# **OX-AN**<sup>®</sup> F - Gas Environmental **Monitoring System Operation** Manual

Issue 1.7

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# **1.0 Introduction**

The OX-AN R-134a Leak detection Monitor provides audible and visual warnings of the presence of R-134a within a specified area. For hazardous areas, the Monitor also provides facilities for monitoring reductions in Oxygen levels.

Features include:

- Up to 4 × USB based signal capture modules (total 32 sensors)
- Up to 4 × USB based relay modules (total 24 relays)
- .Net based software using Windows XP native USB drivers
- 1024×768 Touchscreen interface
- Individual sensor inputs software configurable for R-134a or O<sub>2</sub>.
- 4 configurable alarm levels
- 33 configurable Output Groups
- Sound Alarms
- Relay specific Mute
- Sensor specific Isolate
- Sensor value logging
- Alarm logging
- Test Button which can be used to activate any alarm

# 2.0 Software

The OX-AN R-134a Monitor software comprises:

- 1. PC based application R134AMonitor
- 2. PC XML configuration files
- 3. Signal Board PIC18F2550 Firmware
- 4. Relay Board PIC18F2550 Firmware

OX-AN Monitoring systems are typically configured prior to delivery and commissioning. If a software upgrade or re-install is required please contact OX-AN Gas Detection Ltd.

## 2.1 PC Software

OX\_AN software is designed to run on Windows XP system (SP2) with .Net framework v3.0. The .Net framework is not included within the OX-AN R-134a Leak detection Monitor and hence, if a full installation of the operating system is required, these components must be installed separately.

# **2.2 PC XML Configuration Files**

The XML configuration files contain the configuration data for the system settings. These files are located in **c:\ R134AMonSettings**. If these files require replacement, they can be overwritten by the new version. There are 4 files:

1. OutputContainer.sxml

- 2. RelayContainer.sxml
- 3. SensorContainer.sxml
- 4. SystemSettings.sxml

Note that "restoring system defaults" will overwrite these files.

## 2.3 Signal Board PIC18F2550 Firmware

The firmware located within the embedded boards can only be changed by replacing the PIC processor with a pre-programmed PIC. Please contact OX-AN if the firmware requires replacement.

# 2.4 Relay Board PIC18F2550 Firmware

The firmware located within the embedded boards can only be changed by replacing the PIC processor with a pre-programmed PIC. Please contact OX-AN if the firmware requires replacement.

# **3.0 Getting Started**

The following procedure should be used when starting the system from a complete power down.

- 1. Ensure that power is applied to the UPS
- 2. Isolate the outputs (using the keyswitch)
- 3. Ensure that power is applied to the Signal and Relay boards (using the keyswitch)
- 4. Start the PC (using the key switch)
- 5. System should automatically run the R134aMonitor program. If this does not occur, run the application by selecting **Start>R134aMonitor>R134aMonitor**
- 6. Enable the outputs (using the keyswitch)

The R134aMonitor application will display the screen shown in Fig 2.0. Note that your system may display different data. There are three screen tabs which can be viewed during normal running. Each of these tabs is described in the following sections.

# 3.1 Sensor Value Tab

| 📰 R134A Monitor v1           | .3        |        |                                |               |               |               |               |             |          |     |
|------------------------------|-----------|--------|--------------------------------|---------------|---------------|---------------|---------------|-------------|----------|-----|
| File Settings Log            | ina       |        |                                |               |               |               |               |             |          |     |
| Control Panel 🗸 📮            | Sensor Va | lues 🗐 | utputs Diamostics              |               |               |               |               |             |          | 4 1 |
|                              | Jensol Va | iuos O |                                | -             |               | -             | Casi C        |             |          |     |
|                              | OX-A      | N      | R-134a                         | ) Dete        | ectio         | n Sv          | stem          |             |          |     |
| Sound                        |           |        | IX IS IC                       |               |               | T Jy          | Jeem          |             |          |     |
| Alarme                       |           |        |                                |               |               |               |               |             |          |     |
| Alanna                       |           | Sensor | Location                       | Alarm Level 1 | Alarm Level 2 | Alarm Level 3 | Alarm Level 4 | Value (ppm) | Isolated |     |
|                              | R-134a    | 1      | Sensor 1 location              | 300           | 400           | 800           | 1200          | 81          |          |     |
|                              |           | 2      | Sensor 2 location              | 300           | 400           | 800           | 1200          | 75          |          |     |
|                              |           | 3      | Sensor 3 location              | 300           | 400           | 800           | 1200          | /5          |          |     |
| Muto                         |           | 4      | Sensor 4 location              | 300           | 400           | 800           | 1200          | 28          |          |     |
| mute                         |           | 0      | Sensor S location              | 300           | 400           | 800           | 1200          | 78          |          |     |
|                              |           | 5      | Sensor 6 location              | 300           | 400           | 800           | 1200          | 30          |          |     |
|                              |           | 6      | Sensor 7 location              | 300           | 400           | 800           | 1200          | 22          |          |     |
|                              |           | 8      | Sensor & location              | 300           | 400           | 800           | 1200          | 22          |          |     |
|                              |           | 10     | Sensor 10 location             | 200           | 400           | 900           | 1200          | 0           |          |     |
| 10000                        |           | 11     | Sensor 11 location             | 300           | 400           | 800           | 1200          | 0           |          |     |
| Reset                        |           | 14     | Sensor 14 location             | 300           | 400           | 800           | 1200          | 6           |          |     |
| 110501                       |           | 15     | Sensor 15 location             | 300           | 400           | 800           | 1200          | ů.          |          |     |
|                              |           | 16     | Sensor 16 location             | 300           | 400           | 800           | 1200          | Ő           |          |     |
|                              |           | 10     |                                |               | 100           |               | 1200          |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
| 6                            |           |        |                                |               |               |               |               |             |          |     |
| and the second second second |           |        |                                |               |               |               |               |             |          |     |
| Fan Control                  |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
| On                           |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
| 04                           |           |        |                                |               |               |               |               |             |          |     |
| ΟΠ                           |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           | _      |                                |               |               |               |               |             |          |     |
| Test                         |           |        |                                |               |               |               |               |             |          |     |
| 1050                         |           | Sensor | Location                       | Alarm Level 1 | Alarm Level 2 | Alarm Level 3 | Alarm Level 4 | Value (%)   | Isolated |     |
|                              |           | 12     | Sensor 12 location             | 20.5          | 20            | 19            | 18            | 23.44%      |          |     |
|                              | 0         | 13     | Sensor 13 location             | 20.5          | 20            | 19            | 18            | 23.37%      |          |     |
|                              | $O_2$     | 2.5    | a berenen er en en en er er er | 207241        | 330P          | 1999 C        | 0.000         | 1120100400  |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
|                              |           |        |                                |               |               |               |               |             |          |     |
| 00,00,00                     |           |        |                                |               |               |               |               |             |          |     |
| 23/36/35                     |           |        |                                |               |               |               |               |             |          |     |

