.

Possible damaged Cable. Test or replace cable.

Possible fault in Level Crossing monitor. Replace the level crossing monitor.

If the LED is extinguished

Check the 8 way connector and external signalling circuit for a short.

3.5.5   Replacement Procedure

To remove a board:

*   Unplug the 2 and 8 way green connectors by pulling them directly outward from the board.

*   The Cables are removed by unscrewing the two thumb screw fasteners on each D25 connector, then pull the D25 plug directly outwards.

*   The Optoisolator board is removed by twisting the board off the Klippon rail. Twist by pulling the board on the 'thick' side of the Klippon rail whilst holding the board on the 'thin' side of the Klippon rail.

To install a board:

*   Looking at the mounting feet on the base of the Opto board, one side has a square hole running along the length of the board with a lip that extends to be in line with the side of the board. This side goes toward the 'thick' side of the Klippon rail. The other end has a clip

which extends diagonally out from the base of the board. The notch at the end of this clip is inserted into the edge of the rail at 'thin' end of the Klippon rail. Position this notch on the rail first then clip the board into place by pushing the board at the thick side onto the rail. Check that board is correctly in place by lightly tugging the board (Do not twist the board).

- Plug-in the D25F connectors. The D25M plug on the Cables is connected into its corresponding D25F connector ('O/P1' or 'O/P2'). Screw the thumbscrew fasteners in to place. Ensure that the screws are not so tight as to distort the plastic hood of the D25M plug (finger tight is sufficient).

- Plug-in the 2 and 8 way connectors into their respective sockets.

3.6   Output Optoisolator

3.6.1   Description

The 8 Way Output Optoisolator Board ('Output Opto') is used to control the battery test and operate no fault and no warning relays if required. They are called Optoisolator Boards since the main components on the board which electrically isolates one side from the other are Optoisolators. An optoisolator is a 'chip' that uses an internal LED which emits light to switch a phototransistor on.

The main functions of the output optoisolator boards are:

- To isolate the main box from any possible power surges encountered on the level crossing supply (1500V isolation).
- To convert the output voltage levels of the main box (0 VDC, +5 VDC) to DC voltage levels suitable for operating relays such as QBCA1 and HH23-PW or similar relay used for the timer test cutout.

The Output Opto Board allows connection for up to 8 signalling outputs. Each output is a voltage free contact that can drive nominally 120 mA (E.g. a Q-type relay).

Dimensions are 100 mm (l) x 76 mm (w). The PCB is held in a green plastic circuit board module with mounting feet which clip on to TS32 (Klippon) rail or TS35 (DIN) rail. Identifying features of the board are:

- 1 x 8 way (Green) connector and 1 x 2 way (Green) connector.
- Integrated circuits have a black coloured casing (National/Matsushita AQV214)
- Row of 8 indicating LEDs
- 1 x D15 Female connectors (labelled 'I/P 1')

Refer to drawing M08-871 Layout., M08-872 Circuit, M08-873 cable.

3.6.2   Function

The Output Opto Board allows connection for up to 8 signalling outputs to be driven by the Level Crossing Monitor. Each output is a voltage free contact that can drive nominally 120 mA DC (e.g. two Q-type relay or 5 LEDs). The Output Opto Board is protected against back EMF and is suitable for driving relays directly without any additional protection.

3.6.3   Operation

The level crossing monitor drives circuits 1 to 8 respectively through pins 1 to 8 of the D15F connector. All 8 circuits are identical and have consecutive component numbering.

When +5V is applied to pin 1 of the D15 connector, the indicator LED (LD1) is illuminated and current flows across pins 1 & 2 of the AQV214H optoisolator (U1) and illuminates the internal LED which turns on the internal phototransistor and enables the output. The output is a voltage free contact (i.e. it can be likened to a relay contact). When enabled the contact is closed and a

'short' exists across pins 5 & 6 of U1 (actually the resistance between the pins is about 10 Ohms).

When 0 VDC is applied to pin 1 of the D15 connector, the indicator LED (LD1) is extinguished and no current flows across pins 1 & 2 of the AQV214H optoisolator, the internal LED is turned off and the phototransistor is turned off, so that the output of U1 is disabled (i.e. an open circuit exists between the output pins).

Each output circuit can drive (nominally) up to 120 mA at voltages up to 120 VDC. This means an output can drive, for example, a non-vital relay, two Q-type relays, up to 5 LEDs, or a sonalert.

This particular Output Optoisolator Board cannot switch AC voltages.

The 5 VDC is fed to the board via the Cable. Test points next to the connector are used to verify that +5 VDC is present.

All of the '+' terminals of each individual output are bussed together and connected to the B12 terminals.

The 8-way green connector has each of the 8 switched outputs for connection to the control devices.

3.6.4   Configuration

There are no configurable items.

3.6.5   Troubleshooting

If there is no power supplied to the Output Optoisolator Board then all outputs are 'off'.

Two categories of failures are examined, multiple failures on board and single output failures. The 'Multiple failures' section identifies failure points that will most likely effect more than one circuit. The 'Single Output Failure' section provides a comprehensive fault finding procedure of one output circuit. In the event of a multiple output failure is rectified by following the multiple output failure procedure, the technician should then refer to the single output failure section.

3.6.6   Multiple Output Failures on One Board

If the Outputs are permanently OFF then:

Confirm that the monitor is operating correctly and that the NO FAULT and NO WARNING LEDs are lit on the monitor front panel.

The fault is most likely to be a power supply or connector problem. Check the LEDs on the suspect circuit board.

If the LEDs are extinguished check:

Cable connection

Check the +5V to GND test point next to the D15 connector using a multimeter

Replace Output Opto Board

Check cable for damage

Replace Level crossing monitor

If the LEDs are illuminated check

B12 power

Check that power is being switched to the output (at lamp, relay etc.)

Replace output opto board

If the Outputs are permanently ON then

Check the LED on the suspect circuit board.

If the LEDs are extinguished check:

Replace Output Opto board

If the LEDs on the suspect circuits are lit check:

I/O Cable connection

Replace Output Opto Board

Replace Main Box

Check cable for damage

3.6.6.1 Testing a Single Output

Determine the expected state of the output. Compare the expected state with the state of the LED in the Output Opto Board for the suspect circuit.

If the output is OFF when it should be ON and the LED is illuminated

The fault exists in the Output Opto Board or the signalling system. Check in the following order until the problem is rectified

Check that power is being switched to the output device (i.e. check for blown lamp or fuse etc.).

Check that the supply side of the contact has power if a positive switch wire (on '+' terminal)

Replace Output Opto Board.

The Output Opto board can be double checked by removing the orange 8 way connector. Place an Ohmmeter across the '+' and '-' terminals. If the reading is less than 15 Ohms, then the circuit is OK. If the reading is a open circuit then the circuit is faulty, therefore replace board (or you can try just replacing the AQV214H but ensure the orientation is correct).

Replace the individual Optoisolator IC or the complete Output Opto Board.

The Output Opto board can be double checked by removing the orange 8 way connector. Place an Ohmmeter across the '+' and '-' terminals. If the reading is less than 15 Ohms, then the circuit is OK. If the reading is a open circuit then the circuit is faulty, therefore replace board (or you can try just replacing the Opto Isolator chip AQV214H but ensure the orientation is correct).

If the output is OFF when it should be ON and the LED is extinguished

The fault is unlikely to be in the Output Opto Board. Check in the following order until the problem is rectified:

Double check inputs associated with this output. The output may be behaving correctly, but there may be a faulty input giving the system the wrong information.

Check I/O Cable connections.

Check I/O Cable for damage.

Replace the main box.

The output is ON when it should be OFF and the LED is lit

The fault is unlikely to be in the Output Opto Board. Check in the following order until the problem is rectified:

Double check inputs associated with this output. The output may be behaving correctly, but there may be a faulty input giving the system the wrong information.

Check I/O Cable connections.

Replace associated I/O board.

Check I/O Cable for damage.

The output is ON when it should be OFF and the LED is extinguished

Possible short in the output circuit. Unplug the associated 8-way connector. If the output turns 'off', then replace the Output Opto Board. If the output remains 'on', check 8-way connector and signalling circuit for external short.

3.6.7 Replacement Procedure

1. Removal

*   Unplug 8 and 2 way connectors by pulling outward from board.

- Remove 15 way I/O cable by unscrewing thumbscrews then pulling directly outward.
  - Remove Opto Board by twisting it off the Klippon rail. Pull on board at the thick side of the Klippon rail while holding board a the thin side of Klippon rail.

2. Installation

- Looking at the mounting feet on the base of the Opto board, one side has a square hole running along the base of the board with a lip that extends to be in line with the side of the board. This side goes toward the thick side of the Klippon rail. The other end has a clip which extends diagonally outward from the base of the board. The notch at the end of this clip is inserted into the edge of the rail at the thin end of the Klippon rail. Position this notch on the rail first then clip the board into place by pushing the board at the thick side of the rail. Check that the board is in place by lightly tugging on the board. Do not twist the board.

- If the Opto is upside down, the green base of the Opto can be pulled apart and the circuit board remove and inserted correctly.

- Plug in the D15 connector. Tighten the thumbscrew to finger tight ensuring the plastic hood does not distort.

- Plug the green 8 and 2 way connector into their respective sockets.

3.7   Cables

The cable pin connections for all of the cables are specified in Specification 1071, Level Crossing Monitor Hardware. Copies are also in Appendix C of this document.

The following are the Drawing numbers in Specification 1071 for the particular cables used:

- Level Crossing Monitor to Input Optoisolator (No 1)   M08-861
- Level Crossing Monitor to VIOs (flasher cable)   M08-862
- Level Crossing Monitor to 8 way Output Optoisolator   M08-873
- Level Crossing Monitor Serial channel A to the Modem   M08-863

If a cable is suspected of being faulty then you should check both end connectors and ensure that the cables are securely attached. The cable should also be checked for physical damage.

If still faulty then the cable should be checked for continuity and for shorts. If a fault is found then the cable should be replaced with a new one.

3.8   Modem

The modem must support the Hayes AT command set as its factory default. Besides the configuration commands for the particular modem it must in particular support the ATH, ATD, and ATZ commands which are used by the Level Crossing Monitor software in handling the modem.

The modems used must either operate from the Level Crossing Battery supply or be separately battery backed up so that the Level Crossing Monitor can report loss of the Council Supply. 240V mains supply modems should not be used with any level crossing monitor utilising remote battery testing from a Control Centre.

Dataplex DPX-213 operates from a 10-20V DC supply. This modem and the previously supplied DPX-223 are previously approved modems for use in this arrangement. More recently Cybertec 3G wireless modems have been installed across the CRN. These modems not only have a suitable serial port for the level crossing monitor to report to, but include RJ45 sockets for connection to the CRN operations signalling WAN.

3.9   Interface Relays and Timer

The following list contains the additional relays and timers required for the Level Crossing Monitor installation: Refer to Appendix D for the specification sheets of the relays and timers.

1. BATTERY TEST Relay: QBCA1 12V DC. This relay is a standard Q type relay.

2. TIMER TEST Relay: HH23PW-T 12V DC. This relay is a 11-pin relay with 3 changeover contacts. The 11-pin base mounts onto DIN rail.
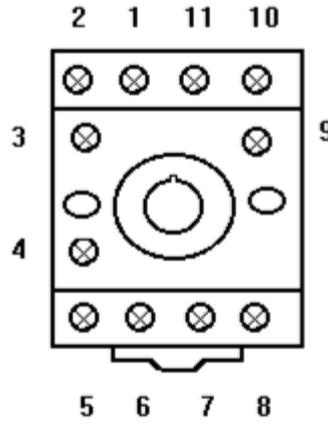
Omron PF113A Base

Base suitable for HH23PW Relays

Suitable for HHP23-W 12V DC
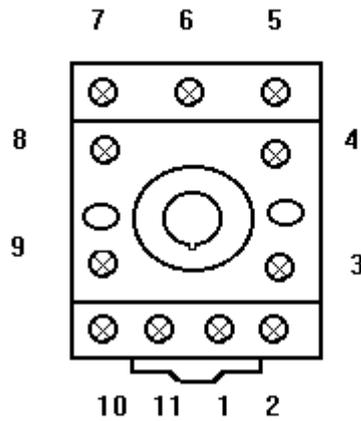
SR3P-05B 11 pin Base

Base suitalbe for HH23PW Relays

3. TEST CUT-OFF Relay - NEW: KUMP-11D18-12 (KUMP-12V, 15 Amp).
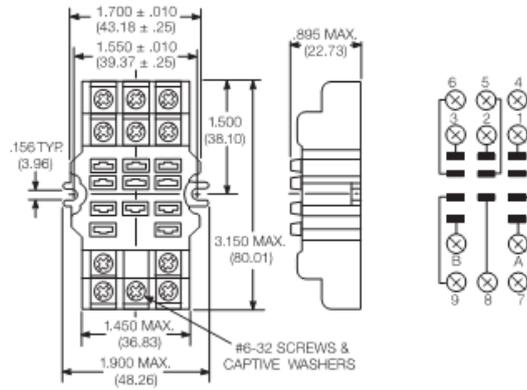
KUP Base: Top and Side View plus electrical arrangement

4. TEST CUT-OFF Relay - SUPERCEDED: HG2-12-20 (HG2-DC12V, 20 Amp).
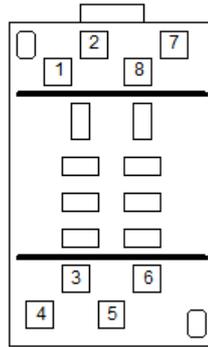
HG2-SF Base: Top View

5. CUT OFF TIMER: NATIONAL PMH 10M 12V DC or OMRON H3CR-A8 12V DC.
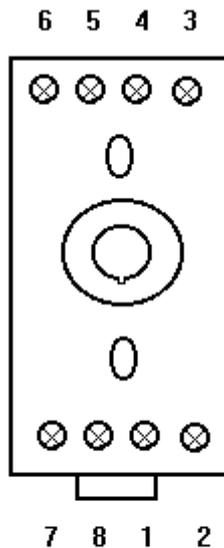
Base for 8 pin Timer

Base suitable for PMH-10M or H3CR-A8 Timers

6. AC SUPPLY Relay: HH23PW-T 120V AC. This relay is an 11-pin relay with 3 changeover contacts. Note that this relay is not always required. Refer to item 2 for details of the HH23PW bases.

