GUARDIAN

# Guardian Visual Designer
# User Manual

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# Introduction

*Guardian Visual Designer* provides the means and methods to create a Guardian System Database, and to maintain it over its use.

Before going into the creation process, we should first understand how the Guardian system interacts with the Database and what work must be done prior to creating the database.

## Database Formats

The Guardian system can use two database formats, the most common being a Microsoft Access file format using the extension (.GDB) and the other a Microsoft SQL Server. Both database formats use the same tables and can be manipulated by all the applications within the Guardian Suite.

It is recommended to first create the database using the Access file format and then to deploy over to a SQL Server, if desired, at a later time.

## File Locations

Guardian is normally installed into the folder "*C:\Program Files\Guardian"*, this is known as the Guardian Application folder. Within this a folder called "*Databases"* is created, in which each Guardian system is placed within its own project folder.

Although it is possible to place a project folder elsewhere, the tools and applications that form the Guardian Suite will not automatically point to this location when opening files. This does not prevent their use and it may be desirable to place a project folder on a separate disk for space or archive reasons.

## Project Folder Contents

### Configuration and Data Files

The Project Folder will contain one or more files with the .GDB extension. Initially there will be only one and this contains the System Configuration and any logged data points already taken. Using the Guardian Database Toolkit it is possible to create additional files to hold the logged data, these will have the same base filename as the System Configuration file, but an extension of "*_DATAx*", where x is a number starting from 1.

### Demo Script Files

Icon Demonstration Databases use a script file to generate simulated data. This file has a "*.BIN*" extension. It is not possible for a user to create one of these files but if present in a project folder, they will be used instead of communicating with real ITA devices.

### User Folders

The use of project folders allows the designer of the system to collate other files relating to the project in one place. The Guardian system will not use these files. Typical uses are for installation notes, configuration details and draft mimic images.

## Guardian Mimic Files

Guardian stores all of the mimic graphic files within the database structure, therefore once a file has been selected for use by Guardian and changes made to it will not be seen within the

Guardian suite. It is practical to keep a folder of the images used within the project fodler for future development.

Guardian supports only a few file formats for its Mimics, refer to the table below to see which formats may be used for each Guardian mimic.

| Format | Use | File Restrictions |
|---|---|---|
| BMP | Display mimics<br>Network mimic<br>About mimic | Can be either uncompressed or use RLE compression. Colours can be either 256 or 16 million, although the size of the file should be considered. |
| GIF | Display mimics<br>Network mimic<br>About mimic | Limited to 256 colours and typically have no transparency layer information |
| JPG | About mimic | None |

# Application Layout

*Visual Designer* opens using the default Guardian project, however if no project has been used before it will have only its toolbar visible and the working area below will be empty. Within this working area the user will be able to open multiple editing windows, but all for a single Guardian system.

## Toolbar

The toolbar provides access to all of the editing facilities of Visual Designer. These can also be accessed using the Menubar above it.


Figure 1 Visual Designer Toolbar

From Left to right the button functions are:

| | |
|---|---|
| New | Creates a new empty Project Folder |
| Open | Opens an existing Project Folder |
| Exit | Exit the application |
| Validate | Performs a series of checks to ensure the configuration is valid |
| Backup | Creates a backup of the configuration currently being used |
| Compact | Removes any surplus space from the database file to reduce its size |
| System | Toggles the System Settings Display |
| Network | Toggles the Network Settings Display |
| Hierarchy | Toggles the Hierarchy Display |
| Details | Toggles the Configuration Detail Display |
| Display | Toggles the Mimic Editing Display |
| Transfer | Toggles the External Data Interface Display |
| LogEntry | Allows an entry to be placed into the system logbook |
| Help | Provides access to the on-line help prompts |

**NOTE:** There is no Save option. All changes made within the Visual Designer are saved as they are made. It is therefore essential to keep backup copies of project folders before major changes are performed

# System Design

*Visual Designer* does not force the user to design their system in any particular order, although there are benefits in doing some processes first.

Before starting the Mimic files will have to have been created, and a general idea of how the system is to be grouped thought out.

## Guardian Hierarchy

The Guardian system is configured as a strict hierarchy of levels. During the discussion of the hierarchy the following terms will be used:

| | |
|---|---|
| Parent | The immediately higher level |
| Child | The immediately lower level |
| Sibling | A level with the same Parent. |
| Root | The uppermost level in the hierarchy |
| Branch | A section of the hierarchy stretching down from a level |
| Leaf | The lowermost levels in the hierarchy (*Sub-Measurement Levels*) |

A Guardian system is based around a hierarchy, in which there are two distinct parts:

An upper part containing Mimic Levels of variable depth

A lower part containing a fixed format

These two parts are joined together by the *Machine Level*. Although its name suggests it should represent a complete machine, it is really only a collection of transducers that are tightly coupled. For very large machine trains, it may be desirable to split it up into several *Machine Levels* to make the system more manageable. It is also possible to combine two or more physical items into one *Machine Level* such as a motor and pump.

## Upper Mimic Levels

Above the *Machine Level* the user can create a hierarchical structure of picture mimic displays, the number and grouping of this structure is completely up to the designer. The only rule is that each Mimic must have at least one level below it.

There are three types of mimic for use in the hierarchy:

| | |
|---|---|
| Picture Mimic: | Basic single image representing a single level |
| Split Mimic: | Two-tier mimic |
| Scroll Mimic: | Two-tier mimic for long machine trains |

### Picture Mimic

A *Picture Mimic Level* is a single bitmap image that fits within the computer screen area. It represents a single Level in the hierarchy and may have other *Mimic Levels* or *Machine Levels* as its children.

Each of the children is assigned a *Hot-Spot* area defined so a click within it will display that child level. Where two or more Hot-Spots overlap the Hot-Spot whose centre is closest to the click point is used. The children also have a list of Fill-Points that will be used as part of a flood-fill routine to indicate their current status.

In addition any of the *Sub-Measurement Level* values that found below the Mimic Level can have their values displayed upon it.

### Split Mimic

A *Split Mimic Level* consists of two levels of the hierarchy. The parent is of type *Split Mimic Main*, while all of the children must be of type *Split Mimic Secondary*. Both the parent and children have bitmaps images associated with them.

The display is configured so that the Split Main Mimic is always visible, and depending where it was has clicked, one of the Split Secondary Mimics will be visible also. The screen may be divided in either a vertical or horizontal manner, a display window is defined for the Main Mimic and one for all of the Secondary Mimics (large enough for biggest).