Fig 2.0 Sensor Values Tab

During normal running the Monitoring Screen (Fig 2.0) displays the location text, alarm levels, sensor value and isolate status for both R-134a and  $O_2$  sensors. This is the normal viewing screen.

# 3.2 Outputs Tab

The Outputs tab, Fig 3.0, displays the current state of the relay outputs connected to the system. During normal running the tab shows the location text and relay state for all relays.



Fig 3.0 Outputs Tab

## **3.3 Diagnostics Tab**

The Diagnostics tab provides a visual and textual indication of the connected Sensor and Relay boards. It is important the number of connected boards is correctly specified in the system settings. A fault condition occurs if any configured boards are missing from the system.

The Diagnostics tab is shown as Fig 4.0

| 📰 R134A Monitor v1 | 1.3                       |                      |                |                |
|--------------------|---------------------------|----------------------|----------------|----------------|
| File Settings Logo | ging                      |                      |                |                |
| Control Panel 👻 📮  | Sensor Values Outputs Dia | agnostics            |                | 4 Þ            |
| Sound              | Sensor Board 1            | Sensor Board 2       | Sensor Board 3 | Sensor Board 4 |
| Alarms             | Device present            | Device present       | Device Missing | Device Missing |
| Mute               | Sensor Board 1 found      | Sensor Board 2 found |                |                |
|                    | Belau Roard 1             | Relau Roard 2        | Relau Roard 3  | Belay Board 4  |
| Reset              | 0                         | 1                    | Theory bland 5 |                |
|                    | Device present            | Device present       | Device Missing | Device Missing |
|                    | Relay Board 1 found       | Relay Board 2 found  |                |                |
| Fan Control        |                           |                      |                |                |
| On                 |                           |                      |                |                |
| Off                |                           |                      |                |                |
| Test               |                           |                      |                |                |
|                    |                           |                      |                |                |
| 23:57:48           |                           |                      |                |                |

Fig 4.0 Diagnostics Tab

# 4.0 User Operation

During normal operation (i.e. not during configuration) the OX-AN R-134a Leak detection Monitor is designed for operation via a touchscreen interface.

## **4.1 Touchscreen Buttons**

Three touchscreen buttons provide the main functionality:

| Sound Alarms | Activates all relays allocated to the Sound Alarms Output Group   |
|--------------|---|
| Mute         | Deactivates, for a specified time period, all relays which are activated but set as<br>muteable                             |
| Reset        | Resets all alarm levels, Test outputs and Fan control outputs   |
| Test         | Activates all relays allocated to the Test Output Group   |
| Fans On      | Activates all relays allocated to the Fan Control Group   |
| Fans Off     | Resets all relays allocated to the Fan Control Group – note relays may remain on if allocated to other active output groups |

## **4.2 Alarm Levels**

Each alarm level changes the corresponding line in the sensor list.

| Alarm Level 1 | Line background LIGHT GREY                                     |
|---------------|--|
| Alarm Level 2 | Line background AMBER  |
| Alarm Level 3 | Line background FLASHING AMBER and AMBER ALARM WARNING visible |
| Alarm Level 4 | Line background RED and RED ALARM WARNING visible              |

Fig 5.0 shows the system output for a RED alarm state.

| 🔜 R134A Monitor v       | 1.3       |  |  |  |  |  |   |   |          |     |
|-------------------------|-----------|--|--|--|--|--|---|---|----------|-----|
| File Settings Log       | ging      |  |  |  |  |  |   | A   | larm     |     |
| Control Panel 👻 📮       | Sensor Va | lues 0   | utputs Diagnostics   |  |  |  |   |   |          | 4 Þ |
| Sound                   | OX-A      | No   | R-134a   | Dete   | ectio  | n Sy   | stem  | AL  | ARM      |     |
| Alarms<br>Mute<br>Reset | R-134a    | Sensor<br>1<br>2<br>3<br>4<br>5<br>5<br>7<br>7<br>8<br>9<br>10<br>11<br>14<br>15<br>16 | Location<br>Sensor 1 location<br>Sensor 3 location<br>Sensor 3 location<br>Sensor 4 location<br>Sensor 5 location<br>Sensor 7 location<br>Sensor 7 location<br>Sensor 6 location<br>Sensor 10 location<br>Sensor 11 location<br>Sensor 11 location<br>Sensor 15 location<br>Sensor 16 location | Alarm Level 1<br>300<br>300<br>300<br>300<br>300<br>300<br>300<br>300<br>300<br>30 | Alarm Level 2 400 400 400 400 400 400 400 400 400 40 | Alarm Level 3 800 800 800 800 800 800 800 800 800 80 | Alam Level 4 1200 1200 1200 1200 1200 1200 1200 120 | Value (ppm)<br>81<br>75<br>75<br>28<br>28<br>47<br>22<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | Isolated |     |
| Fan Control             |           |  |  |  |  |  |   |   |          |     |
| Test                    | 02        | Sensor<br>12<br>13   | Location<br>Sensor 12 location<br>Sensor 13 location   | Alarm Level 1<br>20.5<br>20.5  | Alarm Level 2<br>20<br>20                            | Alarm Level 3<br>19<br>19                            | Alam Level 4<br>18<br>18                            | Value (%)<br>23.41%<br>23.17%   | Isolated |     |