3.10 Battery Test Resistor

The battery test resistor is a 150 watt, 1.5 ohm resistor.

The standard AC track resistor which is available from stores/second hand may be used with the two 3 ohm barrels connected in parallel. Please leave the wiper connected as there have been a number of cases were the 3 ohm barrels were in fact 4 ohms giving a total resistance of 2 ohms. This resulted in failed battery tests as the minimum load current of 6 amps was not obtained.

Using new resistors is not recommended for a level crossing installation due to their excessive cost. Try and reuse second hand resistors.

If the AC track resistor is not available at a suitable price, then alternatives can be used. The criterion for any resistor is that it can handle 7.5-10A at 18VDC for periods of 10 minutes at a time.

A possible alternative would be to use two 1 ohm adjustable resistors in series (as used with the Safeflash flasher unit for pairs of level crossing lamps). The resistors should each be adjusted to approximately 0.75ohms each so that the load is evenly shared between the two resistors.

3.11 Signage for Remote Battery Test Sites

For level crossing installation where a Control Centre is initiating remote battery testing at level crossings and there are no local crossing tests conducted by contractors or station staff than some additional signage is required to be installed at the level crossing.

This additional signage and phone number is required to allow easier access for the public to notify the rail operators of potential faults or damage at the level crossing.

The following example sign or something similar is to be installed on the level crossing which uses remote battery testing.

<div align="center">

LLOYDS ROAD   BATHURST

349.234 km

**Level Crossing
Warning Equipment**

**PLEASE REPORT ALL
FAULTS AND DAMAGE
BY PHONING
1800 XXX XXX**

Please quote ID 004

</div>

Sample only

The sign is to be 600mm long x 450mm high. It is to be made from aluminium of at least 2.5mm thickness. The text is to as the above example. The text shall be black on a retro reflective Class II yellow background. Use AS 1744 (Standard Alphabets for Road Signs) Series C Letter

Dimensions. The letter sizes used should be of a similar scale to those above. The letter size used needs to be as large as possible so that it can be clearly seen.

The phone number for reporting faults to needs to be decided (the above number is an example only) before the signs can be made. The phone number must be at the operations control centre for the line. An answering machine is to be used so that messages can still be received if the phone is unattended.

The signs are to be installed facing the road traffic. The signs are to be visible from the Stop point for motor vehicles using the level crossing in both directions. This requirement may be satisfied by installing one or more signs on the level crossing hut wall or door.

If the hut is placed in an awkward position then the sign may need to be installed on a separate post facing the road (i.e. facing 90 degrees to the track). In some cases it may be necessary to install a sign on each side of the level crossing.

4   Systems Maintenance Program

4.1   Maintenance Tasks

4.1.1   Corrective Maintenance

Fault finding and fault rectification is discussed in section 5 on Fault Diagnosis and the Operation and Functional Checks for each module in section 3.

4.1.2   Preventative Maintenance

Preventative maintenance is carried out in accordance with the signalling Technical Maintenance Plan (TMP) applicable Service Schedule.

4.1.3   EPROM Replacement or Configuration Data Change

If the EPROM which contains the software is to be replaced or if new Configuration Data is to be uploaded then a copy of the log must be taken before change is implemented. This is because the new EPROM or Configuration Data may cause the log to be irretrievable.

The EPROM is fitted in IC site U5 on the SCADA 2000 I/O Board. The power must be turned off before an EPROM is removed or installed.

If the main box is marked Version 1.0:

1. Remove the top cover by undoing the screws around the edge using a Number 1 Posidrive screwdriver.

2. Location the EPROM IC site which is labelled U5. It is at the front of I/O Board, a third of the way in from the left when looking down from the front of the main box.

3. The ADC board may have to be removed by undoing the Phillips screw and lifting it up.

4. Remove the existing EPROM if one is fitted by using a IC extractor to grip both ends and pulling up.

5. The new EPROM must be inserted in the correct orientation. The notch on the EPROM socket must match the notch on the EPROM. The pins on the EPROM may have to be flattened first if the EPROM is being inserted without an insertion tool.

6. Align the EPROM and its pins to the socket.

7. Push the EPROM down into the socket. Taking care not to bend any pins.

8. Check the EPROM is orientated correctly and all pins are properly seated.

9. Replace the ADC board if it was removed.

10. Replace the top cover.

If the main box is later than Version 1.0:

1. Undo the I/O Board securing screws and use the ejectors at either end of the I/O Board pull the board half way out of the main box.

2. Location the EPROM IC site which is labelled U5. It is at the front of I/O Board, a third of the way in from the left when looking down from the front of the main box.

3. The ADC board may have to be removed by undoing the Phillips screw and lifting it up.

4. Remove the existing EPROM if one is fitted by using an IC extractor to grip both ends and pulling up.

5. The new EPROM must be inserted in the correct orientation. The notch on the EPROM socket must match the notch on the EPROM. The pins on the EPROM may have to be flattened first if the EPROM is being inserted without an insertion tool.

6. Align the EPROM and its pins to the socket.

7. Push the EPROM down into the socket. Taking care not to bend any pins.

8. Check the EPROM is orientated correctly and all pins are properly seated.

9. Replace the ADC board if it was removed.

10. Push the I/O Board all the way in and do up the securing screws.

Note: If power is applied to a board with the EPROM incorrectly inserted, it may damage the EPROM or the I/O Board.

4.1.4   Interrogating the Monitor

The control, interrogation, and reporting facilities are provided via the RS232 serial ports labelled channel A, and channel B. Normally the modem is connected to channel A. Maintenance staff may perform the functions described below using a Personal Computer and one of two programs. Either the MS-DOS based program named LX_MAINT.exe or the MS-WINDOWS 3.1/WIN95 based programme named "Cerberus".

Connect one end of the serial cable to a COM: port on the PC. Connect the other end to Channel B on the Monitor.

4.1.4.1 PIN Numbers

The level crossing monitor uses 3 PIN numbers. These are known as the master, operations, and maintenance PIN numbers. They are used to provide security on important functions. They should only be revealed on a need to know basis.

The master PIN number is only used to set the operations and maintenance PIN numbers.

The operations PIN number is used for the following commands:

- Test Battery
- Set phone numbers
- Reset fault and warning
- Set date and time.

The maintenance PIN number is used for the following commands:

- Set battery offset
- Clear log
- Set lamp offset

- – Lamp learn
- – Set modem string
- – Reset monitor

The PIN numbers will be common for a Region and are available through the District Signal Engineer.

4.1.4.2 Using the MS-DOS Program LX_MAINT

The dial-up modem is connected to serial channel A. Serial channel B is available for on-site maintenance staff. The maintainers PC is directly connected to the Level Crossing Monitor serial channel B via a null modem serial cable. The cable must include loopbacks on the Level Crossing Monitor end. These are DTR to CD, and RTS to CTS. See section 4.2 for further details of the cable required. Normally the PC end of the cable is plugged into serial port COM2 of the PC.

The level crossing monitors are normally set-up for:

Serial Channel A	Serial Channel B
9600 bps	19200 bps
8 data bits	8 data bits
1 stop bit	1 stop bit
no parity	no parity

The functions available to a user are menu driven. Some menu items are protected by a PIN number.

Method 1

1. Power up the PC and plug the serial cable into serial port A or COM1: on the PC and channel B on the Level Crossing Monitor.

2. Move to the desired directory and type LX_MAINT and press the <enter> key.

3. Press <enter> to clear start-up screen.

4. A menu will appear. Type 1 and press <enter> to select the Connect menu.

5. Type 3 and press <enter> to establish a connection with the level crossing monitor.

6. A response will be displayed that shows details of the particular Level Crossing Monitor with which you have established a connection. If a error message occurs then try the other method.

7. Type 'Q' and press <enter> to return to the main menu.

8. Use the menus to find and perform the required tasks.

Method 2

1. Power up the PC and plug the serial cable into serial port A or COM1: on the PC and channel B on the Level Crossing Monitor.

2. Move to the desired directory and type LX_MAINT and press the <enter> key.

3. Press <enter> to clear start-up screen.

4. A menu will appear. Type 1 and press <enter> to select the Connect menu.

5. Type 1 and press <enter> to Set Serial Port on the PC.

6. Type '1' to select serial port 1 (com1:) on the PC.

7. Type 9600 and press <enter> to change the bit rate.

8. Press <enter> 4 more times to accept the other default serial port settings or type in the required values. You should not have to change these settings.

9. Type 3 and press <enter> to establish a connection with the level crossing monitor.

10. A response will be displayed that shows details of the particular Level Crossing Monitor with which you have established a connection. If a error message occurs then try another method.

11. Type 'Q' and press <enter> to return to the main menu.

12. Use the menus to find and perform the required tasks.

Screen Layout for LX_MAINT.

```
RSA Level Crossing Monitor ¦
Maintenance Terminal V1.14 ¦
--------------------------¦
                    ¦
--- Main menu ---        ¦
                    ¦
1 - Connect menu         ¦
2 - Lamp setup menu      ¦
3 - Log / IO menu        ¦
4 - Maintenance menu     ¦
5 - Test level crossing  ¦
6 - Send Config data     ¦
7 - Get Config data      ¦
                    ¦
q - quit                 ¦
                    ¦
                    ¦
                    ¦
                    ¦
--------------------------¦
000 Unknown         ¦
NORMAL              ¦
                    ¦
-------------------------------------------------------------
Select option :_
```

The screen is divided into 5 sections. These are:

- Top left is the program title and version number. You should have version 1.6 or later.

- The second top left is the menu area. The current menu or set of choices is displayed in this area.

- The third top left identifies the name and status of the Level Crossing monitor to which you have currently established a connection. UNKNOWN is displayed if a connection has not been established.

- The bottom line is the selection and prompt line. Normally what you type appears on this line.

- The right hand side displays error messages and information retrieved from the Level Crossing Monitor to which a connection is currently established.

Menus Available

Main Menu

1. Connect menu

2. Lamp setup menu

3. Log / IO menu

4. Maintenance menu

5. Test level crossing

6. Send Config data

7. Get Config data

q - Quit

Connect Menu

1. Set serial port config

2. Dial crossing

3. Establish connection

4. Accept Status change

5. Hang up

q.   Return to main menu

Lamp Setup Menu

1. Do lamp learn

2. Get lamp diagnostics

3. Get lamp offsets

4. Set battery offset

5. Set lamp offsets

6. Abort

7. Pause

8. Resume

q.   Return to main menu

Maintenance Menu

1. Enable reporting

2. Get id & status

3. Get modem string

4. Get serial port config

5. Get status times

6. Reset fault

7. Reset monitor

8. Set date/time

9. Set name

(a) Set phone numbers

(b) Set pin's

(c) Set serial port config

(d) Set modem string

(e) Test monitor

(f) Return to main menu

Log /IO Menu

1. Log to screen

2. Log to disk

3. View log from disk

4. Clear log

5. Show IO names

6. Get IO states

q.	Return to main menu

Test Level Crossing

Send Config Dat

Get Config Data

4.1.4.3 Using the Windows Program CERBERUS

Details on using the CERBERUS program are given in it's user manual and are not repeated here. The connection between the PC and the level crossing monitor uses the same null modem serial cable as described in the section below on Tools and Maintenance.

Some facilities are protected by PIN numbers. These are:

Engineering Mode access PIN number

Remote Control Centre connection PIN number

4.2   Tools and Maintenance

A number 1 posidrive screwdriver is required to remove the lid of the main box.

A 2.5 mm flat blade screwdriver is required to remove individual wires from the connectors used on most modules in the system.

A multimeter is required for most fault finding.

A portable PC with a copy of the program LX_MAINT.exe is required.

A suitable 9 pin female to 9 pin female null modem serial cable with possibly a 25 pin to 9 pin converter if required for the PC. Note that the level crossing monitor end of the cable needs a moulded plug with loopback for CD to DTR and RTS to CTS.

Null Modem Cable Connections		
D9 Female (PC)		**D9 Female (LXMON)**
2 RX	↔	3 TX
3 TX	↔	2 RX
5 SG	↔	5 SG
1 CD ↔ 4 DTR (loop Back)		1 CD ↔ 4 DTR (loop Back)

7 RTS ↔ 8 CTS (loop Back)	7 RTS ↔ 8 CTS (loop Back)
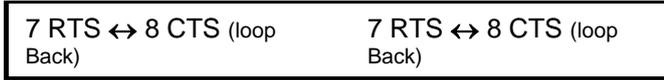
The D9 Female connector at the level crossing monitor end requires a moulded (flush fitting) connector if it is used with a V1.0 monitor. This is due to the recessed serial ports used on the V1.0 monitor. The new V3.0 level crossing monitor does not have recessed serial ports and can use D9 connectors with any type of backshell.

A 28 pin IC extractor for removing EPROMs.

4.3   Carrying out Maintenance in the Level Crossing Location

Prior to conducting routine maintenance of the Level Crossing Signalling equipment the Fault Reset button on the Monitor should be pushed and held for 5 seconds. This places the level crossing monitor in maintenance disable mode. The LOGIC indication should be flashing once per second which indicates that the monitor has had its reporting of status changes disabled temporarily.

When in this state the monitor will not report changes of status to the Control Centre. It is cancelled by a momentary push of the Fault Reset button or at pre-programmed interval after activation. Normally this time-out is set at 45 minutes.

At the completion of the maintenance tasks all Faults and Warnings must be cleared before cancelling this mode otherwise they will be reported to the Control Centre. The maintenance disable state is cleared by a 0.5 second press of the Fault reset button.

When investigating level crossing faults and using the monitor, it is important to download the event log to disk before erasing/deleting the event log.