Each of the mimics behaves in the same manner as the *Picture Mimic Level* in that they have Hot-Spots, Fill-Points and optional Sub-Measurement Values defined.

### Scroll Mimic

A *Scroll Mimic Level* is similar to the Split Mimic Level in that it displays two levels of the hierarchy. The parent is of type *Scroll Mimic*, while all of the children must be of type *Not Set*. The difference being that the parent has two mimics associated with it, a smaller summary image that fits within the computer screen, and a second detailed image that can be larger than the screen area as it can be scrolled.

The Scrolling Mimic behaves in the same manner as the Picture Mimic, in that it has Hot-Spots, Fill-Points and Sub-Measurement Values, the difference is that the Hot-Spots and Fill-Points are all on one mimic rather then on individual mimics for each child.

The smaller summary Mimic is also different in that it only has Fill-Points defined, Hot-Spots are not necessary as clicking on this image scrolls the Scrolling Mimic to the appropriate position.

## Lower Fixed Format Levels

Below the *Machine Level* is a fixed format of *Points*, *Measurements* and *Sub-Measurements*.

A *Point Level* represents a transducer such as an Accelerometer or Eddy-Probe. Every *Machine Level* must have at least one *Point Level* below it, and it cannot contain any other type of level.

A *Measurement Level* represents a sample taken from a transducer using a particular configuration of parameters. Every *Point Level* must have at least one *Measurement Level* below it, and it cannot contain any other type of level.

A *Sub-Measurement Level* represents a value derived from the measurement. Every *Measurement Level* must have at least one *Sub-Measurement Level* below it, and it cannot contain any other type of level.

## Order for Editing

As mentioned earlier the order in which information is entered is not fixed, however there are some positive advantages in doing some items first.

If the number of ITA nodes and which transducer is going to be connected to each is known in advance, it is best to use the Network Settings Display first to enter in the details for each of the ITA nodes. This will allow the node and channel for each transducer to be set when the details for the *Point Levels* are entered. If left to later each *Point Level* will have to be edited twice.

Leave the editing of the Mimics until after the hierarchy is set in place. Any changes to the number or structure of *Machine Levels* to their parent *Mimic levels* will force corrections to be made to these items.

If there are repetitions of identical or similar points, machines or mimics it is better to completely enter the configurations for one of these rather than gradually refining each of them separately. With copy & paste, whole sections of the hierarchy can be re-used in different places, eliminating a lot of repetitive work.

# Database Selection

If a database has already been in use, this will be opened automatically when Visual Designer runs. If a different or new database is required, click the appropriate **New** or **Open** button on the toolbar.

The same dialog box is used to create a new system database or to open an existing database. Both database formats are supported, selected using one of the two radio buttons marked *Microsoft Access Format*, or *Microsoft SQL Server Format.*

When opening a database, the last database used by either Visual Designer, or Guardian Viewer will be selected by default. This is not provided when a new database is being created to prevent accidentally overwriting an existing system.

The opening display prompts for the method the database is stored, and for particular properties for that storage format.

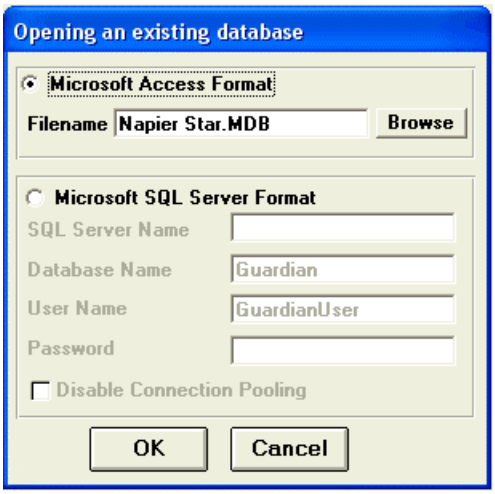


Figure 2. Open / Create New Database Dialog Box

For a Microsoft Access file the file has to be selected (if not already the default option) by clicking the **Browse** Button and using the standard Windows File selection dialog to select the database file. Note if the system has multiple data files, select the master configuration file which is the one without an extension of "_DATA" in its name.

For a SQL Server database several items of information are required. By default the database should have been installed under the name "*Guardian*" and have a user account of "*GuardianUser*" attached to it, therefore these items are added by default.

Once the correct details have been entered click the **OK** button to perform the required create or open operation.

# Hierarchy Display

Once a database has been opened, a display is presented which contains the hierarchy of the system. If this is a new database it will contain only one item, which represent the uppermost level of the system.

This is the focal point of Visual Designer, as it provides the context for many of the other editing displays and allows the structure of the system to be created.

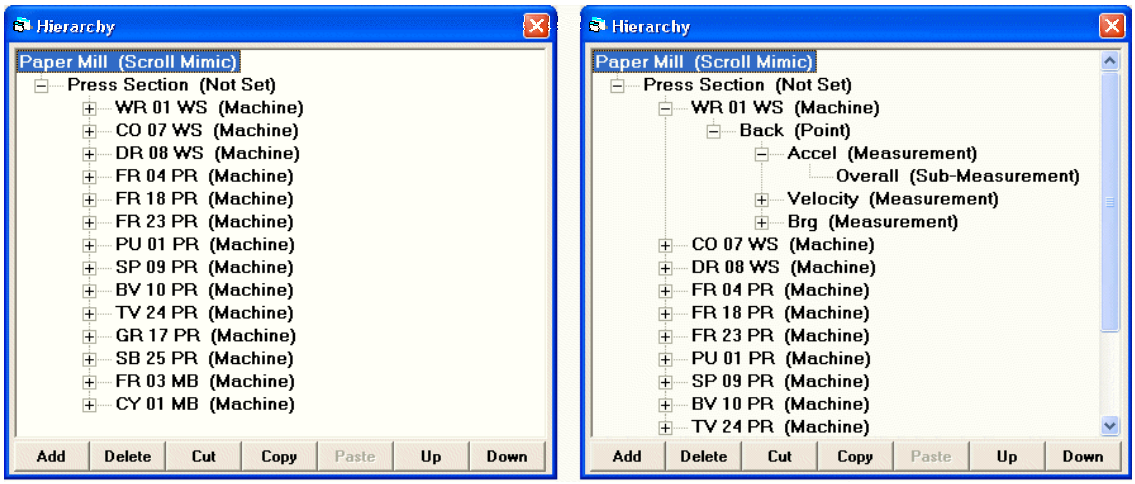


Figure 3: Hierarchy Display Windows

The hierarchy is displayed in the same manner as Windows displays its disk contents. Each level in the hierarchy is displayed with its name and level type. If the level has other *child* levels below it, it will have an expansion box with a plus to allow the level to be expanded, or a minus for it to be contracted.