#### Fig 5.0 Display in Red Alarm

## 4.3 Fault

The system enters fault state if communications are lost with configured Relay or Signal Boards.

Fault state is also entered if the user enters configuration mode or show actual values.

## 4.4 Isolate

The Isolate warning message is shown if any active sensor is isolated. In isolated state the sensor does not cause any output activity (i.e. no relays are activated).

For details of how to isolate a sensor see section 5.1.

### **4.5 Test**

If the Test Output Group has been activated by pressing the **Test button**, the button is illuminated and the system displays the Test Status warning message.

If the test warning message is displayed, the system continues to operate normally. To exit Test mode press the **Reset** button.

## 4.6 Fan Control

The Fan Control buttons activate and reset the Fan Control Output Group. **Note that output relays** which are energised by the Fan Control Output Group being activated will not be muteable.

#### 4.6.1 Fans On

The **Fans On** button activates the Fan Control Output Group. When pressed the button will be illuminated and the system will show the Fans On warning message. The Fan Control Output Group can be reset by either pressing the **Fans Off** button or by pressing the **Reset** button.

#### 4.6.2 Fans Off

The Fans Off button resets the Fan Control Output Group.

# **5.0 System Configuration**

The system provides 4 configurable alarm levels for each sensor input. Each of these alarm levels can be programmed to activate an individual Output Group (up to 33) which, in turn, may contain up to 24 relays.

To program the system:

- 1. Set the number of Sensor boards and Relay Boards
- 2. Ensure that the Sensor and Relay boards are correctly addressed
- 3. Set the location text for the relay outputs
- 4. Allocate the required relays to the individual Output Groups
- 5. Select the type for each sensor
- 6. Set the location text for each sensor
- 7. Set the required alarm levels for each sensor
- 8. Set the alarm text for each sensor alarm level
- 9. Allocate the required Output Group to each sensor alarm level

Note that defaults are provided for all settings.

Selecting menu option **Settings>Configuration** moves the system into the configuration mode and displays the screen shown as Fig 6.0.

In this mode the system is still functional but since the alarm levels cannot be viewed the user is alerted to a change in the mode by entering the fault state. To exit the configuration mode choose the **Cancel** button to exit without saving, or press the **Save** button to save changes.

In both cases the system will show "initialising" for approximately 10 seconds before returning to normal operation.

Note saving configuration changes will cause the system to reset.

The configuration screen has 4 tabs:

- 1. Inputs settings for Sensors
- 2. Outputs settings for Relays
- 3. Input-Output Output Group settings
- 4. System general system settings

# **5.1 Configuring Inputs (Sensors)**

The Input tab is shown in Fig 6.0.