4.4   Incident Investigation

The following actions are to be taken in the event of an incident at a level crossing which has an operational level crossing monitor:

1. Do not disturb the monitor. Note the state of all indicators on the front panel of the monitor.

2. Make a physical inspection of the monitor and interface equipment.

3. If the monitor is physically damaged priority is to be given to recovery of the large DALLAS IC's in positions U6 and U7 on the SCADA 2000 A I/O Board. If these IC's are recovered intact then the log may be retrieved and analysed by Signal Engineering. The EPROM in U5 should also be retrieved if possible.

4. If the monitor is undamaged and operating correctly than connect a portable PC to the monitor and capture a full copy of the event log on the PC.

5. Note the accuracy of the monitors time and date.

6. Reset any alarms or warnings.

7. Examine the log for the time of the incident.

8. Perform any tests required to prove or disprove that the monitor is functioning correctly. This may be best performed by repeating the commissioning tests.

9. Check that both used and unused inputs and outputs are shown by the monitor to be in their actual state. Inputs are to be corresponded to the monitor. This is best done by enabling reporting changes on the appropriate serial channel and watching the changes occur on the PC screen when the inputs states are changed. Cause each input to change to both possible states in turn. This must be done by energising or de-energising the relays etc. For example pull the negative pin for the XR. Then restore it. Note that additional changes will occur and the tests need to be structured to correspond each event.

10. Confirm the battery voltage displayed by the monitor is correct within a tolerance of +/- 0.30 volts. Measure the battery voltage at the battery terminals. Then get the IO states from the monitor to find the monitors measured battery voltage. Record these values and the battery offset.

11. Note down the lamp offset voltages currently in use.

12. Correspond the lamps This is best done by enabling reporting changes on the appropriate serial channel and watching the changes occur on the PC screen when the a lamp is removed or restored. Operate the crossing then correspond one lamp from each lamp stand.

13. Select lamp diagnostics mode. While the crossing is not operating, check that no lamp diagnostic information is displayed for any lamp channel. While the crossing is operating check that the correct number of lamps is reported at least 95% of the time. If not examine lamp adjustment, lamp types.

14. Under no circumstances is the configuration of the monitor to be changed or adjustments altered until the investigation is complete.

5   Fault Diagnosis

The following sections list fault conditions and the things to check for to identify their cause.

5.1   General

There are two processes for fault finding on the Level Crossing Monitors they are; with a PC, and without a PC.

Fault Finding with a PC normally consists of issuing a set of interrogation commands to examine the monitors' current status to find the problem or obtaining a copy of the event log when the problem occurred and examining the log to determine the probable cause of the problem. Fault finding using a PC can be conducted locally or remotely.

Fault Finding without a PC can only be used to find a fault condition that is still current. It consists of:

- Examining the front panel indications to check that they are as per Section 3.

- Note any Fault, or Warning condition.

- Examine the state of the inputs indicated on the Input Optoisolator and Battery voltage to determine if they are the cause of the Fault, or Warning condition.

- Reset any Fault, or Warning condition using the large reset switch on the top right hand corner of the front panel of the main box.

- If the Monitor returns to No Fault and No Warning then operate the crossing using the Test switch. If the problem re-occurs then re-examine the input to determine the cause of the problem.

- If there is a Lamp problem, check the lamps, and the voltage from the current sensors when the crossing is operating (as per Section 3). This problem can only be cleared after the monitor has detected the lamps operating correctly.

5.2   Faults Reported by Operations

The codes that the Level Crossing Control Centre reports to Operators for a particular level crossing have the corresponding meaning as per the following table. The report includes name of the level crossing, date and time the problem occurred, and whether it is a Fault or Warning.

Code reported by Operations	Level Crossing Monitor, Status Codes
Code 1	LAMP
Code 2	LOGIC
Code 3	SYSTEM
Code 4	BATTERY
Code 5	TEST
Code 6	COMMUNICATIONS FAIL
Code 7	SECURITY ALARM
Code 8	EMERGENCY SWITCHES
Code 9	No Train for 72 hours
Code 10	No Test for 36 hours
Code 11	Operating Too long
TRAIN DRAGGING EQUIPMENT	DRAGGING EQUIPMENT

Note 1:Code 7 Security Alarm is intended to be an alarm on the location door. It is optional.

Note 2:TRAIN DRAGGING EQUIPMENT alarm that detects Trains Dragging equipment. It is optional.

The code 6 (Communications Fail) means that the modem, telephone line, or monitor itself has failed.

These problems are then diagnosed as per the other fault diagnosis sections.

5.3 Faults Detected During Maintenance

5.3.1 Monitor Does Not Report a Status Change

Check that the monitor is operational.

Check it is configured to dial-up on status change.

Check the modem cable.

Check the modem configuration.

Check the modem.

Check phone line.

Re-configure the modem.

5.3.2 Changes are not Appearing in the Log

Check inputs fuse.

Check input optoisolator negative connection.

Check cables from the input optoisolator to the back of the monitor unit.

5.3.3 Lamp Learn does not Complete within 40 Seconds

Another symptom of lamp learn not completing is that Led 3 on the SCADA card stays ON and the board has to be manually reset.

Check the flasher cable from Main Box Input port 4 to the SSF ZK and CSF ZK is correctly installed.

Check that the SSF ZK and the CSF ZK are correctly installed and operating correctly.

Check that the XR input is operating correctly.

Check that the SS_LIGHT_ZK and the CS_LIGHT_ZK inputs are operating correctly. These inputs are for the Emergency switches and should be ON when the lights are operational.

5.3.4   Lamp Learn Rejects the Results

An example of lamp learn rejecting the results is as follows:

Run crossing for a minimum of 40 seconds to complete a lamp learn.

Start lamps now...

LAMP OFFSETS

Lamp Channel 2 SS_LAMPS Flasher UP Offset = 1.55   Accepted

Lamp Channel 2 SS_LAMPS Flasher DN Offset = 0.55   Accepted

Lamp Channel 4 CS_LAMPS Flasher UP Offset = -0.45   Accepted

Lamp Channel 4 CS_LAMPS Flasher DN Offset = -14.45 Not Accepted

In the example above the CS_LAMPS (Country Side lamps) Flasher DN (Flasher Down, ie. the lamps operating when the flasher contact 12 and 13 are made) had an offset that was outside acceptable limits and therefore rejected.

The lamp learn offsets are limited to greater than -10.0 and less than +10.0.

Negative offsets are due to lamp currents that are less than expected.

Positive offsets are due to lamp currents that are greater than expected.

Possible causes for large negative offsets are:

Fewer than expected lamps operating.

Calibration of the Current Sensors is not as per Section 3.3.4 of this manual.

The lamp circuit wire is fed through the current sensor in the wrong direction.

Lamp voltage is set too low.

The wrong type of lamp is installed (ensure only 10V 25 Watt lamps are used).

The Flasher is faulty such that it has a large voltage drop when turned ON.

Bad connection between a lamp and its base.

Bad connection in the lamp circuit.

Faulty current sensor.

Faulty main box or wiring from current sensor to the main box.

Possible causes for large positive offsets are:

Calibration of the Current Sensors is not as per Section 3.3.4 of this manual.

More than expected lamps operating.

Lamp voltage is set too high.

The wrong type of lamp is installed.

Faulty main box or wiring from current sensor to the main box.

5.3.5   Lamp Problem Detected While Crossing Operating

Check correct number of lamps are operating, they are adjusted to the correct voltage and they are the correct type.

Wrong Number of Lamps Detected Intermittently or Consistently

Check the calibration of the Current Sensors is as per Section 3.3.4 of this manual.

Check the existing lamp offsets and make a note of them.

Perform a lamp learn.

If the lamp learn accepted all of the new offsets then compare them with the previous offset values. If there is a difference of more 2 in any offset value then consideration should be given as what has caused the change. The section Lamp learn rejects results details those factors that affect the lamp offsets. Lamps offsets for FU (Flasher Up, flasher contact 12 and 11 made), and FD (Flasher Down, flasher contact 12 and 13 made) should be within 2 counts.

If the lamp learn did not accept all of the new offsets then proceed as per the section on Lamp learn rejects results.

Zero Lamps Detected on Either the Country Side or Sydney Side Lamp Circuits

Check flasher inputs and the CSF ZK and the SSF ZK VIOs. See Section 3.4.5 of this manual.

Check the calibration of the Current Sensors is as per Section 3.3.4 of this manual.

Check Current Sensor output is in the correct range for the number of lamps as per Section 3.3.3 of this manual.

Check the analogue inputs on the back of the monitor unit reflect the Current Sensor outputs.

Check the configuration in the monitor is correct.

5.3.6   Lamp Problem Detected While Crossing not Operating

Check the calibration of the Current Sensors is as per Section 3.3.4 of this manual.

Check that the link on current sensor is installed correctly for the site. Refer to section 3.3.5 of this manual for guidance on setting the link.

Check the XR input is operating correctly.

Check SS_LIGHT_ZK, and CS_LIGHT_ZK Emergency switch inputs for correct operation.

If the Current sensor cannot be calibrated then replace it.

If the monitor continuously detects lamps then check the voltage on the appropriate analogue input when the crossing is not operating. It should be the same as that on the current sensor output and less than 80 mV. If this is the case, then replace the main box.

If the problem is intermittent and is not solved by the suggestions given then refer the problem to Signal Engineering, Technical Services.

5.3.7   Battery Test does not Work

Check no fault exists.

Check that the monitor passes the system test.

Check battery test timer is okay and set for the correct time length.

Check battery test relays operate in the correct sequence.

Check test cut off input.

Check battery test current sensor is correctly calibrated.

Check battery test current sensor output.

Check batteries.

5.3.8 Monitor Indicates a Fault

Check the conditions which could cause a Fault These are detailed in section 2 for the generic expressions. You should also check the expressions for the particular crossing.

Examine log to determine exact cause.

5.3.9 Monitor Indicates a SYS Fault

Connect to the monitor with a PC and request System Test.

If the test failed due to one of EPROM error, CPU error, RAM chip U6 error, RAM chip U7 error, or Expression error then replace the main box.

If the test failed due to a LOG error then copy all of the event log onto the PC, clear the log and reset the I/O Board.

If the test failed due to SYSTEM fault not cleared then.

- If the software version is prior to R3.3b then the cause may be due to the CLOCK, BATTERY analogue input, an Expression error (also indicated by a flashing LED 1), or Faulty Battery test outputs.

- If the software version is R3.3b or later then the cause of the System Warning has been cleared. Examine the event log to identify the probable cause.

Take the appropriate action for the probable cause.

If the test failed due to Clock stopped then reset the date and time and reset the I/O Board. If the problem remains then replace the main box.

If the test failed due to Invalid Battery analogue input then use the Display IO states command to check the battery voltage. If it is less than 1 volt or reading zero than the ADC module is not working correctly. Check the internal +12V DC supply rail, check for external shorts on the current sensor supply terminals, and check internal wiring to the level crossing monitor unit. If no faults are found than replace the ADC card or the entire monitor.

If the test failed due to Faulty Battery test outputs then reset the I/O Board. If this clears the problem then report its occurrence to Signal Engineering. If the problem remains then replace the main box.

5.3.10 Monitor Indicates a Warning

Check the conditions which would cause a Warning. These are detailed in section 2 for the generic expressions. You should also check the expressions for the particular crossing.

Examine log to determine exact cause.

5.3.11 Unable to Communicate with the Monitor Locally

Check that the monitor Serial Port B and the PC serial port are set for the same speed.

If unable to establish a connection with port B, try connecting to serial port A.

Confirm that LED3 on the I/O board is not lit. If LED3 is lit than the monitor may be trying to report a status change or event change. Try resetting the monitor and attempt to obtain communications and disable the reporting of status and event changes. If still unsuccessful than try all possible combinations of serial port speeds on both serial port A & B in case the serial ports were inadvertently set for the wrong speed.

5.3.12 Unable to Communicate with the Monitor Remotely

Check that modem power lights are on and that all cables are connected correctly.

Check serial port set-up for port A and that it is correct for the modem being used.

Turn monitor off then on with modem connected. This will re-initialise the modem.

5.3.13   LEDs on the SCADA Card not Behaving Normally

Turn off the Monitor and turn it on again.

Check the 5 volt supply. Measurement on the Output Optoisolator test pins is the easiest. If it is between 4.0 and 4.8 volts then turn off then monitor, remove the top cover, unplug and re-plug the power supply connectors. If below 4.0 volts replace the main box.

If the 5 volt supply is okay and the problem persists then replace the main box.

5.3.14   Monitor Restarting Unexpectedly

The symptoms of this are START and STOP entries in the log and possibly the I/O board has stopped operating with LED1 flashing (indicating too many restarts in the last 5 minutes)

Check the 5 volt supply. Measurement on the Output Optoisolator test pins is the easiest. If it is between 4.0 and 4.8 volts then turn off then monitor, remove the top cover, unplug and re-plug the power supply connectors. If below 4.0 volts replace the main box.

5.3.15   Clock Stopped or Showing Invalid Time

Reset the time. If this does not fix the problem then either replace the IC in U7 of the SCADA board in the main box or replace the main box.

The cause is either due to power supply or pre version 3.3 software. Check the 5 volt supply. Measurement on the Output Optoisolator test pins is the easiest. If it is between 4.0 and 4.8 volts then turn off then monitor, remove the top cover, unplug and re-plug the power supply connectors. If below 4.0 volts replace the main box.

6   Installation

6.1   Circuit Design Considerations

6.1.1   General

A front (make, or pick) contact of each relay function which is readily available at the hut is to be provided as an input to the Level Crossing Monitor.

If there are no spare front contacts for a particular relay then a back (break, or drop) contact may be used instead. When a back contact is used then the expression data must be altered to allow for the use of a back contact.

Additional buried cables to adjacent signalling locations are not normally cost justifiable to provide the normal or additional inputs into the Level Crossing Monitor.

It is not desirable to use of the Level Crossing B12 or B15 supply for inputs outside the Level Crossing Hut. This may however be accepted on a case by case basis.

Standard circuit sheet X15 details the types of inputs to be provided to the Level Crossing Monitor and their preferred input numbers. It includes all the inputs for a double line crossing with signals.