Along the bottom of the display is a row of buttons that allow the contents of the hierarchy to be manipulated. When used correctly these can save a large amount of time when a system has identical or similar machines.

## Add

To add a new level to the hierarchy, select the level that is to be the *Parent* and then click the **Add** button. A new level will be inserted and will be set to the type of level most suited for the parent. In the case of a parent *Mimic Level* this will be a *Machine Level*. The type of the new level can be changed using the Details Display.

## Delete

To remove either an individual level, or a complete section of the hierarchy, select the level that is the head of the branch to be deleted and click the **Delete** button. **NOTE: This operation cannot be undone.**

## Cut

To move either an individual level, or a complete section of the hierarchy, select the level that is the head of the branch to be moved and click the *Cut* button. This branch is now available to for the *Paste* button. Note that if a subsequent cut operation is performed before a paste the item will have been deleted.

## Copy

To duplicate either an individual level, or a complete section of the hierarchy, select the level that is the head of the branch to be duplicated and click the **Copy** button***.*** This branch is now available to the **Paste** button.

## Paste

After either the **Cut** or **Paste** buttons have been clicked, clicking the **Paste** button will insert the Cut branch, or a copy of the Copied branch directly below the level currently selected.

## Up and Down

To change the order of siblings, select the sibling to be re-ordered and then click either the **Up** or **Down** buttons.

## Configuration Settings

Once a section of the hierarchy has been created it is time to enter the configuration settings for each level in that section. This can be done either once or repeatedly as each section of the system is created.

All levels will have to have their names changed, and in most cases several other configuration items. This is done using the *Details Display*. To bring up the *Details Display*, either select the level in the *Hierarchy Display* and click on the **Details** button on the *Toolbar*, or double-click the level in the *Hierarchy Display*.

Mimic levels also need to have their mimics configured. To bring up the *Mimic Display*, select the *Mimic Level* in the *Hierarchy Display* and then click on the **Display** button on the *Toolbar*,

The *Details Display* can be left open as it will change depending on which level is selected in the *Hierarchy Display*. The *Mimic Display* will only remain open while a *Mimic Level* is selected in the *Hierarchy Display*

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# Details Display

The *Details Display* allows the particular configuration settings for each type of level to be entered. It changes its appearance depending on the type of level selected in **the *Hierarchy Display***. It is best used by keeping it open either to the left or right of the *Hierarchy Display* in order that both may be operated alternatively.

The display has two parts, a General Header and the context sensitive lower part.

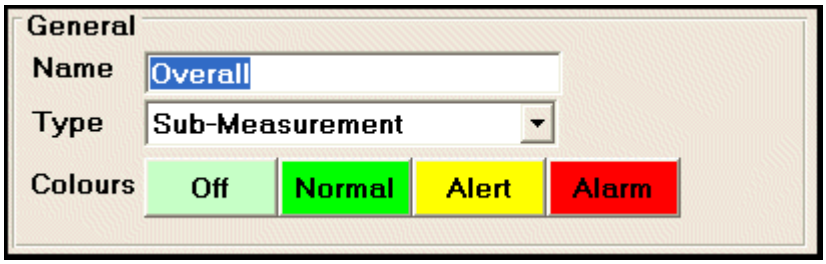


Figure 4. Details Display General Header Section

The General Header allows a name to be allocated to the Level, and if required, for the type of level to be changed. This will be required when adding additional *Mimic Levels*, as the child of a *Mimic Level* is set by default as a *Machine Level*.

The four coloured buttons allow the fill colour of the level to be set for each of the four state conditions it can be in. Note that these are disabled for *Point*, *Measurement and Sub-Measurement Levels* as they do not display their status onto a mimic.

The Context Sensitive part has four forms for the level types of *Machine*, *Point*, *Measurement and Sub-Measurement.* Before going into these is details it is worth considering what type of transducers may be used, and what type of readings may be taken.

## Transducers and Measurements

The following table lists the types of transducers that can be connected, the types of measurements that may be taken from them, and the sub-measurement values that may be derived.

| **Transducer** | **Measurement** | **Sub-Measurement** |
|---|---|---|
| Accelerometer | Acceleration | Sum / Peak / Floor |
| | Velocity | Sum / Peak / Floor |
| | Displacement | Sum / Peak / Floor |
| | Bearing | Sum / Peak / Floor |
| | Phase | Order Phase |
| | Time Waveform | Mean / RMS / Pk / Pk-Pk / Impacts |
| | Tacho | Speed |
| Velometer | Velocity | Sum / Peak / Floor |
| | Displacement | Sum / Peak / Floor |
| | Phase | Order Phase |
| | Time Waveform | Mean / RMS / Pk / Pk-Pk / Impacts |

| | | |
|---|---|---|
| | Tacho | Speed |
| Voltage | Spectrum | Sum / Peak / Floor |
| | Time Waveform | Mean / RMS / Pk / Pk-Pk / Impacts |
| | Static | Mean |
| | Phase | Order Phase |
| | Tacho | Speed |
| Pressure | PV | PA / PV Derivatives |
| | Time Waveform | Mean / RMS / Pk / Pk-Pk / Impacts |
| | Tacho | Speed |
| Eddy Probe | Spectrum | Sum / Peak / Floor |
| | Time Waveform | Mean / RMS / Pk / Pk-Pk / Impacts |
| | Tacho | Speed |
| Orbit Pair | Sync Orbit | Max Excursion |
| | Tacho | Speed |
| Trigger Pulse | Tacho | Speed |
| Virtual | Virtual | Virtual |

Table 1. Points and their Measurements

Note that a speed reading can be measured as part of any other point other than a Virtual as long as a trigger pulse is connected to the ITA. This can reduce the number of points created in the database and therefore make it easier to comprehend.

Virtual Points are special calculations based on the values of other *Sub-Measurement Levels*, this will be discussed in more detail later.

The Number of PA / PV derived Sub-Measurements is extensive and will be discussed in more detail later.