| 🖷 R134A Monitor v | 1.3           |              |        |                    |                     |   |               |                  |               |                            |                   |       |
|-------------------|---------------|--------------|--------|--------------------|---------------------|---|---------------|------------------|---------------|----------------------------|-------------------|-------|
| File Settings Log | ging          |              |        |                    |                     |   | 5             | ystem ⊢ault      |               |                            |                   |       |
| Control Panel 👻 👎 | Config        |              |        |                    |                     |   |               |                  |               |                            |                   | 4 Þ : |
| Sound             | System Co     | nfiguratio   | n      |                    |                     |   |               |                  |               | Cancel Save                |                   |       |
| Alarmo            | mpors Durpurs | input-output | System |                    |                     | 1.1.2.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1 |               | 1                | I North March |                            |                   |       |
| Alainis           | Sensor Number | Sensor Type  | Active | Location Text      | Samples per Reading | Isolated                                | Alarm Level 1 | Hysteresis Value | Latching      | = Isolate                  |                   | 10    |
|                   | 1             | R134a        | True   | Sensor 1 location  | 8                   | False                                   | 300           | 10               | False         | Isolated                   | False             |       |
|                   | 2             | R134a        | True   | Sensor 2 location  | 8                   | False                                   | 300           | 10               | False         | Board                      |                   |       |
|                   | 3             | R134a        | Irue   | Sensor 3 location  | 8                   | False                                   | 300           | 10               | False         | Card Switch Setting        | 0                 |       |
| 100 PT 12         | 4             | H134a        | True   | Sensor 4 location  | 8                   | False                                   | 300           | 10               | False         | USB PID                    | 64                |       |
| Mute              | 2             | H134a        | True   | Sensor 5 location  | 8                   | False                                   | 300           | 10               | False         | LISB VID                   | 1240              |       |
|                   | 7             | D134a        | True   | Sensor 6 location  | 0                   | False                                   | 200           | 10               | False         | - Senear                   |                   |       |
|                   | 6             | D1245        | True   | Sensor 9 location  | 0                   | Enlog                                   | 200           | 10               | False         | Constitution               | 14                |       |
|                   | °<br>a        | D1245        | True   | Sensor 9 location  | 0                   | False                                   | 200           | 10               | False         | Sensor Number              | 1                 |       |
|                   | 10            | P1245        | True   | Concor 10 location | 0                   | Ealao                                   | 200           | 10               | Enlog         | Sensor Type                | R134a             |       |
|                   | 11            | B134a        | True   | Sensor 11 location | 8                   | False                                   | 300           | 10               | False         | Active                     | True              |       |
| Deeet             | 12            | 02           | True   | Sensor 12 location | 8                   | False                                   | 20.5          | 10               | False         | Location Text              | Sensor 1 location |       |
| Reset             | 13            | 02           | True   | Sensor 13 location | 8                   | False                                   | 20.5          | 10               | False         | Samples per Beading        | 8                 |       |
|                   | 14            | B134a        | True   | Sensor 14 location | 8                   | Ealse                                   | 300           | 10               | False         | And Make                   | 100               |       |
|                   | 15            | B134a        | True   | Sensor 15 location | 8                   | Ealse                                   | 300           | 10               | False         | 4114 Value                 | 160               |       |
|                   | 16            | B134a        | True   | Sensor 16 location | 8                   | False                                   | 300           | 10               | False         | 20mA Value                 | 803               |       |
|                   | 17            | B134a        | True   | Sensor 17 location | 8                   | False                                   | 300           | 10               | False         | Sensor Value Step Size     | 3                 |       |
|                   | 18            | B134a        | True   | Sensor 18 location | 8                   | False                                   | 300           | 10               | False         | Alarm Level 1              |                   |       |
|                   | 19            | R134a        | True   | Sensor 19 location | 8                   | False                                   | 300           | 10               | False         | Alarm Level 1              | 300               |       |
|                   | 20            | R134a        | True   | Sensor 20 location | 8                   | False                                   | 300           | 10               | False         | Husteresis Value           | 10                |       |
|                   | 21            | R134a        | True   | Sensor 21 location | 8                   | False                                   | 300           | 10               | False         | Lataking Makes             | False             |       |
|                   | 22            | R134a        | True   | Sensor 22 location | 8                   | False                                   | 300           | 10               | False         | Laterning value            | Faise             |       |
|                   | 23            | R134a        | True   | Sensor 23 location | 8                   | False                                   | 300           | 10               | False         | Uutput Group               | 1                 |       |
|                   | 24            | R134a        | True   | Sensor 24 location | 8                   | False                                   | 300           | 10               | False         | Alarm Text                 | Level1 Alarm      |       |
| Ean Control       | 25            | R134a        | True   | Sensor 25 location | 8                   | False                                   | 300           | 10               | False         | Alarm Level 2              |                   |       |
|                   | 26            | R134a        | True   | Sensor 26 location | 8                   | False                                   | 300           | 10               | False         | Alarm Level 2              | 400               |       |
|                   | 27            | R134a        | True   | Sensor 27 location | 8                   | False                                   | 300           | 10               | False         | Husteresis Value           | 10                |       |
| On                | 28            | R134a        | True   | Sensor 28 location | 8                   | False                                   | 300           | 10               | False         | L stalaine Value           | Falsa             |       |
|                   | 29            | H134a        | True   | Sensor 29 location | 8                   | False                                   | 300           | 10               | False         | Latering value             | raise             |       |
|                   | 30            | H134a        | True   | Sensor 30 location | 8                   | False                                   | 300           | 10               | False         | Output Group               | 1                 |       |
|                   | 31            | H134a        | True   | Sensor 31 location | 8                   | False                                   | 300           | 10               | False         | Alarm Text                 | Level2 Alarm      |       |
| Off               | 32            | R134a        | True   | Sensor 32 location | 8                   | False                                   | 300           | 10               | False         | Alarm Level 3              |                   |       |
|                   |               |              |        |                    |                     |   |               |                  |               | Alarm Level 3              | 800               |       |
|                   |               |              |        |                    |                     |   |               |                  |               | Husteresis Value           | 10                |       |
|                   |               |              |        |                    |                     |   |               |                  |               | Late Constant and Constant | Table             |       |
|                   |               |              |        |                    |                     |   |               |                  |               | Latching value             | raise             |       |
| Test              |               |              |        |                    |                     |   |               |                  |               | Uutput Group               | 3                 |       |
|                   |               |              |        |                    |                     |   |               |                  |               | Alarm Text                 | Level3 Alarm      | ~     |
|                   |               |              |        |                    |                     |   |               |                  |               | Alarm Level 1              |                   |       |
|                   |               |              |        |                    |                     |   |               |                  |               |                            |                   |       |
|                   | 1             |              |        | 1                  |                     |   |               |                  | >             |                            |                   |       |
| 0.23.27           |               |              |        |                    |                     |   |               |                  |               |                            |                   |       |

Fig 6.0 Configuration Input Tab

To change a setting select the appropriate line in the sensor list and then modify the parameters using the property sheet on the right hand side of the tab.