Inputs 1 to 8 should always be used for their nominated purpose and if the input is not available then it should be left spare.

Inputs 9 to 12 should be used for any readily available Signals, Ground Frames, or Points etc so that their operation may be logged.

Inputs 13 to 23 should always be used for their nominated purpose and if the input is not available then it should be left spare.

Inputs 24 to 31 may be used for any purpose. The inputs detailed are a suggestion only. It is normal for Country Level Crossings to have the DSPR on input 28, DSJR on input 29, DSJPR on input 30.

When applying Standard circuit sheet X15 to a particular Level Crossing the designer must check:

When applying Standard circuit sheet X24 to a particular Level Crossing the designer must check is there is a NO Charge relay provided with the Store 74. If there is then use example 1 otherwise use example 2.

When applying Standard circuit sheet X26 to a particular Level Crossing the designer must check what model Store 74 Battery charger is fitted at the Level Crossing. Sheet X26 gives example designs for both types of Store 74 in use.

6.1.2   Battery Test Outputs

Circuit sheet X14 shows the connections for the LX Monitor. The 8-way Output Optoisolator terminals 1 & 8 are used to control the remote battery test. The outputs switch to B12 to start a remote battery test. Both outputs are used instead of only one to minimise the risk of a false remote battery test failing the battery.

6.1.3   Battery Test Relay

The Battery Test Relay is a Q type, 12 volt QBCA1. The heavy duty contacts of this relay are designed to carry a DC current of at least 30A for a minimum of 10 seconds on a 50% duty cycle. It is capable of breaking a current of 30A without damaging the relay. The normal duty contacts of this relay are rated 18V- 250V Switching AC Inductive and 3 Amps continuous.

The heavy duty contacts place a load resistor across the level crossing battery, see sheet X25. Two back contacts of this relay disconnect the STORE 74 Battery Charger for the duration of the test. The Battery Charger will draw a maximum of 3 Amps which is well below the current capacity of these two parallel back contacts. A front contact of this relay is also fed into the LX monitor for detection purposes.

6.1.4   Non-Vital Timer

The Non-Vital timer circuit is shown on sheet X25 of the Standard Circuits. The CUT OFF Timer is a delay ON timer set for 300 seconds. The unit is an industrial quality timer designed for critical timing applications. It is used to stop the Battery test if the test continues for significantly longer than the Battery test should last for. The CUT OFF Timer de-energises the TEST CUT OFF Relay to stop the test.

The CUT OFF Timer and the TEST CUT OFF Relay are tested by the Level Crossing Monitor prior to a remote battery test.

The CUT OFF Timer is used as an independent control to prevent a failure of the Level Crossing Monitor failing the Level Crossing Battery which would be a serious safety risk.

6.1.5   Test Load Resistor

The test resistor is required to draw a test current from the Level Crossing Battery. Current practice for testing level crossing batteries is to operate the Test Switch for 2 minutes. This runs the crossing with the AC supply disconnected. The battery voltage is continually monitored by the Store 74 Alarm card and gives a indication if the battery voltage falls below a preset level.

A 10 cell level crossing will draw approximately 15A for the duration of the 2 minute test using the Test Switch box. A 12 cell level crossing draws approximately 23A for the duration of the

test. The equivalent ampere - hour drains on the batteries are 0.5AH for 10 cells and 0.76AH for 12 cells. The remote test of the Level Crossing Battery using the level crossing monitor should provide a similar load test.

A 1.5* resistor is used as the Battery test load. Allowing for losses in wiring the following maximum currents will be drawn.

Voltage	Number of cells	Test Resistance	Max Current	Required AH	Time needed
15V	12 cells	1.5Ω	10A	0.76A	280 seconds
12V	**10 cells**	**1.5Ω**	**8A**	**0.50A**	**225 seconds**

A remote test duration of 5 minutes was chosen as an adequate test time.

6.2 Equipment Installation

Signalling wiring 7/0.4 should be terminated with red bootlace ferrules. Either a Cable Accessories BLP 100, a Klippon 901908, a Wago 216-203, or a Phoenix 3200030. The Cable Accessories HNKE4, and Klippon PZ4 crimp tools are suitable.

The main box is normally secured to the top of the relay rack. It is designed to be mounted horizontally but may be mounted vertically. Space should be left above the main box so that the top cover can easily be removed.

Current sensors, VIOs, input optoisolators, and output optoisolator are mounted on DIN rail. The modem is typically sat on the monitor box. The cables are laid in the cable ducts and the screw locks at both ends screwed up.

The wire run through the current sensors must be run so that the direction of +ve current flow is in the direction marked on the current sensor. The current sensors will not work if the current flow through the sense wire is in the wrong direction.

The battery test load resistor generates a significant amount of heat while a battery test is being conducted. Therefore space must be left above the resistor so that relays etc mounted above the resistor are not damaged over time by the heat generated.

6.3 Hardware Configuration

Refer to the level crossing monitor block diagram in Appendix C and drawing X14 - X26 & X49, X50 of the Standard Circuits or the particular circuits for the level crossing.

The hardware comes preconfigured in regard to links. These may be checked by referring to the relevant parts of Section 3.

The generic data must be customised for the particular Level Crossing. The configuration data must be uploaded to the monitor. This process is detailed in Section 7.

6.4 Commissioning Procedure

This section describes the commissioning procedure. Details of the commissioning activities are recorded on a copy of the Level Crossing Monitor - Test and Commissioning form. This form is provided in Appendix B and is to be followed in order while commissioning the level crossing monitor.

Before turning on power on to the Level Crossing Monitor the links must be set as per section 3.2.2.3. The test form identifies links that may not have been set correctly. These must be checked and set correctly especially Link 12-13 which is positioned near the front of the I/O board near the push button reset switch.

Check wiring, connectors and that the correct version EPROM is fitted for the level crossing. It is important to check the correct polarity of the power.

Turn power on and check that the LEDs on the monitor behave as described in section 3.1. It does take 2 or 3 seconds before LED 4 starts flashing. This is due to the time taken to perform self tests. At start up a System Fault will be indicated since there is no Configuration Data in the memory of the level crossing monitor.

Connect a PC running one of the level crossing programs (LX_MAINT or Cerberus) to serial channel B. The serial cable plug into COM2: on the PC and Channel B on the monitor.

Start the PC program and use the menus to Establish communications with the monitor.

It is possible for a new monitor at start-up to be in a state where it is continuously trying to report changes of state. This is indicated by LED 3 on the I/O card being lit. This reporting of changes of state must be disabled before others commands will be accepted.

Set the Pin numbers. To do this you need to know the Master pin number. The operations pin number required, and the maintenance pin number required. These may be obtained from Signal Engineering or the District Signal Engineer.

After the pin numbers are set it is time to send the expression data (configuration data).

See sections 7.2 & 7.3 for details on how to prepare this data to create the binary (.bin) file.

Select the option Send Config data. This option is selected to upload the previously compiled expression data. The compiling of this expression data is described in another section of this manual. After entering the pin number you then must enter the file name of the expression data. This file has a .bin extension and would normally be in the same directory as the LX_Maint program or Cerberus program. After the upload is complete the level crossing monitor is ready to be commissioned and tested.

Get the monitors ID and Status. Using this information record the Data details, Code version, and Crossing number.

Set the name using the menus.

Set the date and time using the menus and the operations pin number.. You must always set the date and time even if it is correct as there may be some change in the way in which the clock is dealt with between software versions.

Clear the log using the menus and the maintenance pin number. The System Fault should clear.

Using the menus request a System test.

Reset the monitor to ensure the oldest event in the log has the correct date and time.

Display the Input information. Check that the names for each used input bit correspond with the circuit book. Check that the input states are as expected.

Display the Output information. Check that the names for each used output bit corresponds with the circuit book and the ".io" configuration data file. Check that the output states are as expected.

Display the Intermediate terms information. Check that the names correspond with the ".io" configuration data file. Check that the intermediate states are as expected.

Display the Timer information. Check that the names correspond with the ".io" configuration data file. Check that the timer states and lengths are as expected.

Display the analogue data. Check that the information corresponds to both the ".exp" configuration data file and the circuit book. Check that the information reflects the current expected state.

Check and adjust battery charger. An additional load of approximately 1.0A is required to power the level crossing monitor and the modem. This additional load may result in not enough trickle charge current for the level crossing battery. Approximately 100-300 mA of trickle charge current is required (measured with a current gun) into a fully charged level crossing battery. The battery charger voltage may need to be increased.

Check the current sensor output voltages when there is no current flowing through the measured circuit. The voltages should be in the range of 50 to 110 mV. If they are not then set them correctly as per section 3.3.

Check that both used and unused inputs and outputs are shown by the monitor to be in their expected state. Inputs are to be corresponded to the monitor. This is best done by enabling reporting changes on the appropriate serial channel and watching the changes occur on the PC screen when the inputs states are changed. Cause each input to change to both possible states in turn. This must be done by energising or de-energising the relays etc. For example pull the negative pin for the XR. Then restore it. Note that additional changes will occur and the tests need to be structured to correspond each event.

Make sure that the lamps are correctly adjusted and all are operating correctly. Then place the monitor in lamp learn mode and operate the crossing by pulling the pin for the XR circuit or XT track relay. Record the learnt lamp offset values. Lamp learn should not be done using the TEST Switch as this turns off the battery charger and is not the normal case. The lamp learn takes approximately 40 seconds to complete. If the lamp learn does not accept all the offsets then proceed as per Section 5 Fault Diagnosis.

Confirm the battery voltage displayed by the monitor is correct within a tolerance of +/- 0.30 volts. The level crossing monitor will display slightly less voltage than the crossing B12 busbar due to voltage drops on the cable and connectors supplying the 12V for the monitor. This is corrected using the set battery offset command. Measure the battery voltage at the battery terminals. Then get the IO states from the monitor. Record these values and the battery offset. The battery offset is changed to correct the displayed voltage.

Set the allocated IP address for the Cybertec modem so that it can connect and communicate with the Control Centre.

Correspond the lamps: This is best done by enabling reporting changes on the appropriate serial channel and watching the changes occur on the PC screen when the lamp is removed or restored. Operate the crossing then correspond one lamp from each lamp stand.

Test and confirm that the expression data is correct for any non-generic expression by function testing them.

Select lamp diagnostics mode. While the crossing is not operating, check that no lamp diagnostic information is displayed for any lamp channel. While the crossing is operating check that the correct number of lamps is reported at least 95% of the time. If not examine lamp adjustment, lamp types, and retry lamp learning.

Set modem initialisation string as per the form and reset monitor with the modem connected and turned on.

Ensure both serial ports for the monitor are set at the correct values.

Use a phone on the telephone line to make a test phone call. Paying attention to any audible noise on the line. If the line is noisy have Telstra fix the line.

Use the menus to enable reporting of status changes for serial channel A. (only if level crossing monitor is reporting to a Control Centre)

Use the menus to enable maintenance disable of reporting for serial channel A.

Perform a battery test using the operations pin number and measure the test current using a tong meter.

Cause a battery fault by pulling out the Alarm relay on the alarm card in the battery charger. Confirm that this fault status is correctly reported to the Control Centre. Restore the alarm relay and reset the battery charger alarm card. Press the Fault Reset push button on the front of the front of the monitor. Confirm that this normal status is correctly reported to the Control Centre.

As a final check visually confirm and verify with the XR circuits that the TEST SW ZK VIO is the correct voltage type and that it is correctly marked in the circuits.

Check to confirm that the monitor case is isolated from the B12 and N12 supplies. This is done as an additional check against manufacturing defects or installation problems.

Get a copy of the log from the monitor. Examine the log to confirm that it contains an accurate record of the events on the crossing during the commissioning period with no anomalies or spurious events. Unexplained event or problems must be investigated and corrected.

One week after commissioning a copy of the log from the monitor. Examine the log to confirm that it contains an accurate record of the events on the crossing during the commissioning period with no anomalies or spurious events. Unexplained event or problems must be investigated and corrected.

7 Data Configuration

7.1 Configuration Data Description

7.1.1 Scope of Data

Configurable items that need to be defined are:

- Name and date of the permanent configuration data.
- For each digital input, its name.
- For each digital output, and intermediate state, their name and controlling Boolean expression.
- For each Timer its name, controlling Boolean expression, and duration in hours, minutes, and seconds.
- For the battery analogue input, its name, fail voltage, and bus voltage correction.
- For each lamp analogue input, its name, analogue channel number, number of lamps expected on flasher up, number of lamps expected on flasher down, flasher input, and an intermediate state that identifies when the lamps should be on.
- For the battery test current analogue input, its name, analogue channel number, on current in amperes, off current in amperes.
- Crossing Identification number
- Input/Output configuration. Note that this is not normally changed.

7.1.2 Permanent Configuration Data Syntax

The configuration data is detailed in three separate text files which have a common file name and one of the following extensions.

The I/O listing file has the extension ".io". The Configuration file has the extension ".cfg". The expression file has the extension ".exp".

7.1.2.1 Comments

Anything following a ";" character on a line of text is treated as a comment and is ignored. Note that a line of text is terminated by a return.

7.1.2.2 Variable Names

Valid characters for variable names are:

Upper and lower case letters,

Numbers,

And the following characters ( ) . _ - / *

Variable names can not include white space characters like tabs and spaces. If a space is desired in a name then it is recommended to use the underscore character "_" instead.

Variable names can be up to 20 characters long and are case sensitive.

7.1.2.3 Variable Types

The level crossing monitor supports the following variable types:

- Input
- Output
- Intermediate
- Special Intermediate
- Timer
- Special Timer
- Lamp
- Battery

An input variable directly reflects the state of a digital input.

An output variable directly reflects the state to which a digital output is set.

An intermediate variable is an internal state of the level crossing monitor which is controlled by a logical relationship of inputs and outputs.

A special intermediate variable is an internal state of the level crossing monitor which is directly controlled by or is used by the level crossing monitor software.

A timer variable is an internal state of the level crossing monitor which is controlled by a logical relationship of inputs and outputs and the length of time the state is maintained.