The meanings of the other Sub-Measurements are as follows:

| | |
|---|---|
| Sum | The RMS sum of all the spectral bins |
| Peak | The maximum value of all the spectral bins |
| Floor | The average of all spectral bins which are not part of trace peaks |
| Mean | The straight average of all samples |
| RMS | The RMS sum of all samples |
| Pk | The Maximum Absolute difference from the average base |
| Pk-Pk | The difference between the Maximum differences from the average base |
| Impacts | The number of excursions over a Pk value |
| Speed | Shaft speed in RPM (may be scaled for any intervening gearbox) |
| Order Phase | Spectral Phase of a particular order |
| Max Excursion | Vector distance from a sample to the origin |

## Machine Level Details

As had been previously mentioned, the *Machine Level* is an important point in the hierarchy as it is the junction between the user variable *Mimic Levels* and the fixed part of the *Points Level* and below.

It is also at this point that the decision as to how often data is logged is taken depending on the alarm condition of this level. Also, it also can be used to send emails or switch circuits using relays in order that external systems are notified of its alarms.

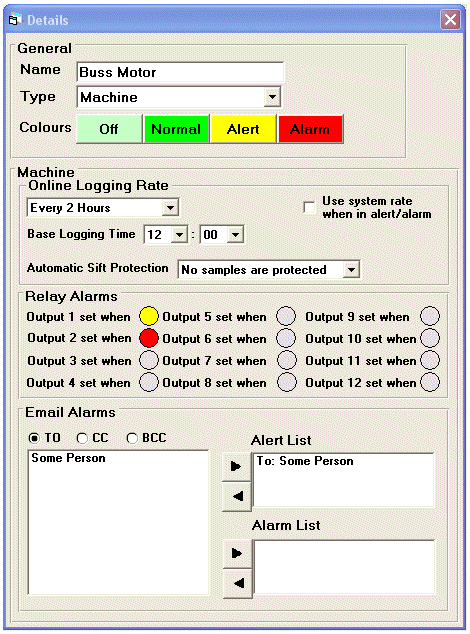


Figure 5. Machine Level Details Display

### Online Logging Rate

This control adjusts how often the Machine level will save its data to disk. The drop-down list has a selection of the most common intervals and also an option to allow a *User Interval* in minutes to be selected. It can also be set to store every reading taken or none at all.

In many cases the frequency at which data is logged needs to increase when points go into alert. A system wide Alarm rate is configured within the *System Settings Display*, and this rate will be used if the *Use System Rate* option is selected.

In order to ensure that logged values are synchronised regardless of when Guardian is started or stopped, a *Base Logging Time* can be specified. When Guardian starts it uses this time to determine when the first set of data should be logged and then increments according to the specified interval.

### Automatic Sift Protection

All logged data, that has not been logged manually, can be sifted. To prevent sifting the user may choose to protect the logged data for a machine. The drop-down list has options to protect logged data depending on the alert state of the machine.

### Relay Alarms

If a PCI263 Relay Card is to be installed into the Guardian Computer, the alert states of the machines can be used to alter the open / closed state of the 12 user relay outputs. Clicking on the circle rotates through the colours of

| | |
|---|---|
| Grey | Relay channel not used |
| Yellow | Set Relay if machine goes into alert |
| Red | Set Relay if machine goes into alarm |

The state of being *Open* or *Closed* when a relay is *Set*, is configured within the *System Settings Display*.

### Email Alarms

If the Guardian computer is configured with an Email account, Guardian can send an email when a machine goes into alert and/or alarm.

The address book is provided within the *System Settings Display***.** Addressees may be selected to receive emails depending on the alert state of the machine. The Mail contains all of the values for the *Sub-Measurement Levels* that make up the *Machine Level*.

## Point Level Details

The *Point Level* defines how a transducer is connected to Guardian. From this level down, the levels will have their items selected depending on the context of their parents.

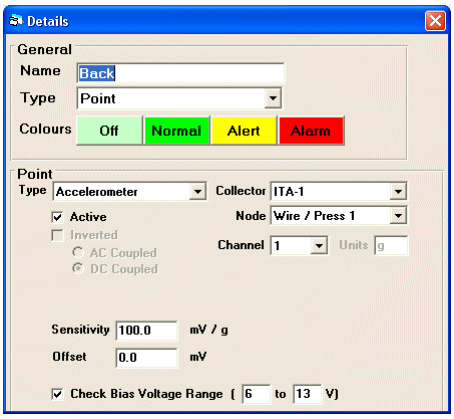


Figure 6. Point Level Details Display

## Point Type

Select the type of transducer. The drop-down lists contains all the types listed in Table 1 earlier. By default the point will be made *Active*, however it is possible to include points that will be connected in the future and have them disabled by clearing the *Active Option*.

Certain point types allow for the signal to be inverted within software or for it to be processed as an AC or DC coupled signal. When allowed these options will be enabled.

### Collector Selection

Once the type of transducer has been selected, the list of available collector types will be indicated. Selecting the collector type will provide a list of currently known devices that have been entered within the *Network Settings Display* in order that a Node and channel may be allocated to the transducer. It is therefore wise to enter these prior to configuring *Point Levels*.

### Calibration Details

In order that the correct values are displayed, the sensitivity and offsets for the transducer can be entered. When the units are not known by convention, the user can enter the name of the unit to be used.

Note that the Offset is in mV, and this is removed from the signal before dividing by the sensitivity.

### Transducer Range Check

Accelerometers and Eddy Probes can be automatically checked to ensure that the transducer and cable has not been damaged. In this case the option to perform the check should be selected, and a valid range for the transducer entered.

**NOTE**: Any transducer detected as failed will **NOT** have any of its measurements logged to disk.

## Measurement Level Details

The *Measurement Level* defines how a sample is to be taken from a transducer.

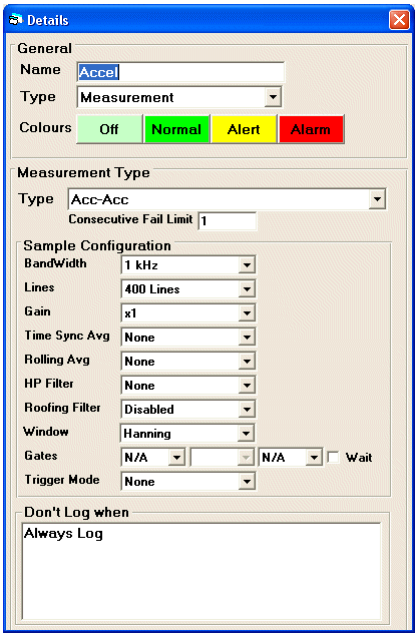


Figure 7. Measurement Level Details Display for a Spectrum

### Measurement Type

The list of available types of measurement is dependent on the type of transducer selected for the parent *Point Level*.