#### 5.1.1 Input (Sensor) Properties

The configurable input parameters are:

For each sensor

- 1. Isolated Isolation state, when true sensor does not trigger alarm levels
- 2. Sensor Type R134a or O<sub>2</sub>
- 3. Active Set true if sensor is present (if false sensor is ignored)
- 4. Location Text Text shown as sensor location in log
- 5. Samples Per Reading Number of samples used in calculating the sensor value
- 6. 4mA Value Offset for zero
- 7. 20mA ValueOffset for full scale
- 8. Sensor Value Step Size Delta for changing the screen display

For each sensor Alarm Level

| 1. | Alarm Level    | The level above (or below for $O_2$ ) which the alarm is generated |
|----|----------------|--|
| 2. | Hysteresis     | The percentage which is added to the alarm level for state changes |
|    |                | in non-latching alarms   |
| 3. | Latching Value | Set true to make alarm latch                                       |
| 4. | Output Group   | The Output Group for this sensor's alarm level                     |
| 5. | Alarm Text     | The alarm text for this sensor's alarm level                       |
|    |                |  |

# **5.2 Configuring Outputs (Relays)**

The Output tab is shown in Fig 7.0.

| 🛃 R134A Monitor   | v1.3                          |       |              |                     |                  |
|-------------------|-------------------------------|-------|--------------|---------------------|------------------|
| File Settings Lo  | ogging                        |       | System Fault |                     |                  |
| Control Panel 👻 👎 | Config                        |       |              |                     | 4 Þ <b>;</b>     |
|                   | System Configuration          | 1     |              | Cancel Save         |                  |
| Sound             |                               |       |              |                     |                  |
| Alama             | Inputs Outputs Input-Output S | ystem |              |                     |                  |
| Alarms            | Relay Number Location Text    | Mute  |              | E Relay             |                  |
|                   | 1 relay 0 location            | False |              | Relay Number        | 1                |
|                   | 2 relay 1 location            | False |              | Location Text       | relay 0 location |
|                   | 3 relay 2 location            | False |              | Mute                | False            |
| 42102             | 4 relay 3 location            | False |              | E Board             |                  |
| Mute              | 5 relay 4 location            | False |              | Card Switch Catting | 0                |
| 0.000             | 6 relay 5 location            | halse |              | LICE DID            | 49               |
|                   | 7 relay 7 location            | True  |              | USB PID             | 48               |
|                   | 8 relay 8 location            | True  |              | USB VID             | 1240             |
|                   | 5 relay 9 location            | Tue   |              |                     |                  |
|                   | 10 relay 10 location          | True  |              |                     |                  |
| -                 | 11 relay 11 location          | True  |              |                     |                  |
| Reset             | 12 relay 12 location          | False |              |                     |                  |
|                   | 14 relay 14 leasting          | False |              |                     |                  |
|                   | 14 Telay 14 location          | False |              |                     |                  |
|                   | 10 relay 10 location          | False |              |                     |                  |
|                   | 17 relay 17 location          | Eales |              |                     |                  |
|                   | 19 relay 17 location          | False |              |                     |                  |
|                   | 19 relay 10 location          | Ealos |              |                     |                  |
|                   | 20 relay 20 location          | False |              |                     |                  |
|                   | 21 relay 20 location          | False |              |                     |                  |
|                   | 22 relay 22 location          | False |              |                     |                  |
|                   | 23 relay 23 location          | False |              |                     |                  |
|                   | 24 relay 24 location          | False |              |                     |                  |
| Fan Control       |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
| On                |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
| Off               |                               |       |              |                     |                  |
| UI                |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
| Tost              |                               |       |              |                     |                  |
| 1050              |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              | Board               |                  |
|                   |                               |       |              | Doura               |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       |              |                     |                  |
|                   |                               |       | -            |                     |                  |
| 1012/10151        |                               |       |              |                     |                  |

#### Fig 7.0 Configuration Outputs Tab

To change a setting select the appropriate line in the relay list and then modify the parameters using the property sheet on the right hand side of the tab.

## 5.2.1 Output (Relay) Properties

The configurable output parameters are:

- 1. Location Text The text displayed in the Output tab of the monitoring screen
- 2. Mute If set true, the relay is switched off when system is muted

# **5.3 Configuring Input-Outputs**

The Input-Output tab is shown in Fig 8.0.