A special timer variable is an internal state of the level crossing monitor which is controlled by a logical relationship of inputs and outputs and the length of time the state is maintained and is directly used by the level crossing monitor software.

A Lamp variable reflects the state of the level crossing highway lamps.

A Battery variable reflects the state of the level crossing battery.

7.1.2.4 I/O List

The I/O list is a text file that lists each variable, allocates is I/O bit and declares its types.

Inputs and Outputs are declared in the form:

- Name board bit
- Where
- Name is the input or output variable name.
- Board is 0 for all level crossing monitors.

– Bit is in the input or output bit number.

Intermediate variables are declared in the form:

– *name1
– *name2

Where

– *name1 is the variable name of the first intermediate variable.
– *name2 is the variable name of the second intermediate variable.

Note that the order in which Intermediate variables are declared sets their number. Special intermediate variables are declared first, and must not be changed by anyone who does not have a detailed knowledge of the level crossing monitor software.

Timer variables are declared in the form:

– *name1 T
– *name2 T

Where

– T identifies the variable as a timer variable.
– *name1 is the variable name of the first timer variable.
– *name2 is the variable name of the second timer variable name.

Note that the order in which Timer variables are declared sets their number. Special Timer variables are declared first, and must not be changed by anyone who does not have a detailed knowledge of the level crossing monitor software.

The Battery variable is declared in the form:

– *name B

Where

– B identifies the variable as a Battery variable.
– *name is the variable name of the Battery variable.

The Lamps variable is declared in the form:

– *name L

Where

– L identifies the variable as a Lamp variable.
– *name is the variable name of the Lamp variable.

7.1.2.5 Configuration

The configuration of input and outputs is set-up in the ".cfg" file. This only exists for the Level Crossing Monitor to maintain consistency with the Telemetry systems which share the same data generation program.

It contains one, one line entry of the form:

– ss bb cccccccc

Where

ss is the station number, this is normally 01.

bb is the board number, this is normally 01.

cccccccc   is the IO configuration for each word of the board. Starting at input word one, which contains bits 1 to 8 and finishing on word 8, which contains bits 57 to 64. An I configures

the word as Inputs, and an O configures the word as outputs. The standard value for this is "IIIIIIIO".

For example a normal configuration file will contain:

; station board_address BOARD CONFIGURATION

;

01 01 IIIIIIIO

7.1.2.6 Expression Data Name

The expression data name is the first non-comment line in the ".exp" configuration data file. The first 40 characters of this line appear in the Level Crossing monitor EPROM. They are used to identify the configuration data in use by a particular level crossing monitor.

The first non-comment line of the ".exp" file must be the Level Crossing name and the date of the last alteration to the particular configuration data files. The normal format is "000 Generic, Generic Rd 000.00 07/09/94".

Where:

000 is the Level Crossing ID number.

Generic, Generic Rd is the Location and Road name.

000.00 is the Kilometerage.

07/09/94   is the date

Refer to Section 7.3 Customising Generic expressions for details of the allocation of Level Crossing ID numbers.

7.1.2.7 Boolean Expressions

Boolean expressions are combinations of logic operations on Boolean variables. Boolean variables may have either of two values or states. One of these states is called TRUE, ON, or 1. The other state is called FALSE, OFF, or 0.

In relay terms TRUE is equivalent to UP, and FALSE is equivalent to DOWN.

The level crossing monitor uses Boolean expressions to derive different logic states of the level crossing in order to determine the whether or not the level crossing is operating correctly.

There is a direct correspondence between relay circuits and Boolean expressions. The Boolean expressions will be related to relay circuit as a way of describing their operation.

7.1.2.7.1   AND Operator

The logical AND operation is represented by the "&" character.

Examples of logical AND operations are as follows:

Either as relay logic by:
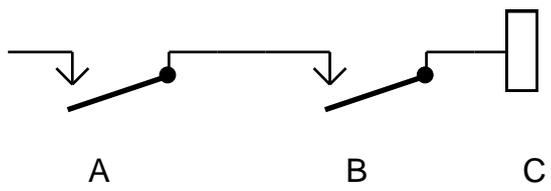
Or as a Boolean expression

C = A & B

C will only be true when both A and B are true.

7.1.2.7.2 OR Operator

The logical OR operation is represented by the "+" character.

Examples of logical OR operations are as follows:

Either as relay logic by:
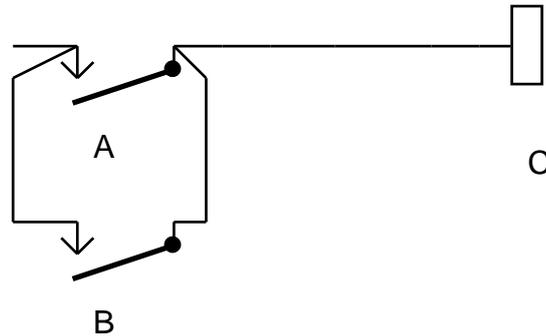
Or as a Boolean expression

C = A + B

C will be true when either A or B are true.

7.1.2.7.3 NOT Operator

The logical NOT operation is represented by the "!" character.

Examples of logical NOT operations are as follows:

Either as relay logic by:
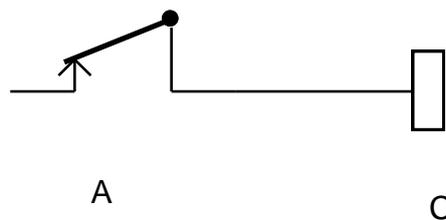
Or as a Boolean expression by:

C = !A

C will be true when A is not true.

7.1.2.7.4 Combinations of Logic Operations

The logical operators AND, OR, and NOT can be combined using brackets [, and] to form any required Boolean expression.

An example of a combinational logical operations is:

Either as relay logic by:
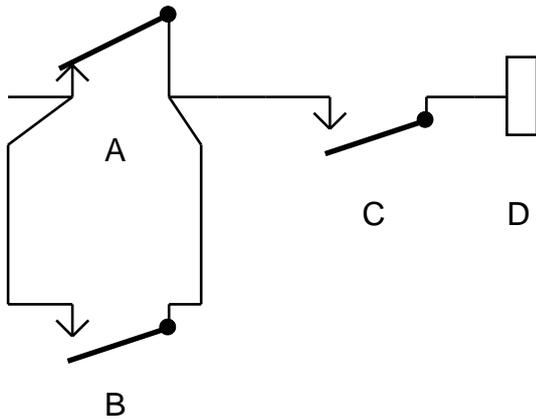
Or as a Boolean expression

D = [!A + B] & C

D will be true when C is true and [A is not true or B is true].

7.1.2.8 Steady Result Expression

Intermediate variables and Output variable are controlled by steady result expressions. These variables become TRUE (or ON) when the steady result expression controlling the variable becomes TRUE. The variables become FALSE (or OFF) when the steady result expression controlling the variable becomes FALSE.

Steady result expressions have the following format:

x = y

Where

x is variable which was declared in the IO list as either an Intermediate or an Output.

= identifies the expression as being a steady result type of expression.

y is a Boolean expression as described previously.

7.1.2.9 Timer Expression

A timer variable becomes TRUE when the expression that drives the timer has been TRUE for the length of time that the timer is set for. The timer variable becomes FALSE immediately that its expression becomes FALSE.

Timer expressions have the following format:

x =T Ah Bm Cs y

Where

 x is a internal variable which was declared in the IO list as a Timer.

=T identifies that it is a Timer expression.

Ah is length of the timer in hours. A is the number of hours in the range of 0 to 255 and h identifies that A is the number of hours. Ah is optional when the timer length is less than one hour.

Bm is length of the timer in minutes. B is the number of minutes in the range of 0 to 59 and m identifies that B is the number of minutes. Bm is optional when the timer length is less than one minute.

Cs is length of the timer in seconds. C is the number of seconds in the range of 0 to 59 and s identifies that C is the number of seconds. Cs must always be declared even when C is 0.

y is a Boolean expression as described previously.

Example Timer Expressions:

```
; Check that a local or remote test of LX is done within 36hrs
of previous test
*NO_TEST  =T 36h 0m 0s !BATT_TEST_OP & TEST_ZK

; Check AC supply
*AC_SUP_WAR =T 6h 30m 0s !AC_SUPPLY
; warn if AC supp out longer than 6hrs 30 min
; Low battery timer
*LOW_BATT_TIMER =T 3s !BATT_ALARM_CARD + *BATT_LOW
; time delay before low batt
```

7.1.2.10 Lamp Expression

A lamp expression is used to configure the system with the analogue channel a particular set of level crossing lamps are being monitored by, the number of lamps expected when the flasher is in the UP position, the number of lamps expected when the flasher is in the DOWN position.

Lamps expressions have the following format:

x =L A B C u

Where

x is a internal variable which was declared in the IO list as a Lamp.

=L identifies that it is a Lamp expression.

A is the analogue channel in the range of 1 to 7 that is used to monitor the particular set of lamps. Typically Channel 2 is used for the Sydney side lamps, 4 is used for the Country side lamps, 3 is used for the Sydney side tip lights for booms, and 5 is used for Country side tip lights for booms.

B is the number of lamps expected when the lamps are operating and the flasher is in the UP state. The number must be in the range of 0 to 4. This is the number of lamps when a steady set of lamps is being monitored.

C is the number of lamps expected when the lamps are operating and the flasher is in the DOWN state. The number must be in the range of 0 to 4. This is zero when a steady set of lamps is being monitored

u is an Input variable which corresponds to the state of the Flasher used for the set of lamps. If the particular set of lamps are not flashed, that is a steady lamp like the tip lamps on booms, then they are identified by using the word "STEADY" instead of the name of a flasher input.

Example Lamp Expressions:

```
; Lamps Expressions
; analogue channel number, num lamps flasher up, num lamps
flasher down,
; flasher input name

*SS_LAMPS  =L 2 2 2 FLASH_SYD
*CS_LAMPS  =L 4 2 2 FLASH_COU
*SS_TIP    =L 3 1 0 STEADY
*CS_TIP    =L 5 1 0 STEADY
```

7.1.2.11   Battery Expression

A battery expression is used to configure the system with the battery alarm voltage, a battery offset voltage, the analogue used to monitor the battery test current, the battery test current in amps required for the battery test, and the no battery test current threshold in amps.

There can be only one Battery expression for each level crossing. Battery expressions have the following format:

x =B A B C D E

Where

x is a internal variable which was declared in the IO list as a Battery.

=B identifies that it is a Battery expression.

A is the battery alarm voltage in volts. Typically this is set at 11.7 volts for a flashing light level crossing, and 14.1 volts if booms are fitted. The voltage is a real number and must be in the range of 7.0 to 18 volts. These alarm voltages are set 0.5V less than the battery charger alarm card.

B is the battery offset voltage in volts. This is used to correct for the voltage drop between the Level Crossing monitor and the Level Crossing Bus. Typically this value is 0.16 volts. The voltage is a real number and must be in the range of 0 to 0.5 volts.

C is the analogue channel used to monitor the battery test current. The number must be in the range of 1 to 8. Typically channel 8 is used.

D is the required battery test current in amps. This is the current that must be maintained through the battery test load for the duration of the battery test. Typically this is set at 6.0. It is a real number and must be in the range of 5.0 to 20.

E is the value below which the battery test current in amps is checked to be whilst a battery test is not being carried out. A value of 0 is not normally suitable due to problems with the Analogue to Digital Converter used, and the Current Sensor used. Typically this is set to 1.0 amps. It is a real number and must be in the range of 0 to 2.0.

Example of a Battery Expression:

```
*BATTERY  =B 11.7 0.16 8 6.0 1.0
```

7.1.2.12 Analogue Expression

A analogue expression is used to configure analogue inputs for general purpose logging. It details the type of measurement the analogue channel is being used for, its channel number, the scale for the input, and the percentage change to log.

Analogue expressions have the following format:

*x =A A B C D

Where

*x is the name used for the analogue channel.

=A identifies that it is an Analogue expression.

A is the analogue channel number for the this expression.

B is the type of measurement the analogue channel is being used for. This is VOLTS for voltage measurements, AMPS for current measurements, and TEMP for temperature measurements.

C is the scale factor used for displaying the measure value. The measured value is scaled so that it is in the range of 0 to the scale number. The scale number must be in the range of 1 to 255. Typically it will be 5, 20, 50, or 100.

D is the percentage change required between the current measured value and the previously measured value for the current value to be logged. This must be in the range of 2 to 50 percent.

Examples of Analogue Expressions are:

```
*VOLTAGE    =A 5 VOLTS 5 2%

*CURRENT    =A 6 AMPS 20 3%

*TEMPERATURE =A 7 TEMP 100 5%
```

7.1.3 Variable Configuration Data

Configurable items that can be changed during normal operation and their purpose are detailed in this section. These values are set during Commissioning and are checked by the Control Centre during either a Status check, or a Battery test.

These settings can be inspected using the Get information and status, Get serial port configuration, Get Lamp offsets commands.

Level Crossing Name: 39 characters which identify the Level Crossing. Normally Placename, Street name St.

Date & Time: The current date and time.

Number Monitor Dials 19 characters which give the normal phone number in Hayes AT command format, that the monitor dials to report a status change. These are the digits 0 to 9, and dial modifiers ',' for a pause, 'P' for pulse dialling and 'T' for tone dialling. It is recommended to always start the number with a pause.

Alternate number 19 characters which give the alternative phone number in Hayes AT command format that the monitor dials to report a status change. These are the digits 0 to 9, and dial modifiers ',' for a pause, 'P' for pulse dialling and 'T' for tone dialling. It is recommended to always start the number with a pause.

Report Changes Port A: Either ENABLED or DISABLED. If ENABLED the monitor reports any changes of state via serial port A. It is cancelled by loss of Carrier Detect (CD), or the abort command.

Report Changes Port B: Either ENABLED or DISABLED. If ENABLED the monitor reports any changes of state via serial port B. It is cancelled by loss of Carrier Detect (CD), or the abort command.

Dial on fault Port A: Either ENABLED or DISABLED. If ENABLED the monitor report any changes of status to either the normal or alternate phone numbers via the modem connected to serial port A.