To provide a form of damping, the measurement can be required to be n alarm for a number of consecutive blocks of samples before alerting the user. This may be important in areas where large external vibrations may occur at random or intermittent process effects can interfere with condition assessment. Note, that setting this value too high may prevent the detection of transient or very short-term fault conditions.

### Sample Configuration

This area of the display can vary significantly depending on the type of transducer, the type of measurement being made and the type of ITA used to take the measurement. All controls will now be discussed.

### Lines / Bandwidth

For frequency-domain measurements the *Bandwidth* selects the highest frequency that will be detected, while the number of *Lines* will define how precisely each signal frequency will be detected. When the *Trigger Mode* is set to *Phase-Locked-Loop (PLL),* the *Bandwidth* is selected automatically depending on the running speed of the machine.

### Samples / Sample Rate

For time-domain measurements, the Sample Rate selects how often the signal will be sampled and the number of Samples combines with this to determine the duration of the sample. The Sample Rate should be at least twice the maximum frequency you wish to detect. For frequency domain measurements, Guardian automatically sets a *Sample Rate* 2.56 times the *Bandwidth* (maximum frequency). When the *Trigger Mode* is set to *Cycle-Locked-Loop (CLL),* the *Sample Rate* is selected automatically depending on the running speed of the machine.

### Resolution

Orbits and PV measurements are a specialised form of time-domain measurements. The *Sample Rate* is selected automatically depending on the running speed of the machine. Defining the angular Resolution required sets the number of Samples.

### Window

When working in the frequency-domain, the signal is passed through an FFT process. Sampled data is shaped by a *Window* in order to improve the spectrum results for different purposes. The drop-down list gives the options of:

Flattop

Rectangular

Hanning

Hamming

The Flat Top window is used for amplitude calibration, because it gives the best amplitude accuracy; the Rectangular window is used for measuring transient vibrations; Hanning and Hamming windows are used for general purpose measurement of continuous vibration signals.

### Gain

To allow the maximum use of the ADC range in the node, a gain may be applied to the signal before sampling. Ensure that the maximum signal amplitude when multiplied by the gain does not exceed the input range of the ITA selected for the measurement, or misleading results will be obtained. When the Auto Gain option is selected, the node's gain will be adjust automatically, but this will require more time before measuring and may not be suitable in many applications.

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### Gates

In order to allow a measurement to be taken only under the correct operating process, it is possible to connect one or two signal lines to Trigger Inputs 3 & 4 of the ITA node. A rule can be entered using one or both of these inputs to indicate the conditions for a good sample to be taken. If the condition is not met the sample is discarded. In addition an option of *Wait* can be selected to force the ITA to continuously sample this measurement until the correct conditions are met.

**Note** that the test for the conditions are only done immediately before and after the sample is taken. Changes to the signal during the sample are not noticed.

### Averages

Guardian allows for three different types of averaging

### Time Synchronous Averaging

When a trigger signal is available, it is possible to instruct the ITA to average the time waveform over a number of blocks of data. This will emphasise effects which are synchronous with the trigger and reduce effects of random noise on the signal.

### Linear Averages

For spectral work, it is possible to take more samples than are required for the spectrum at the one time and use this to produce multiple spectra for averaging. The overlay used is 50%, therefore each additional average requires only 50% of a standard data block. For example, 2 averages requires 1.5 data blocks, 3 averages requires 2 data blocks and 4 averages requires 2.5 data blocks.

### Rolling Averages

Rolling averages can be used to reduce the effect of a single sample. In this case each time a measurement is taken and processed, the results are kept in a queue buffer, the average of which is presented to the user. As each new sample is taken, the oldest one in the queue is discarded. In the case of spectra an averaged spectrum will be returned.

### HP Filter

Some measurement types allow for the signal to be passed through a high-pass filter, four frequency limits are available, namely: 0.5Hz, 2Hz, 10Hz and 100Hz.

### Roofing Filter

The ITA-1 has the option for a 2kHz roofing (low-pass) filter. This is automatically selected for the *Bearing* measurement type and can optionally be selected for others.

### Trigger Mode

When a trigger signal is available it can be used in a variety of ways. Depending on its mode of operation additional configuration options are made available. A drop-down list contains the options for:

| | |
|---|---|
| None | Trigger is not used |
| Trigger | Sample will commence at trigger |
| Post Trigger | Sample will commence a fixed delay after trigger |
| Pre Trigger | Sample will commence a fixed delay before trigger |
| Phase Lock | Sample will be synchronised with machine running speed |
| Speed | The machine running speed will be sampled only |

### Trigger Channel

Select one of the four trigger channels available.

### Delay

When sampling Post or Pre Trigger, the number of samples that will used to determine the delay should be entered here. Note the actual time delay will depend on the *Sample Rate* or *Bandwidth* used.

### Order / Cycles

When working in the frequency-domain with a *Phase Lock* trigger, a number of *Orders* is used to specify the *Bandwidth*.

When working in the time-domain with a *Phase Lock* trigger, a number of *Cycles* over which the sample is taken is used to specify the *Sample Rate*.

### Trigger Offset

Rather than use the Post or Pre Trigger mode, a time-domain signal sampled with *a Phase Lock* trigger can be adjusted by a specified number of degrees during its processing.

### Don't Log When

In order to reduce the amount of samples logged to disk when a machine is not running, it is possible to set a condition when the logging process is halted. To enter a condition double-click on the edit field to bring up the *Equation Editor Display*, the operation of this will be described later.

It is possible to cut & paste the contents of this edit field to allow the identical condition to be quickly set in other *Measurement Levels*.

### Virtual Equation

A Virtual Measurement is simply an equation that generates a numerical value using the other *Sub-Measurement Level* values. To enter the equation double-click on the edit field to bring up the *Equation Editor Display*, the operation of this will be described later.

## Sub-Measurement Level Details

The Sub-*Measurement Level* defines how a value is to be derived from a sample measurement, and what limits should be set for alarm purposes.

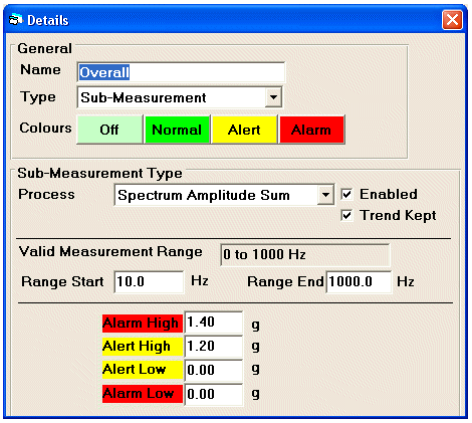


Figure 8. Sub-Measurement Level Details Display

### Sub-Measurement Type

The definitions for each sub-measurement were listed earlier. The drop-down list will provide a context sensitive list of options.