|                           | 1.2            |          |             |          |          |          |          |          |          |          |           |           |           |                 |           |                                    |                        |
|---------------------------|----------------|----------|-------------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------------|-----------|------------------------------------|------------------------|
| e Settings Log            | ging           |          |             |          |          |          |          |          |          | Syst     | em Fau    | it        |           |                 |           |                                    |                        |
| trol Panel 👻 👎            | Config         |          |             |          |          |          |          |          |          |          |           |           |           |                 |           |                                    |                        |
| Sound                     | System C       | onfigur  | ation       |          |          |          |          |          |          |          |           |           | Cancel    | Sav             | •         |                                    |                        |
| Alarma                    | Inputs Uutputs | input-ou | tput Syster | m        |          |          | -        | -        |          |          |           | -         |           |                 |           |                                    |                        |
| Alarms                    | Output Group   | Output 1 | Output 2    | Output 3 | Output 4 | Output 5 | Output 6 | Output 7 | Output 8 | Output 9 | Output 10 | Output 11 | Output 12 | Output 13       | Output 14 | <ul> <li>Uutput</li> </ul>         |                        |
|                           | 1              | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output Group                       | 1                      |
|                           | 2              | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 1                           | True                   |
|                           | 3              | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 2                           | True                   |
|                           | 4              | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 3                           | True                   |
| Mute                      | 2              | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 4                           | False                  |
|                           | 7              | False    | raise       | Faise    | False    | False    | False    | False    | False    | False    | Faise     | Faise     | False     | False           | Faise     | Output F                           | Falsa                  |
|                           | 6              | Falsa    | Falsa       | Falsa    | False     | Faise     | False     | False           | Faise     | Output 5                           | False                  |
|                           | ŝ              | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Uutput 6                           | False                  |
|                           | 10             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | r dise    | r dise<br>Enlee | False     | Output 7                           | False                  |
|                           | 11             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 8                           | False                  |
| 100                       | 12             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 9                           | False                  |
| Reset                     | 12             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 10                          | Ealer                  |
|                           | 14             | False    | Falso       | False    | False    | False    | Ealao    | False    | Falso    | False    | Foloo     | False     | False     | False           | False     | Ouput to                           | T disc                 |
|                           | 15             | False    | False       | False    | False    | False    | Enlag    | False    | False    | False    | False     | False     | Falso     | False           | False     | Output 11                          | False                  |
|                           | 16             | Falce    | False       | Falco    | Falce    | False    | Falco    | Falce    | False    | Falco    | Falce     | Falce     | Falce     | False           | Falco     | Output 12                          | False                  |
|                           | 17             | Falce    | Falco       | Falco    | Falco    | Falco    | Falco    | Falce    | Falco    | Falco    | Falce     | False     | Falce     | Falce           | Falce     | Output 13                          | False                  |
|                           | 18             | False    | False       | Falce    | False    | False    | Falce    | False    | False    | Falce    | False     | False     | False     | False           | False     | Output 14                          | False                  |
|                           | 19             | False    | Falce       | Falco    | Falce    | False    | Falce    | Falce    | Falce    | Falco    | False     | False     | False     | False           | Falce     | Output 15                          | Enlog                  |
|                           | 20             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 15                          | T disc                 |
|                           | 21             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Uutput 16                          | False                  |
|                           | 22             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 17                          | False                  |
|                           | 23             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 18                          | False                  |
|                           | 24             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 19                          | False                  |
|                           | 25             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 20                          | Enlog                  |
| n Control                 | 26             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 20                          | T disc                 |
|                           | 27             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Uutput 21                          | False                  |
| 1000                      | 28             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | Ealse     | False     | False           | Ealse     | Output 22                          | False                  |
| On                        | 29             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 23                          | False                  |
| Contraction of the second | 30             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     | Output 24                          | False                  |
|                           | 31             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     |                                    | and the second second  |
| 1000000                   | 32             | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     |                                    |                        |
| Off                       | Sound Alarms   | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     |                                    |                        |
| <b>U</b>                  | Test Outputs   | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     |                                    |                        |
|                           | Fan Outputs    | False    | False       | False    | False    | False    | False    | False    | False    | False    | False     | False     | False     | False           | False     |                                    |                        |
|                           |                |          |             |          |          |          |          |          |          |          |           |           |           |                 |           |                                    |                        |
| <b>Fest</b>               |                |          |             |          |          |          |          |          |          |          |           |           |           |                 |           |                                    |                        |
|                           |                |          |             |          |          |          |          |          |          |          |           |           |           |                 |           |                                    |                        |
|                           |                |          |             |          |          |          |          |          |          |          |           |           |           |                 |           | Output 3<br>Set true if output sho | uld be triggered by th |
|                           |                |          |             |          |          |          |          |          |          |          |           |           |           |                 |           | output group                       | ins are inggered by th |
|                           |                |          |             |          |          |          |          |          |          |          |           |           |           |                 |           | A LANCE COMPAREMENTS               |                        |

#### Fig 8.0 Configuration Input-Outputs Tab

The Input-Output tab is used to change the contents of the Output Groups. To change a setting select the appropriate line in the Output Group list and then modify the parameters using the property sheet on the right hand side of the tab.

#### **5.3.1 Output Group Editing**

Setting the Outputx value an output group means that the output (Relay) will be set to ON when the Output Group is activated. As an example, in the setup shown in Fig 8.0, Relays 1, 2 and 3 will be set to ON if Output Group 7 is activated.

#### 5.3.2 Sound Alarms Output Group

The Sound Alarms Output Group is activated when the **Sound Alarms** button is pressed. Within the input/output listview (shown in Fig 8.0), the group is located immediately below output group 32.

Relay outputs allocated to this group will be energised when the group is activated.

#### 5.3.3 Test Output Group

The Test Output Group is activated when the **Test** button is pressed. Within the input/output listview (shown in Fig 8.0), the Test Output Group is located immediately below the Sound Alarms Output Group.

Relay outputs allocated to this group will be energised when the group is activated.

#### 5.3.4 Fan Control Output Group

The Fan Control Output Group is activated by the **Fans On** button. Within the input/output listview (shown in Fig 8.0), the Fan Control Output Group is located immediately below the Test Output Group.

Relay outputs allocated to this group will be energised when the group is activated.

## 5.4 System Settings

The System tab is shown in Fig 9.0.