Maintenance Disable: Either ENABLED or DISABLED. If ENABLED the maintainer can temporarily disable the Dial of Fault via a 5 second press of the Reset Fault and Warning button while maintenance is carried out.

Battery offset: An offset in the range of 0.0 to 0.5 volts to correct the battery voltage read by the monitor. Nominally 0.16. The value displayed may not be the same as the value entered due a conversion in the monitor software for the A to D. If the value is changed it will be lost when the monitor restarts and the original fixed value is read from EPROM.

Modem initialisation string   this holds the configuration string for the particular modem. It may be up to 49 characters long. Refer section 3.8 for details of typical modem initialisation strings.

Operations pin number. 5 characters. Normally digits. It is used to protect certain functions.

Maintenance pin number 5 characters. Normally digits. It is used to protect certain functions.

Serial port set-up port A: This is the configuration of the RS232 serial port A. It is always 8 data bit, No parity, and a bit rate. The serial protocol used requires that it is 8 data bits. AT compatible modems will not handle parity with 8 data bits. The bit rate is one of 1200, 9600, and 19200. Normally set for 9600.

Serial port set-up port B: This is the configuration of the RS232 serial port B. It is always 8 data bit, parity, and a bit rate. The serial protocol used requires that it is 8 data bits. Parity is Odd, Even, or None. None is normally chosen. The bit rate is one of 1200, 9600, and 19200. 19200 is normally set.

Lamp Offsets: The lamp offset is used to compensate for variations in the lamp currents at particular locations. On each lamp circuit there are two values. One labelled FU (Flasher Up, flasher contact 12 and 11 made), and one labelled FD (Flasher Down, flasher contact 12 and 13 made). The lamp learn offsets are limited to greater than -10.0 and less than +10.0. Negative offsets are due to lamp currents that are less than expected. Positive offsets are due to lamp currents that are greater than expected. Both FU and FD values should be within 2 counts for

flashing lamps. Only the FU value is used for steady lamps. Offsets are normally set using Lamp learn but may be manually adjusted.

7.2   Customising Generic Expressions

A set of generic configuration data files have been created. These are called generic.cfg, generic.io, and generic.exp. When the data files need to be defined for a new Level Crossing these generic files are copied as file names having a unique identifier for the particular level crossing. A batch file has been created for this purpose. It is invoked by the DOS command line "NEWEXP name" or in "Cerberus' with a menu selection. Please note that the name chosen must be 8 characters or less without spaces.

E.g. typing in >newexp name

The specific configuration data files are then edited using any TEXT file editor or word processor. If you are using a word processor such as Word 6.0 for Windows you need to make sure that the edited file is saved as a 'Text Only' file.

Edit the new ".io" file for the crossing. Change the title of the file from generic.io to your chosen name name.io. Also update the date and comments section so that a record is kept of modifications made to the file. Either delete the line starting with ";;" if these inputs or variables are not applicable to the particular crossing, or delete the ";;" to make them applicable. They mostly relate to booms. Check the inputs against the circuits for the crossing and make the relevant changes by adding or deleting inputs.

Edit the new ".exp" file for the crossing. On the first line of the file change 000 to the level crossings ID number. ID numbers are in the range of 001 to 199 for Western Region. 200 to 399 Southern Region. 400 to 599 for Northern Region. 900 to 999 for Metropolitan. Note that each Level Crossing in RAC must have a separate ID number. Change the rest of the first line to have the name of the crossing, it kilometerage, and the date. Change the title of the file from generic.exp to your chosen name name.exp. Also update the date and comments section so that a record is kept of modifications made to the file

Modify the TEST Switch expression to the relevant type.

If any input have used back contacts then change its name to the form "NOT_NAME". Check is the input is used in the expressions. If it used the for each time it is used change the name form "NAME" to "*NAME" and make an additional expression at the beginning of the expression file of the form "*NAME = !NOT_NAME" which will correct the inversion due to the back contact.

Find each expression line starting with ";;" or ";" and examine it and the adjacent expressions to see which are applicable. Delete those not applicable and remove the ";;" or ";" to bring the commented out expressions into use.

If the Level Crossing has interlocked signals or other special conditions like an adjacent ground frame then examine the *NOT_STOP, *NOT_START, *STICK_WARN, *STICK_FAIL expressions must be checked and either deleted or modified.

Additional expressions may be added to check for track failures, detection failures, or additional alarm or warning conditions. Examples of these are:

*TRACK_FAULT =T 1h 0m 0s !*TRACK_UP

*DETECT_FAULT =T 30m 0s !6NK & !6RK

If the crossing is not being remotely tested then replace the *NO_TEST expression with:

*NO_TEST =T 36h 0m 0s TEST_ZK.

Edit the new ".cfg" file for the crossing. Change the title of the file from generic.cfg to your chosen name name.cfg. No other modifications are to be done to this file.

A number of warnings are included in the generic configuration files regarding deleting of variable and inputs such as Special Intermediate variables. Please adhere to these warnings.

7.3 Data Generation

To produce a binary file ready to be uploaded to a level crossing monitor use the batch file "COMPEXP". This is used in the format "COMPEXP name".

E.g. typing in >**compexp** name

This will compile the 3 files (.exp, .io, .cfg) created above and compile them. If there are any errors then you will soon know about it. If a error in the expression or i/o files is detected then the computer will write the faults and errors to a file called **name.err**. By examining this file you can debug your expression and i/o files.

Assuming all is well then the compiled files will be linked to the main code to create one file called '**name.bin**'. This file is the file that is then placed in the directory used by LX_MAINT or 'Cerberus' ready for uploading into the required level crossing monitor.

Files required in the current directory or path for data generation:

compexp.bat

newexp.bat

generic.cfg, generic.io, generic.exp

ppgen.exe Version 3.4 or later.

A51.EXE, L51EXE, OHS51.EXE, FAD.EXE, FCSUM.EXE.

addr.equ

The relevant ".io", "..cfg", and ".exp" files in the same directory.

7.4 EPROM Programming

Normally a programmed EPROM with R3.7 or later software will be supplied with each level crossing monitor.

If additional EPROMs are required or a older monitor is being upgraded than the procedure below must be followed to program an EPROM.

1. Obtain a 27512, 200ns EPROM. Note that the EPROM may be any of the 27512, 27C512 family of EPROMs.

2. The binary file that is to be burnt into the EPROM should be obtained from Signal Engineering Services. Must be version R3.7 or later. The file name will be LXR37.bin where 37 is the release number for version R3.7.

3. Connect the JED PC EPROM programmer to the PC's parallel port and make sure that power is connected to the prom programmer.

4. Invoke the prom programmer software by the DOS command "pp".

The default eprom type should be 27512 (on RHS). If it is set to anything else then you will have to go to the option menu and select the eprom type 27512.

Select the option 'Program EPROM from diskfile' (this is the first menu item)

The program will come back with:

COMMAND

Enter filename:

type in **'lxr37.bin'** and hit **return**

The program will come back with:

Enter offset <diskfile> [0] : (hit **return**)

Use standard Algorithm ? [Y/n] : (hit return)

Programming will begin by doing a blank check of the EPROM, the EPROM will be programmed with the file named name.bin, then the EPROM will have it's contents verified. The whole procedure takes just over 4 minutes on a 386SX computer. Do not disturb the EPROM until the whole process is complete.

5. A label must be affixed to the window of the EPROM when it has been programmed. This label must have written on it the date and the software version number. The software version should be R3.7 or later. Suitable labels can be obtained from most newsagents.

6. Replace the EPROM or fit the new EPROM as per the instructions in Section 4.

8 Log Interpretation

8.1 General

Log entries are displayed in the following format:

DOW, dd-mm-yy, hh:mm:ss.f, TYPE, NUMBER, NAME, STATE

Where

DOW is the day of the week. This is formatted as Sun for Sunday, Mon for Monday, Tue for Tuesday, Wed for Wednesday, Thu for Thursday, Fri for Friday, Sat for Saturday.

dd, is the day of the month that the event occurred.

mm, is the month in which the event occurred. This is formatted as 01 is January, to 12 is December.

yy, is the year in which the event occurred. This is formatted such that numbers greater than 91 refer to the year 1992 etc., and years less than 92 refer to the years 2000 etc.

hh, is the hour of the day that the event occurred in 24 hour format.

mm, is the minutes at which the event occurred.

ss   is the seconds at which the event occurred.

f, is fractions of a second at which the event occurred with a 0.25 second resolution.

TYPE , defines the type of log entry.

NUMBER, this is a number which starts at one for each type. It relate the log entry to external input, output, the internal logic that controls the event.

NAME, this is the name of the external input, output, or internal logic for which the event occurred.

STATE, this is the state to which the external input, output, or internal logic for which the event occurred has changed too.

Note that the Level Crossing monitor scans all of its inputs once every 0.25 seconds. Therefore any log entries that have a time stamp that matches to the fraction of a second occurred in the same scan. This means that the order log entries for which the time stamps match only identifies the order in which they were scanned and not the order in which they occurred.

The date and hours for each log event are stored as separate entries in the log. This may cause the oldest log entries to lose the date and hours information. When this occurs log entries similar to the following will occur for the oldest hour of the log:

??? 00-00-91 00:09:58.6 D 3   XT 1

All the information is correct with the exception of the hours of the day, day of the week, and date.

8.2 Log Entry Types

8.2.1 Digital Inputs and Outputs

A log entry type of "D" means that the log entry is for a digital input or digital output. Numbers in the range of 1 to 56 are inputs. Numbers in the range 57 to 64 are outputs.

The state for inputs is either "0" or "1". "0" means that the input is OFF. Normally this indicates that the relay or device being monitors is now in the down or de-energised state. "1" means that the input is ON. Normally this indicates that the relay or device being monitors is now in the up or energised state. If the name is prefixed by "NOT_" then the input state represents the inverse of the normal case.

Examples of an input changing state are:

```
        Wed 06-04-94 22:09:09.4 D 4        UXT 0

        Wed 06-04-94 22:10:27.4 D 4        UXT 1
```

The state for outputs is either "0" or "1". "0" means that the output is OFF. "1" means that the output is ON. If the name is prefixed by "NO_" then the output state represents the inverse of the sense.

Examples of an output changing state are:

```
        Tue 08-03-94 10:40:26.7 D 63       LOGIC 0

        Mon 14-03-94 15:18:48.2 D 63       LOGIC 1
```

8.2.2   Intermediate Variables

A log entry type of "I" means that the log entry is for an Intermediate variable. Numbers in the range of 1 to 10 are special Intermediate variable which are controlled by the Level Crossing Monitor software. Numbers in the range 11 to 32 are Intermediate variables which are controlled by Boolean expressions.

The state for Intermediate variables is either "0" or "1". "0" means that the Intermediate variable is OFF or has a logical state of FALSE. "1" means that the Intermediate variable is ON or has a logical state of TRUE.

Examples of an Intermediate variable changing state are:

```
        Wed 06-04-94 22:09:09.4 I 10   *LAMPS_ON 1

        Wed 06-04-94 22:10:27.4 I 10   *LAMPS_ON 0
```

8.2.3   Timers

A log entry type of "T" means that the log entry is for an Timer variable. Numbers in the range of 1 to 3 are special Timer variables which are controlled by the Level Crossing Monitor software. Numbers in the range 4 to 22 are Timer variables which are controlled by Boolean expressions.

The state for Timer variables is either "0" or "1". "0" means that the Timer variable is OFF or has a logical state of FALSE. "1" means that the Timer variable is ON or has a logical state of TRUE. The Timer will only become TRUE when the controlling Boolean expression has been TRUE for the Timer length.

Examples of a Timer variable changing state are:

```
        Mon 07-03-94 12:16:22.3 D 2        DXT 0

        Mon 07-03-94 12:16:42.1 T 19   NORM_APP_T 1

        Mon 07-03-94 12:16:58.3 D 2        DXT 1

        Mon 07-03-94 12:16:58.8 T 19   NORM_APP_T 0
```

Note that the DXT becoming "0" starts the 20 second NORM_APP_T timer which becomes TRUE 20 seconds later. The DXT becoming "1" cancels the NORM_APP_T timer which becomes FALSE shortly afterwards.

8.2.4   Analogue

A log entry type of "A" means that the log entry is for an Analogue event. There are four types of analogue events. These are Voltage, Lamp, Current, and Temperature events.

The number identifies the analogue channel for which the event occurred.

The state is different for each analogue event type and is a means of identifying the different types.

States of the form "nn.mm volts" are for battery voltage and voltage change events.

States of the form "FU n" and "FD n" are for lamp change events.

States of the form "nn.m amps" are for battery test current, and current events.

States of the form "nn.m degrees" are for temperature events.

8.2.4.1 Voltage

Battery voltage change events occur when the battery voltage has changed by more than 0.5 volts from the last logged value.

General voltage change events occur based on the percentage change specified in the expressions.

An example is:

```
        Thu 07-04-94 03:51:01.0 A 1    Battery 14.53 volts
```

8.2.4.2 Lamp

Lamp events occur when the number of lamps operating is detected to have changed. Typically the time taken to detect a change is 4 seconds.

The names are normally abbreviated. Typically the names and their meaning is as follows:

SS_LAMPS   Sydney Side lamp stand

CS_LAMPS   Country Side lamp stand

SS_TIP   Tip lights on the Sydney Side boom

CS_TIP   Tip lights on the Country Side boom

The state is of form "FU n" or "FD n". FU refers to the set of lamps operating when the flasher is UP state. FD refers to the set of lamps operating when the flasher is DOWN state. n is the number of lamps detected as operating.

Note that if the flasher fails whilst the lamps are operating the Level Crossing Monitor will not log a lamps event for the state to which the flasher no longer changes too. The "FU" or "FD" event logged may equally apply to the other flasher state even though it is not logged.