It is possible to disable the calculation of a sub-measurement by removing the *Enabled* option, however at least one *Sub-Measurement Level* must be enabled per *Measurement Level*.

If a trend of the value is not required this can be achieved by removing the *Trend Kept* option.

### Valid Measurement Range

The process performed to calculate the sub-measurement does not have to use all the data samples or spectrum lines. In many cases only a small section is desired, therefore the range of the process can be configured here. A prompt for the entire range is given for your reference. The units of measurement for the range will depend on the type of measurement taken, and how it was sampled.

### Alarm Limits

Each sub-measurement can have two levels of alarm, and each level may have an upper threshold, lower threshold or both. The values can be either a constant value, or a calculation based on other Sub-Measurement values, in which case double-click the entry to start the *Equation Editor Display*, which is described later.

## Network Settings Display

The *Network Settings Display* is where data acquisition nodes are defined so they can be used within the *Details Display* to configure the *Point Levels*.

Initially all that is required is for each node to be given an entry and configured for its *Type* and *IP Address*. To make things more readable a more suitable *Name* can be allocated.

Once the hierarchy has been completed the final tasks of configuring any *Trigger Channels* and editing the *Network Mimic* can be performed.

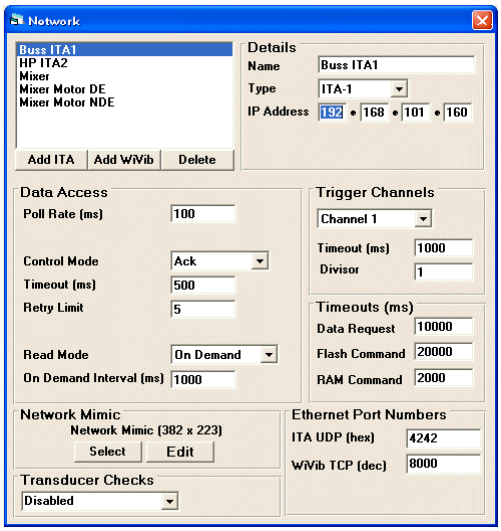


Figure 9. Network Settings Display

### Add / Delete

The network can accommodate both ITA and WiVib style Nodes, and will adjust its options accordingly.

To add a new node of either type, simply click the appropriate button. A new entry will be added to the list called "*NoName*", this should be selected to allow its options to be set.

To remove a node that is no longer required, select it from the list and click the **Delete** button. **Note:** any points associated with a deleted node will cause a validation error.

### Details (ITA Nodes)

The name allocated to an ITA node is purely to assist the user to identify it within the Guardian system. Guardian uses the IP address to create the link to the specific ITA node on the network, therefore this must match the address entered into the node itself.

The type of the ITA can be selected in order that Visual Designer correctly allocated the transducer points. This can be changed at any time, however any incorrectly allocated points will cause a validation error.

It is also possible to change from An ITA node to a WiVib Node. While some points will automatically be correctly adjusted, some with incompatible settings will cause a validation error.

## Details (WiVib Nodes)

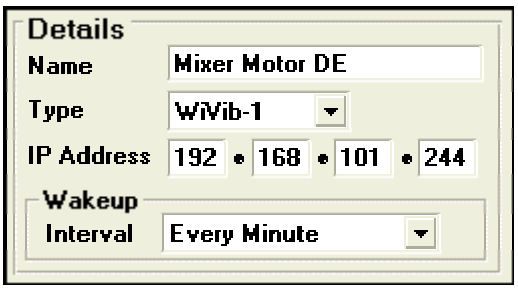


Figure 10. WiVib Node Details Frame

WiVib nodes are slightly different, in that it is their name that is used to create the link to the Node. The IP address if known may be entered as a confidence check as it will also be compared during the link. If this check is not required, or the IP address is not known, this can be left as "*255.255.255.255*".

The Type list operates in the same manner as for an ITA node.

An additional control for the WiVib allows the Wakeup Interval frequency to be selected.

## Trigger Channels (ITA Only)

Each ITA has four trigger channels. If a toothed gear is supplying trigger pulses, it may be necessary to enter the number of teeth on the wheel as the *Divisor* in order to get the correct speed.

The *Timeout* value indicates how long an ITA will wait for a trigger pulse before it gives up taking the measurement. This does not have to be set accurately, and normally should be twice the longest rotation period expected. Setting the value to "*0*" will instruct the ITA to wait indefinitely for the trigger.

## Data Access (ITA Only)

In normal circumstances these controls do not need to be changed, however in large systems it may be necessary to slow down the data acquisition in order to reduce the network bandwidth used by Guardian.

Control Mode: The Control Mode allows three different methods of data flow control to be selected. Each has its advantages and disadvantages

> *None*: ITA sends the data as fast as it can. Obviously for small systems this will increase the update rate of the data, however even for medium systems or busy networks it may result in missed data messages which will cause sampled measurements to be discarded.

*Ack*: ITA waits for an acknowledgement from Guardian before sending next data item. This is the most reliable method but incurs additional time to perform the acknowledgement. For this mode two parameters are required, first a *Timeout* after which the ITA assumes the acknowledgement is not going to arrive, and secondly a *Retry* count after which the transmission will be abandoned.

*Delay*: A compromise, in which a fixed delay is inserted between data packets to allow the computer to process each in turn. The time of the *Delay* has to be manually entered which may take some experimentation to get correct. This mode is not recommended for most normal cases.

Read Mode: Two modes of reading the data from the ITA into the computer are possible.

*On Demand*: This is the most common, in which the Guardian will prompt the ITA node to send its next measurement at a regular interval. This interval is entered in the space below. If this interval is too small, data will be requested before the next sample has been taken by the ITA, in which case it will be ignored. If this interval is too long the system update rate will be affected.

*On Read*: For small systems, or ones in which the time taken to sample the data is long this method may be used. In this case the ITA will automatically send the measurement after it has been taken. If used incorrectly it can cause excessive network Bandwidth use and overload Guardian with too much data.

Poll Rate: The Poll rate is how often Guardian checks for new messages from the ITA. While setting this to a smaller value can increase system scan rates it can easily overload the computer and result in bad user response times. If the CPU loading is noted as too high, or the user response is suffering, this value can be increased to suit.

## Timeouts (ITA Only)

It is most unlikely that, or a site layout indicating where they can be found.