| Test System Fault   Control Sound   Alarms System Configuration   Mute System Selling:   Mute System Selling:   Reset System Selling:   Fin Control Sound Selling:   Offi Selling:   Test Data Logging   | 📰 R134A Monitor v1.3             |                             |                            |       |
|--|----------------------------------|-----------------------------|----------------------------|-------|
| Centrel       1       Control       Swe       4         Sound<br>Alarms       Impute South System       Swe       Swe         Mute       Impute South System       South Sector       Swe         Mute       System Configuration       Swe       Swe         Reset       Statem Sector       Swe       Swe         Fan Control       Off       S       System Sector Debug Re       Statem Sector         Off       Test       Debugging       Statem Sector       Statem Sector         Data Logging       Statem Sector       Statem Sector       Statem Sector         Off       Off       Statem Sector       Statem Sector       Statem Sector         Data Logging       Statem Sector       Statem Sector       Statem Sector       Statem Sector         Off       Off       Statem Sector       Statem Sector       Statem Sector       Statem Sector         Data Logging       Statem Sector       Statem Sector       Statem Sector       Statem Sector   | File Settings Logging            |                             | System Fault               |       |
| Sound<br>Alarms       System Configuration       Cancel       Sow         Mute       Pair boding impublished System <ul> <li>Pair boding impublished System</li> <li>System Hackward</li> <li>Syst</li></ul> | Control Panel 👻 📮                | Config                      |                            | 4 Þ 🗙 |
| Alarms       Interval       State       Interval         Mute       Interval       State       Interval         Reset       State       Interval       Interval         Fan Control       Interval       Interval       Interval         Test       Interval       Interval       Interval         Interval       Interval       Interval       Interva  | Sound                            |                             | Cancel Save                |       |
| Reset       Data Logging       00         Fan Control       Off       01         Off       Data Logging       Data Logging   | Alarme                           | pas capas inpactaqua system | E Data Logging             |       |
| Mute       Fe Davgo Peod       7         Mute       System Statup Davidsaux       Mater Time (see)       5         System Statup Davidsaux       2       Mater of Simon Boards       2         Number of Simon Boards       2       Mater of Simon Boards       2         Number of Simon Boards       2       Mater of Simon Boards       2         Number of Simon Boards       2       Mater of Simon Boards       2         Number of Simon Boards       2       Simon Boards       2         System Statup David (see)       5       Boards       Boards         Off       Off       False       Binerade David (see)       False         Test       Data Logging       Data Logging       Data Logging   | Alamis                           |                             | File   Indate Period (sec) | 300   |
| Mute       Status       Status         Mute       Separation Status       Separation Status         Reset       Separation Status       2         Fan Control       On       Official         Official       Data Logging       Data Logging   |                                  |                             | File Change Period         | 7     |
| Mute       Mute Time Ise(1)       S         Reset       System Adamse       Number of Smirnt Boads       2         Number of Smirnt Boads       2       System Adamse       S         Number of Smirnt Boads       2       System Adamse       S         System Adamse       Debugsing       Debugsing       Debugsing         Generate Debug Pie       False       False       Debugsing         Test       Data Logging       Test       Debugsing   |                                  |                             | System Settings            | 11x2- |
| Mute       System Fandoara         Reset       System Status Delay (sec)         Debuging       Generate Debug File         Fan Control       On         Offi       Debuging         Test       Debuging   | 100 million (100 million)        |                             | Mute Time (sec)            | 5     |
| Reset     Number of Smath Doday (2)   System Statup Delay (sc)   System Statup Delay (sc)   Debugging   Green also Debug Fle     Fan Control   On   Off     Test     Data Legging  | Mute                             |                             | 😑 System Hardware          |       |
| Reset       2         System Sharup Debug (sec)       5         Debugging       Generate Debug Fle         Fan Control       On         Offi   |                                  |                             | Number of Sensor Boards    | 2     |
| Fan Control   Orn   Off     Test     Data Logging  |                                  |                             | Number of Relay Boards     | 2     |
| Reset     Fan Control   Off   Off     Test     Debugging     Debugging     Generate Debug File     Faire     Persete     Debugging     Debugging     Debugging   |                                  |                             | System Startup Delay (sec) | 5     |
| Fan Control   On   Offi   Test     Data Logging  |                                  |                             | Debugging                  |       |
| Fan Control<br>On<br>Offi<br>Test  | Reset                            |                             | Generate Debug Fle         | False |
| Data Logging   | Fan Control<br>On<br>Off<br>Test |                             |                            |       |
|  | 00-36-53                         |                             | Data Logging               |       |

#### Fig 9.0 Configuration Systems Tab

#### **5.4.1 System Properties**

#### The configurable system parameters are:

#### Data Logging

| 1.     | File Update Period             | The time between log samples( in seconds)  |
|--------|--------------------------------|--|
| 2.     | Alarm State File Update Period | <i>The time between log samples when the system is in an alarm state ( in seconds)</i> |
| 3.     | File Change Period             | The number of days for each log file   |
| System | n Settings                     |  |
| 1.     | Mute Time                      | The time in seconds to deactivate muteable relays                                      |

#### System Hardware

| 1. | Number of Sensor Boards | The number of Sensor Boards (these must be present) |
|----|-------------------------|---|
| 2. | Number of Relay Boards  | The number of Relay Boards (these must be present)  |
| 3. | System Startup Delay    | Number of seconds to wait at system startup before  |
|    |                         | triggering alarms                                   |

# 6.0 Sensor Level Logging

The system continuously logs the value of all sensors to a CSV file located in **C:\R134AMonLog**. The disk files are named as R134aMon\_yyyymmddhhmmss.csv where yyyymmddhhmmss specifies the creation date.

Samples are written to the log file at a predetermined time interval as well as whenever an alarm occurs.

The format of the CSV file is:

Date, Time, S1 Type, S1 Value, S2 Type, S2 Value, S3 Type, S3 Value ..... up to number of sensors

05/09/2007 23:36:47 R134a 27.99 R134a 31.1 R134a 24.88

If a sensor is isolated, "Isol" is written immediately before the sensor type.