An example of lamp log entries is as follows:

```
        Wed 06-04-94 22:09:11.9 A 2    SS_LAMPS FU 3

        Wed 06-04-94 22:09:12.7 A 2    SS_LAMPS FD 3

        Wed 06-04-94 22:09:12.7 A 4    CS_LAMPS FU 3

        Wed 06-04-94 22:09:13.2 A 4    CS_LAMPS FD 3

        Wed 06-04-94 22:10:27.9 A 2    SS_LAMPS FD 0

        Wed 06-04-94 22:10:27.9 A 2    SS_LAMPS FU 0

        Wed 06-04-94 22:10:27.9 A 4    CS_LAMPS FD 0

        Wed 06-04-94 22:10:27.9 A 4    CS_LAMPS FU 0
```

8.2.4.3 Current

Battery test current change events occur when the battery test current has changed by more than 2.0 amps from the last logged value.

General current change events occur based on the percentage change specified in the expressions.

An example is:

```
        Thu 07-04-94 03:51:01.0 A 8      B_TEST_I 7.53 amps
```

8.2.4.4 *Temperature*

Temperature change events occur based on the percentage specified in the expressions.

An example is:

Thu 07-04-94 03:51:01.0 A 7   Ambient 28.53 degrees

8.2.5   Connection Status

A connection status log entry identifies when someone has either remotely or locally connected or disconnected a computer to the level crossing monitor.

Examples of the connection status of a serial port changing is:

Wed 06-04-94 22:09:09.4 Serial Port A connected

Wed 06-04-94 22:10:27.4 Serial Port A disconnected

8.3   Analysis

Analysis of multiple log entries requires a knowledge of the Boolean expressions with which the level crossing monitor has been configured.

An example is the following set of log entries:

```
Tue 08-03-94 10:43:37.2 D 16    LOW_BATT 0

Tue 08-03-94 10:43:37.2 D 58  NO_LX_FAULT 0

Tue 08-03-94 10:43:37.2 D 61    BATTERY 1

Tue 08-03-94 10:43:37.2 I 20   *DO_FAULT 1
```

The input LOW_BATT has become false. This caused the Intermediate variable *DO_FAULT to become true due to the Boolean expression upon which *DO_FAULT is based. This in turn caused the output NO_LX_FAULT to become false which is indicated on the front panel of the monitor and also is reported to the Control Centre. The input LOW_BATT has become false also caused the output BATTERY to become true due to its Boolean expression. BATTERY is used to indicate the type of fault that has occurred.

Note that because all the events occurred in the same 0.25 scan the order in the log is based on the scan order and not the order in which the events occurred.

An extract for a typical level crossing operation is as follows:

```
Wed 15/06/94 07:05:50.7 D 2        DXT 0

Wed 15/06/94 07:05:50.7 D 7        XR 0

Wed 15/06/94 07:05:50.7 D 8        XPR 0

Wed 15/06/94 07:05:50.7 I 10     *LAMPS_ON 1

Wed 15/06/94 07:05:50.7 I 13     *TRACK_UP 0

Wed 15/06/94 07:05:53.4 A 4      CS_LAMPS FU 3

Wed 15/06/94 07:05:54.2 A 2      SS_LAMPS FD 4

Wed 15/06/94 07:05:54.2 A 4      CS_LAMPS FD 3

Wed 15/06/94 07:05:54.9 A 2      SS_LAMPS FU 4

Wed 15/06/94 07:05:58.7 A 0       Battery 13.83 Volts

Wed 15/06/94 07:06:10.6 T 16     NORM_APP_T 1

Wed 15/06/94 07:06:21.6 D 3        XT 0
```

```
        Wed 15/06/94 07:06:21.6 I 15      *DOWN_TRAIN 1
        Wed 15/06/94 07:06:21.9 D 6        DDSR 1
        Wed 15/06/94 07:06:23.1 D 4        UXT 0
        Wed 15/06/94 07:07:00.4 D 3        XT 1
        Wed 15/06/94 07:07:00.6 D 2        DXT 1
        Wed 15/06/94 07:07:00.9 D 7        XR 1
        Wed 15/06/94 07:07:00.9 D 8        XPR 1
        Wed 15/06/94 07:07:00.9 I 10      *LAMPS_ON 0
        Wed 15/06/94 07:07:01.1 A 2       SS_LAMPS FU 0
        Wed 15/06/94 07:07:01.1 A 2       SS_LAMPS FD 0
        Wed 15/06/94 07:07:01.1 A 4       CS_LAMPS FU 0
        Wed 15/06/94 07:07:01.1 A 4       CS_LAMPS FD 0
        Wed 15/06/94 07:07:01.4 T 16      NORM_APP_T 0
        Wed 15/06/94 07:07:31.1 D 4        UXT 1
        Wed 15/06/94 07:07:31.1 I 13      *TRACK_UP 1
        Wed 15/06/94 07:07:31.1 I 15      *DOWN_TRAIN 0
        Wed 15/06/94 07:07:32.9 D 6        DDSR 0
        Wed 15/06/94 07:07:38.9 A 0        Battery 14.84 Volts
```

The level crossing for the example has 4 flashing lamps on the Sydney side lamp stand and 3 flashing lamps on the Country lamp stand.

8.4   Spurious Events

It is possible for some spurious events to occur and be reported in the log. These are:

- Analogue entries for lamps and battery test current due to the use of hand held radios or cellular telephones with-in the level crossing hut.

- Digital input events due to someone touching pins 5 and 6 on the 4N35 optoisolator on the Input Optoisolator board.

- Digital input events due to a faulty input on the SCADA 2000 A I/O Board.

Appendix A: Generic Configuration Data

File   GENERIC.CFG

```
; generic.cfg

; Configuration for Level Crossing monitors

;

;************** WARNING ! WARNING ! WARNING !
************************

;* This file should not be altered or modified by un-authorised
personnel*

;*****************************************************************
****

;

;------------------------------------------------

;FORMAT

;

; configuration I = input, O = output

; starts at the first word on the board

;------------------------------------------------

; station board_address BOARD CONFIGURATION

;

01 01 IIIIIIIO

;

;------------------------------------------------
```

File   GENERIC.IO

```
; Level Crossing

; GENERIC.IO

; Modification History

; 17 June 94 PJM updated for REL 3.2c or later code

; 03 July 94 updated

; 07 Sept 94 added train order working relays.

; 18 May 95 comments and warnings improved.

;

;**************** WARNING ! WARNING ! WARNING ! ***************

;* This file should not be altered or modified by un-authorised *

;* personnel. Any modifications to these i/o listings must be  *

;* fully tested before placed in to use!!!!!!            *

;**************************************************************

;

;INPUT I/O Listing


; NAME   BOARD BIT

BATT_TEST_IN 0  1 ; contacts from QBCA1 Battery Test Relay

DXT       0  2 ; DXT track circuit

XT       0  3 ; XT track circuit

UXT       0  4 ; UXT track circuit

UDSR      0  5 ; Up direction stick

DDSR      0  6 ; Down direction stick

XR       0  7 ; Crossing Control Relay

XPR       0  8 ; Crossing Control repeat relay


; inputs 9-12 are for signal ALSR & HR contacts


LOCAL_PB_RESET 0 13 ; push button reset from monitor front panel

TEST_ZK     0  14 ; level crossing test switch input

AC_SUPPLY    0  15 ; AC supply availability

BATT_ALARM_CARD 0 16 ; input from Store 74 alarm card relay

SS_LIGHT_ZK  0  17 ; SS emergency light switch

CS_LIGHT_ZK  0  18 ; CS emergency light switch

BELL_ZK    0  19 ; Bell emergency light switch

;;SS_BOOM_ZK   0 20 ; SS emergency gate switch
```

```
;;CS_BOOM_ZK    0 21 ; CS emergency gate switch
;;SS_GATE_UP_ZK 0 22 ; position of SS gate, 1 is gate up
;;CS_GATE_UP_ZK 0 23 ; position of CS gate 0 is gate down


; inputs 24-31 are for additional tracks and relays


DSPR      0  28 ; train order working
DSJR      0  29 ; train order working
DSJPR     0  30 ; train order working
DRAG_EQUIP  0  31 ; dragging equipment detector


TEST_CUT_OFF 0  32 ; Test Cut Off contact in battery test circuit


DOOR_SWITCH  0  33 ; location door switch


; inputs 49-56 are not logged and should not to be used except for
; monitoring the the flasher states.
FLASH_SYD   0  49
FLASH_COU   0  50



;OUTPUT I/O


BATT_TEST_OP 0  57 ; battery test relay output to do battery test
NO_LX_FAULT  0  58 ; normally output is 'on' indicating all OK
NO_LX_WARNING 0  59 ; normally output is 'on' indicating all OK
SYS_FAULT   0  60 ; system fault cannot be cleared with normal reset
BATTERY     0  61 ; problem with the battery
LAMP      0  62 ; either one lamp out or 2 or more lamps out
LOGIC      0  63 ; error in sequencing or direction sticks or timed out
TIMER_TEST_OP 0  64 ; TIMER TEST Relay to test timer and do battery
test



;*****************************************************************
; START SPECIAL INTERMEDIATE TERMS  WARNING ! WARNING ! WARNING !
; These intermediate terms are used by the system software.
; SPECIAL INTERMEDIATE TERMS MUST NOT BE ALTERED.
```

```
*SYSTEM_FAULT   ; Set/Cleared by system - a fault with the system

*ONE_LAMP_OUT   ; Set/Cleared by system - one lamp out detected

*LAMP_FAULT     ; Set/Cleared by system - > 1 lamps out or extra lamps

*BATT_LOW       ; Set/Cleared by system - Battery voltage below fail
point

*REMOTE_RESET   ; Set/Cleared by system - Remote reset of fail and
warning

*TEST_CURRENT_HIGH ; Set/Cleared by system - Battery test HIGH current
state

*TEST_CURRENT_LOW ; Set/Cleared by system - Battery test LOW current
state

*SECURITY       ; Used by system - Location Alarm/door switch

*TRAIN_FAULT    ; Used by system - Dragging equipment etc

*LAMPS_ON       ; Used by system to detect lamps on

*MAINT_DISABLE  ; Used by system to detect presence of maintenance
staff

*USER_STATUS1   ; Used by system - user status bit 1 for reporting

*USER_STATUS2   ; Used by system - user status bit 2 for reporting

; END SPECIAL INTERMEDIATE TERMS

;*****************************************************************


;*****************************************************************

; START NORMAL INTERMEDIATE TERMS

; These intermediate terms are modified to suit each site.

*RESET      ; OR's the push button reset and computer reset

*TRACK_UP   ; no tracks are down

*UP_TRAIN   ; train going in the UP direction

*DOWN_TRAIN ; train going in the DOWN direction

*APPROACH_WARN  ; train approach time < 20 sec

*FLASH_FAIL ; a flasher has failed or stuck in one position

*DO_WARNING ; Status of monitor is now WARNING

*FAULT_ON   ; fault sub expression

*DO_FAULT   ; Status of monitor is now FAULT



;Battery intermediate term

*BATTERY  B ; battery expression for battery alarm values etc
```

```
;Lamp intermediate terms
*SS_LAMPS   L ; allows you to set the number of SS flashing lamps
;;*SS_TIP   L ; allows you to set the number of SS boom steady lamps
*CS_LAMPS   L ; allows you to set the number of CS flashing lamps
;;*CS_TIP   L ; allows you to set the number of CS boom steady lamps


;********************************************************************
; START SPECIAL TIMERS           WARNING ! WARNING ! WARNING !
; These timers are used by the system software.
; SPECIAL TIMERS MUST NOT BE ALTERED.
*TIMER_SHORT   T ; timing test of NV battery test timer short
*TIMER_LONG    T ; timing test of NV nattery test timer long
*BATT_TEST_TIMER T ; battery test timer
*EMERGENCY_SW  T ; emergency switches left OFF for longer than set
time
*NO_TRAIN    T ; timer set for maximum period allowed with no trains
*NO_TEST     T ; timer set for maximum period allowed with no tests
*TOO_LONG    T ; crossing running for too long
; END SPECIAL TIMERS
;********************************************************************


;********************************************************************
; START NORMAL TIMERS
; These timers are modified to suit each site.
*BATT_TEST_FAULT  T ; battery test fault timer
*BATT_RELAY_FAULT T ; Battery test relay failed up
*MAINT_ON     T ; long push of the fault reset button
*MAINT_TIMEOUT   T ; time delay for maintenance before re-enable
reporting
*STICK_WARN    T ; direction stick failed to energize before departing
track dropped
*STICK_FAIL    T ; either direction stick is UP and no train about
*NOT_START     T ; crossing failed to start
*NOT_STOP      T ; crossing failed to stop
*NORM_APP_T    T ; crossing approach warning timer
*SS_FAIL_UP    T ; SS flasher failed in Up position
*SS_FAIL_DN    T ; SS flasher failed in Down position
*CS_FAIL_UP    T ; CS flasher failed in Up position
```

```
*CS_FAIL_DN     T ; CS flasher failed in Down position

*AC_SUP_WAR     T ; AC supply out longer than set time period

*LOW_BATT_TIMER  T ; low battery timer to allow for momentary dips

*VALID_TEST     T ; Check for correct test time

;;*GATE_DOWN     T ; gate should be down

;;*GATE_UP       T ; gate should be up

;;*GATE_FAIL     T ; gates failed to come to correct position


; END of I/O listing
```