The mimic is not used to display WiVib status, they use a tabular form instead.

## Ethernet Port Numbers

The default port numbers used to communicate to the ITA (using UDP/IP) and WiVib (using TCP/IP) can be changed here. Note that all Nodes will have to have this same port number programmed into them to work, therefore only change this if a conflict with other network devices is present.

## Transducer Checks

The frequency at which transducer tests are carried out is specified here. For ITA nodes the tests will interrupt the sampling for a short period while the test is performed. For WiVib nodes, any these values will need to be changed unless the system is being run across a busy WAN when the messages take a long time to be passed.

## Network Mimic

To allow the status of the network to be displayed, a Mimic depicting the ITA nodes is required. On this mimic each node will be allocated an area to indicate it's status. The editing of this mimic is identical to the main system mimics so refer to the section on the **Mimic Editing Display** for details.

The format of the mimic typically is either a schematic indicating how the ITA nodes are connected to the Computerenabled test frequency will instruct the Node to test the transducer on each sample.

# System Settings Display

The *System Settings Display* provides eight panels of configurations that affect the whole of the Guardian system. Not all of the panels will be relevant for each system. The panels are:

| | |
|---|---|
| General | Most common attributes that will always need setting |
| Relays | Configure the optional PCI 263 Relay card |
| Email | Configure email alarms and the address book to be used |
| Maintenance | Indicate how frequently the system should archive and sift |
| Modbus | Configure the optional Modbus interface |
| Display | Allows default user display settings to be set (can be changed within Guardian Viewer) |
| Printers | Indicates alternative to the default printer |

Above the panels is an edit field to allow the name of the Guardian System to be entered, and also a button to allow the Guardian About Box Mimic to be selected or changed.

## General Panel

This panel contains the most frequently changed settings in Guardian.

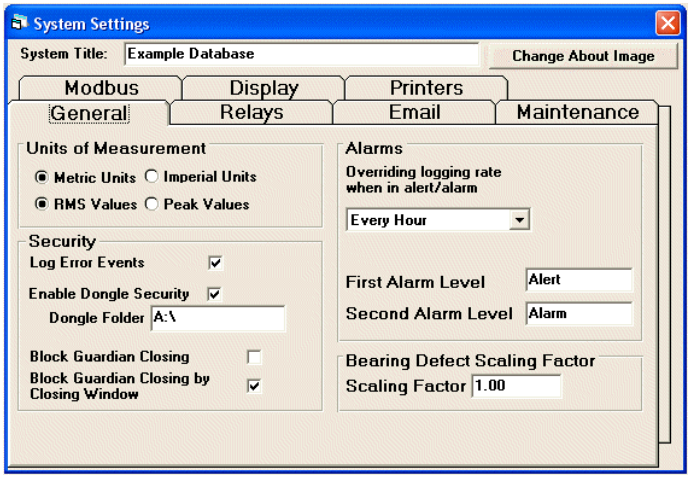


Figure 11. System Settings Display: General Panel

### Units of Measurements

Metric / Imperial (Standard English): It is possible to set Guardian to automatically work in either *Metric* or *Imperial* units for known measurements types such as velocity / displacement. And manually defined units will not be affected by this setting.

RMS / Peak: When working in the frequency-domain, the resultant spectrum may also be configured so it is scaled to either *RMS* or *Peak* values.

### Security

Log Error Events: When Guardian detects an internal error due, either due to a database not being validated correctly, or an imbalance with the operating system, it can enter a log event into the *Windows Event Viewer* to enable diagnostics to detect the root cause.

Dongle Security: To prevent accidental changes from within *Guardian Viewer*, a security test is required before certain actions. The security test searches for the presence of a file called “Dongle.L1” or “Dongle.L2” for level 1 and level 2 security respectively. By removing the *Enable Dongle Security Option*, the test will not look for the file and always return level 2 security status. The *Dongle Folder* can also be changed to point to any folder on the computer.

### Alarms

Override Logging Rate: Each machine has its own logging rate, however they may be configured to use a system-wide logging rate when in alarm. This is the system-wide setting and has the same options as in the *Machine Level*. **Note**: If the machine is set to log more frequently it will not use this value when in Alarm.

Alarm Names: Guardian uses the terms *Alert* and *Alarm* to describe the two stages of warning. These terms may be changed as desired.

### Bearing Detect Scaling Factor

The Bearing signal is an artificially processed acceleration value, therefore different manufacturers have similar methods of producing a value but these will vary in amplitude. To allow Guardian to return values similar to previously used equipment, the Bearing signal can have an additional scaling applied.

## Relays Panel

If a PCI 263 Relay card is installed within the Guardian computer, this panel allows it to be configured so it interfaces correctly with the outside world. The driver for the card is installed using the suppliers instructions and CD.

If relays are not being used ensure that the *Relay Card Disabled* option is selected.

The 16 relay channels are allocated with the first 4 being used for system diagnostic indicators, and the remaining 12 for the User Alarms.

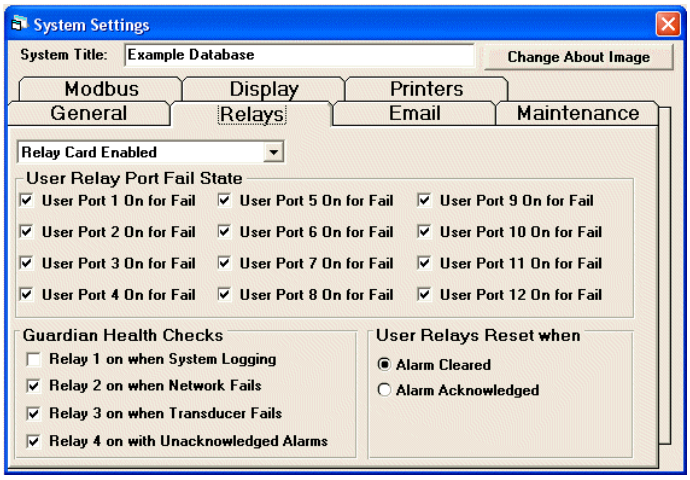


Figure 12. System Settings Display: Relays Panel

### Enable Option

The functionality for the Relay card can be switched on or off using the drop-down list. If no relay card is fitted this must be disabled.

### User Port Fail State

The *Machine Level* is configured to indicate which relay port will *Fail* as it goes into alarm, however this does not indicate if the relay is to fail open or closed circuit. To configure the relay to fail *closed-circuit* select the *On for Fail Option*.