If the sample is written in response to an alarm the sensor data is followed by the alarm data, for example, if sensor 4 enters alarmlevel 2 state the CSV file will contain 2 additional entries immediately after the sensor value entries:

S4: Sensor 4 location text AlarmLevel2: Level2 Alarm Text

## 6.1 Fast Log Time

If the system is in alarm state the logging time interval is determined by the **Alarm State File Update Period** setting. In this condition the system displays the "Fast Log" message on the upper part of the interface as shown in Fig 10.0

| 🔡 R134A Monitor v1.6             | i de la companya de l |        |                   |                 |               |                |                |             |          |     |  |
|----------------------------------|---|--------|-------------------|-----------------|---------------|----------------|----------------|-------------|----------|-----|--|
| File Settings Lo                 | gging   |        |                   |                 |               |                | 1              | Fast Log    |          |     |  |
| Control Panel 👻 📮                | Sensor Values Outputs Disonotics  |        |                   |                 |               |                |                |             |          | 4 Þ |  |
|                                  |   |        | D 434-            | Det             |               |                |                |             |          |     |  |
|                                  | UX-A  | No     | R-134a            | Det             | ectio         | n sv           | stem           |             |          |     |  |
| Sound                            |   |        |                   |                 |               | ,              |                |             |          |     |  |
| Alarms                           |   | Sensor | Location          | Alarm Level 1   | Alarm Level 2 | Alarm Level 3  | Alarm Level 4  | Value (pom) | Isolated |     |  |
|                                  | R-134a  | 1      | Sensor 1 location | 800             | 900           | 1000           | 1200           | 31          |          |     |  |
|                                  | 1   | 2      | Sensor 2 location | 800             | 900           | 1000           | 1200           | 34          |          |     |  |
| 842.44                           |   | 3      | Sensor 3 location | 800             | 900           | 1000           | 1200           | Under Range |          |     |  |
| Mute                             |   | 4      | Sensor 4 location | 800             | 900           | 1000           | 1200           | 302         |          |     |  |
|                                  |   | 5      | Sensor 5 location | 800             | 900           | 1000           | 1200           | 305         |          |     |  |
|                                  |   | 6      | Sensor 6 location | 800             | 900           | 1000           | 1200           | 28          |          |     |  |
|                                  |   | 7      | Sensor 7 location | 800             | 900           | 1000           | 1200           | Under Range |          |     |  |
|                                  |   | 8      | Sensor 8 location | 800             | 900           | 1000           | 1200           | 865         |          |     |  |
| Depet                            |   |        |                   |                 |               |                |                |             |          |     |  |
| Reset                            |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
| - Superson and a superson of the |   |        |                   |                 |               |                |                |             |          |     |  |
| Fan Control                      |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
| On                               |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
| 011                              |   |        |                   |                 |               |                |                |             |          |     |  |
| Off                              |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
| lest                             |   | Sensor | Location          | Alarm Level 1   | Alarm Laval 2 | Alarm Level 2  | Alarm Level 4  | Value (%)   | Isolated |     |  |
|                                  |   | 301301 | Lucduuri          | Additin Level 1 | Admin Level 2 | Addini Level 3 | Addini Level 4 | value (4)   | isolatou |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  | 02  |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |
| 0.000                            |   |        |                   |                 |               |                |                |             |          |     |  |
| 23:01:36                         |   |        |                   |                 |               |                |                |             |          |     |  |
|                                  |   |        |                   |                 |               |                |                |             |          |     |  |

## 6.2 Start New Log

The menu option **Logging>Start New Log** closes the current log file and begins writing samples to a new log file.

# 7.0 Hardware

A block diagram of the hardware used in a 2 Signal Board/ 2 Relay Board OX-AN R-134a Leak Detection Monitor is shown as Fig 11.0



Fig 11.0 R-134a Hardware

The Uninterruptible Power Supply (UPS) powers all of the hardware components of the OX -AN R-134a Leak Detection Monitor.

# 7.1 Sensor and Relay Card Addressing

Each Sensor Board and Relay Board has a small DIL switch which is used to set an address. This address is used as part of the USB communications and hence the system will not function correctly unless the cards are correctly addressed.



[For Signal boards the USB PID is given by 0x40+Address]

[For Relay boards the USB PID is given by 0x30+Address]

Note: Boards must be addressed without gaps, i.e. only boards 0 and 2 are not allowed and the addressing should be changed to 0 and 1.

# 7.2 Relay Board Fail Safe Feature

If a Relay board does not receive a specified USB based PC communication within a 10 minute period the relay board will automatically activate all output relays. Please ensure that the outputs are isolated if the R134aMonitor application is not running for any prolonged periods.

## 8.0 Calibration

The menu option **Settings>Show actual values** displays the actual averaged values read from the AtoD. In the calculation for the ppm or % levels these values are multiplied by the relevant factor.

To calibrate the system (without sensors):

- 1. Set the 4-20mA box to 4mA using a meter. Note the values of the individual inputs.
- 2. Set the 4-20mA box to 20mA using a meter. Note the values of the individual inputs.

The zero offset is the 4mA value.

The full scale value is the 20mA value.

Providing the sensor has a linear response, the system can be calibrated by setting the relevant 4mA and 20mA values for each sensor input and then adjusting the actual sensor to provide 4mA to 20mA across its range.

The equation used to generate the displayed value is:

$$Value = \frac{AtoDValue - AtoDZeroOffset}{AtoDFullScale - AtoDZeroOffset} \times SensorRange$$

#### 8.1 Notes for R-134a Boards

For 2000ppm R-134a sensors 1800ppm = 18.4 mA

On R134a sensor adjust Z pot until led moves from red to green.

Adjust 4mA pot until 4mA is read on the meter

Adjust the 20mA pot to give the correct mA for the test gas – 18.4mA for 1800ppm.

| Z                  | 4 | 20 |  |  |  |  |  |  |
|--------------------|---|----|--|--|--|--|--|--|
|                    |   |    |  |  |  |  |  |  |
|                    |   |    |  |  |  |  |  |  |
|                    |   |    |  |  |  |  |  |  |
| R134a Sensor Board |   |    |  |  |  |  |  |  |
|                    |   |    |  |  |  |  |  |  |
|                    |   |    |  |  |  |  |  |  |
|                    |   |    |  |  |  |  |  |  |