File   GENERIC.exp

```
000 Generic, Generic Rd 000.00 07/09/94
; GENERIC.EXP Level Crossing expressions
; The 000 in the top line is the level crossing ID number
; each level crossing must be allocated a different ID number
;
; To print this file use courier fonts, do not use TABS when editing


; Modification History
; 17 JUN 94 PJM modified for R3.2 and later code
; 03 JUL 94 added disable for boom switches
; 08 JUL 94 allowed self clearing of no_test
; 07 SEP 94 altered too_long timer
; 18 MAY 95 altered maintenance disable timer
;
; Syntax Description
; =T  Timer time out timer in ###h ##m ##s expression is true.(max
255hrs)
; =L  Lamp channel, number of lamps flasher up, down, flasher i/p.
; =B  Battery configuration.
; =  Steady output. Output is on when expression is true.
; +  Logical OR
; &  Logical AND
; !  Logical NOT
; []  Grouping
; *  Identifies an intermediate term ( a result that is not an
output)
; ;  The rest of the line is a comment and ignored by system.


; Note: Expressions are evaluated in the order that they appear in
this file
;*************** WARNING ! WARNING ! WARNING ! **************
;* This file should not be altered or modified by un-authorised *
;* personnel. Any modifications to these expressions must be   *
;* fully tested before placed in to use!!!!!!           *
;*************************************************************
```

```
;BEGINNING OF EXPRESSIONS


;***************************************************************
; Timer and battery test expressions. DO NOT ALTER.
*TIMER_SHORT =T 4m 30s TIMER_TEST_OP ; minimum timing period for NV
timer
*TIMER_LONG =T 5m 30s TIMER_TEST_OP ; maximum timing period for NV
timer
*BATT_TEST_TIMER =T 4m 0s TIMER_TEST_OP & BATT_TEST_OP ; battery test
timer
*BATT_TEST_FAULT =T 7s TIMER_TEST_OP & BATT_TEST_OP &
!*TEST_CURRENT_HIGH
*BATT_RELAY_FAULT=T 3s [!TIMER_TEST_OP + !BATT_TEST_OP] &
!BATT_TEST_IN
;***************************************************************


; Reset of LX_fault or LX_warning
; This expression combines the front panel PB with the remote terminal
reset
*RESET = LOCAL_PB_RESET + *REMOTE_RESET


; Temporary Maintenance disable of reporting status if allowed.
*MAINT_ON   =T 5s LOCAL_PB_RESET   ; Requires long button press
*MAINT_TIMEOUT =T 45m 0s *MAINT_DISABLE ; disable reporting of changes
*MAINT_DISABLE = !*MAINT_TIMEOUT & [*MAINT_DISABLE & !LOCAL_PB_RESET +
*MAINT_ON]


;Site specific expressions which may need alteration to suit the LX
installation


; For CTC areas where the XZR relay is controlling a remote XR the
following
; equation is required to give the equivalent TEST_ZK input to the
monitor
; *TEST_ZK_TIMER =T 3s XZR & !XR ; add this timer variable to the I/O
list
; *TEST_ZK = !*TEST_ZK_TIMER   ; add this variable to I/O list


; For level crossings which have interlocked signals the *NOT_START,
*NOT_STOP,
; *STICK_WARN, *STICK_FAIL, *UP_TRAIN, *DOWN_TRAIN should be deleted
```

```
; Check for train direction and for all tracks up
*TRACK_UP  = UXT & XT & DXT
*UP_TRAIN  = [[!UXT & !XT] + [!*TRACK_UP & *UP_TRAIN]] & !*DOWN_TRAIN
*DOWN_TRAIN = [[!DXT & !XT] + [!*TRACK_UP & *DOWN_TRAIN]] & !*UP_TRAIN


; Check direction sticks
; direction stick failed to energize before departing track dropped
*STICK_WARN =T 3s [!DXT & *UP_TRAIN & !UDSR] + [!UXT & *DOWN_TRAIN &
!DDSR]
; direction stick failed energized
*STICK_FAIL =T 6s [DDSR + UDSR] & *TRACK_UP


; Check for proper crossing operation
*NOT_START =T 6s [[!UXT & !DDSR] + [!DXT & !UDSR] + !XT] & XR
*NOT_STOP  =T 6s [UXT + DDSR] & [DXT + UDSR] & XT & !XR & TEST_ZK
*TOO_LONG  =T 20m 0s !XR   ; level crossing activated for > 20 minutes


; Check approach times for train approaching level crossing
*NORM_APP_T   =T 20s *LAMPS_ON ;20 sec approach warning timer
*APPROACH_WARN  = [!*NORM_APP_T & !XT + *APPROACH_WARN & !*TRACK_UP] &
SS_LIGHT_ZK & CS_LIGHT_ZK


; Check flashing speed for both SS and CS flashers
*SS_FAIL_UP =T 5s FLASH_SYD & *LAMPS_ON
*SS_FAIL_DN =T 5s !FLASH_SYD & *LAMPS_ON
*CS_FAIL_UP =T 5s FLASH_COU & *LAMPS_ON
*CS_FAIL_DN =T 5s !FLASH_COU & *LAMPS_ON
*FLASH_FAIL = *SS_FAIL_UP + *SS_FAIL_DN + *CS_FAIL_UP + *CS_FAIL_DN


; Check emergency switches are left in correct position,timer set for
10 minutes
;
*EMERGENCY_SW =T 10m 0s !SS_LIGHT_ZK + !CS_LIGHT_ZK
;;*EMERGENCY_SW =T 10m 0s !SS_LIGHT_ZK + !CS_LIGHT_ZK + !SS_BOOM_ZK +
!CS_BOOM_ZK


; Check time since last train through level crossing
```

```
*NO_TRAIN =T 72h 0m 0s UXT & DXT ; either approach track down resets
timer


; Lamps should now be ON

*LAMPS_ON = !XR & SS_LIGHT_ZK & CS_LIGHT_ZK

;;*LAMPS_ON = [!XR + [!SS_GATE_UP_ZK & SS_BOOM_ZK] + [!CS_GATE_UP_ZK &
CS_BOOM_ZK]] & SS_LIGHT_ZK & CS_LIGHT_ZK


; Gate expressions if required

;; *GATE_DOWN =T 21s !XR ; gate lowers within 21sec of XR dropping

;; *GATE_UP  =T 16s XR ; gate raises within 16sec of XR energizing

;; *GATE_FAIL =T 5s [*GATE_DOWN & !XNR + *GATE_UP & [!SS_GATE_UP_ZK +
!CS_GATE_UP_ZK]] & SS_BOOM_ZK & CS_BOOM_ZK


; Check that a local or remote test of LX is done within 36hrs of
previous test

*VALID_TEST  =T 2m 0s !TEST_ZK ; TIMER SET FOR LOCAL TESTER.

*NO_TEST  =T 36h 0m 0s !BATT_TEST_OP & !*VALID_TEST


;*NO_TEST  =T 36h 0m 0s !BATT_TEST_OP   ;Original Expression


; Check AC supply hasn't been off for too long.

*AC_SUP_WAR =T 6h 30m 0s !AC_SUPPLY


; Low battery timer so that short voltage dips are ignored.

*LOW_BATT_TIMER =T 3s !BATT_ALARM_CARD + *BATT_LOW


; Check of ancillary deterors that may be fitted later.

; Dragging equipment detector and door alarm.

*SECURITY  = DOOR_SWITCH

*TRAIN_FAULT = DRAG_EQUIP

;; Other user status bits. These are assigned as follows.

;; *USER_STATUS1 = !HIGH_LOAD

;; *USER_STATUS2 = whatever.

;; These must be included in Failure or warnings and added to

;; Control Centre database for the message required.


; Warning Expressions
```

```
*DO_WARNING = [!*RESET & *DO_WARNING] + *AC_SUP_WAR + *ONE_LAMP_OUT +
*SYSTEM_FAULT + *EMERGENCY_SW


; Fault Expressions

; Don't forget to include *GATE_FAIL if their are BOOMs.

*FAULT_ON  = *STICK_FAIL + *NOT_START + *NOT_STOP + *FLASH_FAIL +
*TOO_LONG


*DO_FAULT = [!*RESET & *DO_FAULT] + *FAULT_ON + *LOW_BATT_TIMER +
*LAMP_FAULT + *BATT_RELAY_FAULT + *BATT_TEST_FAULT


; Set output expressions

NO_LX_WARNING = !*DO_WARNING & !*NO_TRAIN & !*NO_TEST

NO_LX_FAULT  = !*DO_FAULT

SYS_FAULT   = *SYSTEM_FAULT

LOGIC    = *FAULT_ON + *BATT_RELAY_FAULT + LOGIC & !*RESET

LAMP     = *ONE_LAMP_OUT + *LAMP_FAULT + LAMP & !*RESET

BATTERY   = *LOW_BATT_TIMER + *AC_SUP_WAR + *BATT_TEST_FAULT +
BATTERY & !*RESET


; Battery Expression

; fail point, battery offset, battery test channel, battery test min
on current

; max test off current

; set battery fail point to 14.1 for 12 cells and 11.7 for 10 cells

; set the battery offset for 0.16 as this is typical

; battery test channel is 8

; battery test min of 6.0 (amps) is the minimum current required
during battery test

; battery max test off current is the maximum current allowed when no
test is

; being done, the value of 1.0 allows for the current sensor offset


*BATTERY  =B 11.7 0.16 8 6.0 1.0


; Lamps Expressions

; analogue channel number, num lamps flasher up, num lamps flasher
down,

; flasher input name
```

```
*SS_LAMPS  =L 2 2 2 FLASH_SYD
*CS_LAMPS  =L 4 2 2 FLASH_COU


; if you have boom gates you need the following for the boom tip
lights
;*SS_TIP =L 3 1 0 STEADY
;*CS_TIP =L 5 1 0 STEADY


; END of Expression file
```

Appendix B: Level Crossing Monitor - Test and Commissioning Form

Location:		Kilometerage:	

Installation Inspected and Correct:	
SCADA 2000 A Link 12-13 installed:	
SCADA 2000 A Link 13-14 removed:	
EPROM installed correctly and labelled:	

Monitor Powers Up:		Name Set:	
Code:		Crossing ID number:	
Data:		Pin numbers set	
Date and Time set		Log cleared:	
System test:		Monitor reset:	
Dialup on fault and warning enabled		Maintenance facility enabled	

Input information displayed and checked:	
Output information displayed and checked:	
Intermediate information displayed and checked:	
Timer information displayed and checked:	
Analogue information displayed and checked:	
Battery charger adjustment correct for additional load:	

Current sensor no current output voltages

Country side lamps:		Sydney side lamps:	
Country side tip:		Sydney side tip:	
Battery test:			

Input correspondence in accordance with circuit book and I/O list.

1 BATT_TEST_IP		2 DXT		3 XT	
4 UXT		5 UDSR		6 DDSR	
7 XR		8 XPR		9	
10		11		12	
13 LOCAL_PB_RESET		14 TEST_ZK		15 AC_SUPPLY	
16 BATT_ALARM_CARD		17 SS_LIGHT_ZK		18 CS_LIGHT_ZK	
19 BELL_ZK		20		21	
22		23		24	
25		26		27	
28		29		30	
31		32 TESTCUTOFF			

Lamp learn successfully performed:	

Lamp learn results: (FU/FD differences >5 need to be investigated)

Country side lamps FD		Country side lamps FU	
Sydney side lamps FD		Sydney side lamps FU	
Country side tip FD		Country side tip FU	
Sydney side tip FD		Sydney side tip FU	

Battery voltage measured on battery terminals:	
Battery voltage offset set in monitor:	
Battery voltage reported by monitor:	
Modem IP address set to:	
Country side lamps corresponded by removing a Country side lamp:	
Sydney side lamps corresponded by removing a Sydney side lamp:	
Restore both lamps and clear lamp fault OK:	
Country side tip corresponded by removing the Country side lamp:	
Sydney side tip corresponded by removing the Sydney side lamp:	

Non-generic expressions which were tested

Name	Result	Name	Result

Monitor reset with modem connected and turned on:	
Serial Channel A left set at 9600, 8, N, 1	
Serial Channel B left set at 19200, 8, N, 1	
3G connection checked:	
Modem Surge Protection unit installed correctly	

Battery test successfully performed:	
Battery test current:	
Check the monitor case is isolated from level crossing supply:	
Check that correct voltage TEST_SW VIO is installed on XR circuit	

Battery fault simulated and reported correctly to the Control Centre	
Log of testing period reviewed:	

Comments:					
Flasher model currently installed SS Flasher:		Date	CS Flasher:	Date:	

Tests performed by :	
Signed :	
Date :	

Initial 7 days of log reviewed by:	
Comments:	
Signed :	
Date :	

Appendix C: Standard Level Crossing Monitor Interface Circuits

A copy of the Signalling Standard circuits for interfacing to a level crossing monitor are contained in CRN specification CRN SM 015 "Cerberus Level Crossing Drawings and Circuit Diagrams". These are sheets X3, X7, X14, X15, X20, X23, X25, X26, X42, X45, X121, and X122.

Appendix D: Drawings

The drawings listed below appear in CRN specification CRN SM 015 "Cerberus Level Crossing Drawings and Circuit Diagrams".

1033-3 Vital Indication Optoisolator (VIO) Circuit schematic

1033-4 Vital Indication Optoisolator (VIO) Housing

M08-723	SCADA-2000 A/2.0 I/O Board component layout
M08-724	SCADA-2000 A/2.0 I/O Board Block diagram
M08-731	Individual input optoisolator mechanical diagram
M08-732	Individual input optoisolator schematic diagram
M08-733	Individual input optoisolator circuit diagram (marked up for 12 volts)
M08-781	SCADA-2000 A/2.0 I/O Board jumper allocations. (marked up for LX monitor)
M08-782	Individual input optoisolator operational circuit diagram (marked up for 12 volts)
M08-851/1	ADC Circuit
M08-851/2	ADC PCB Dimensions
M08-854	Current sensor physical details
M08-855	Current sensor circuit
M08-861	Optoisolator board cable
M08-862	Level Crossing Monitor Flasher cable
M08-863	Level Crossing Monitor Modem Cable
M08-864/A	Level Crossing Monitor wiring diagram Page 1 of 2 V2
M08-864/B	Level Crossing Monitor wiring diagram Page 2 of 2
M08-865/A	Level Crossing Monitor front panel layout V2
M08-865/B	Level Crossing Monitor rear panel layout
M08-866	Lightning protection unit and voltage limiter circuit diagram
M08-870	Backplane physical aspects
M08-871	8-way output optoisolator layout
M08-872	Level Crossing Monitor - 8 way output optoisolator
M08-873	8-way output optoisolator cable
CSSC SRA1016	Level Crossing Monitor unit assembly. Sheet 4
CSSC SRA1016	Level Crossing Monitor unit assembly. Sheet 5
CSSC SRA1022	V/Suppress PCB for SRA1016.