### Guardian Health Checks

As previously mentioned the first four relays are used to indicate the system health status of Guardian. They can be configured for open or closed circuit operation as follows:

Relay 1: Set whenever Guardian starts to run

Relay 2: Set whenever one of the ITA nodes is not detected on the network

Relay 3: Set whenever a transducer has been detected as faulty

Relay 4: Set whenever a new Alert or Alarm is detected

### Relay Reset

As soon as a *Machine Level* goes into alarm, the relay will be activated accordingly. There are two methods by which the relay condition can be deactivated:

Alarm Cleared: The Machine goes back into Normal Status, and the *Current Events Display* is cleared of its latched alarm status.

Alarm Acknowledged: The alarm status of the machine is *Acknowledged* **within *the Current Events Display***.

## Email Panel

If an email account has been configured for use with the Guardian computer, this panel allows Guardian to be configured so it interfaces correctly with the email application.

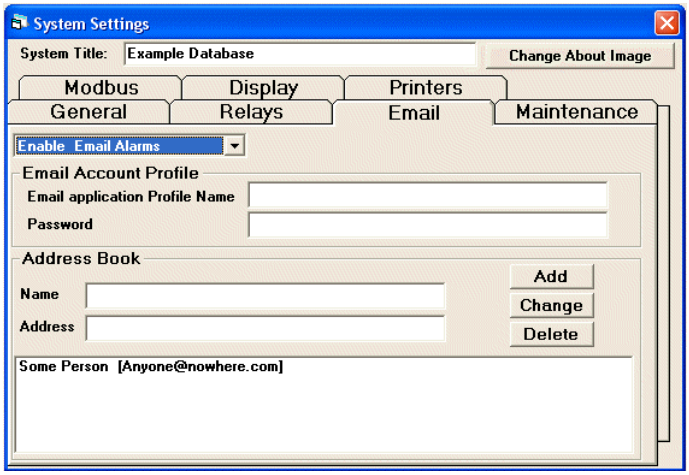


Figure 13. System Settings Display: Email Panel

### Enable Option

The functionality for the Email alerts can be switched on or off using the drop-down list. If no email account is configured for the computer this must be disabled.

### Account Profile

Depending on how the email account has been configured and with what software, it may be necessary to tell Guardian the *Profile Name* and the *Password* for the account.

### Address Book

Guardian does not access the address book of the email account directly as this may trigger virus or malicious code detection systems. Only the email addresses entered within this panel can be used by Guardian.

To add a new entry, enter the display *Name* and email *Address* in the fields provided and then click the **Add** button.

To change an entry, select it from the list, amend the information in the edit fields and click the **Change** button.

To delete an entry, select it from the list and click the **Delete** button, the settings removed will be inserted into the fields in case this action was performed by mistake.

## Maintenance Panel

Guardian can be configured to automatically archive its logged data and also to sift out its data in order to keep a smaller working database size. Both of these options can be selected independently.

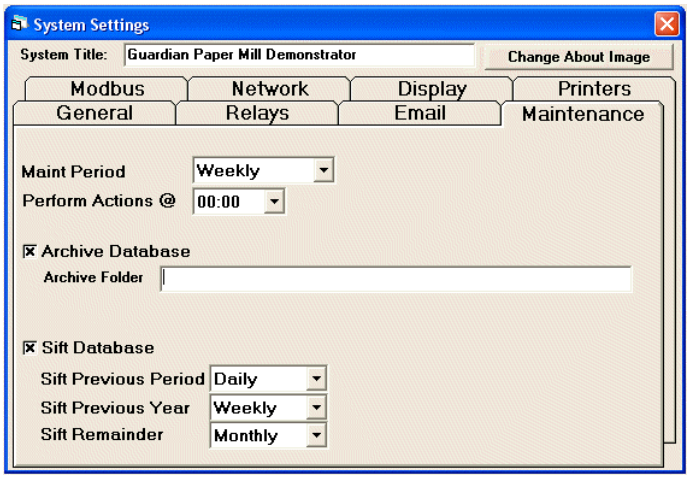


Figure 14. System Settings Display: Maintenance Panel

### Maintenance Period

The maintenance actions can be scheduled for Weekly, Bi-Weekly or Monthly. The monthly action will be carried out on the 1st of the month, while the others will be performed on the Monday.

The time of day at which this should be performed can also be set in order to avoid busy network activity or important operational processes.

### Archive Database

Each maintenance period will create a separate archive database folder. The database will contain the system configuration and all logged data since the last maintenance period ran.

### Sift Database

The database is sifted using three layers that can allow for a gradual removal of logged data over time. The current period that is just completing is untouched. The *Previous Year* does not contain the *Previous Period*, therefore for a weekly period it will sift 50 weeks of data (52 – Current – Previous).

## Modbus Panel

If Guardian is accessed by an external system as part of a Modbus link, this panel configures the serial interface needed for the link.

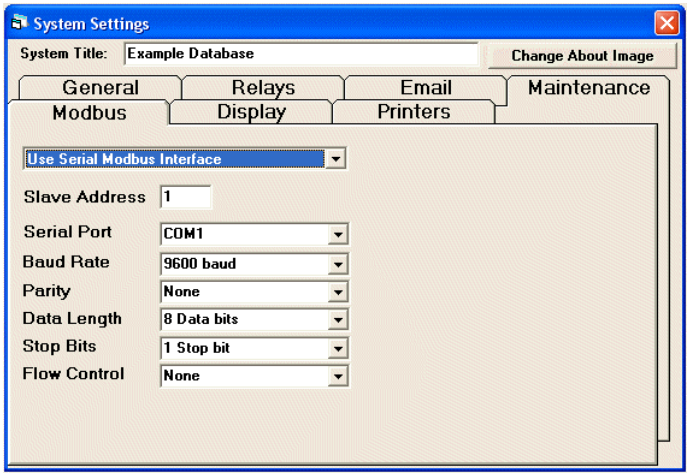


Figure 15. System Settings Display: Modbus Panel

Operation Mode: The Modbus link can be disabled, or enabled for either a Serial or TCP interface. If neither is fitted this option must be disabled. Only the Serial interface requires any of the subsequent options to configure it's port and identity.

Slave Address: This is the Modbus ID to which the Guardian system will respond.

Serial Port: Select the serial port that represents the physical Modbus link.

Parameters: Configure the RS232 interface to match that of the Modus Master device.

## Display Panel

The controls within the display panel are also available in ***Guardian Viewer***. They allow the user to customise how certain aspects of the data are displayed. These may be set by the designer in advance.

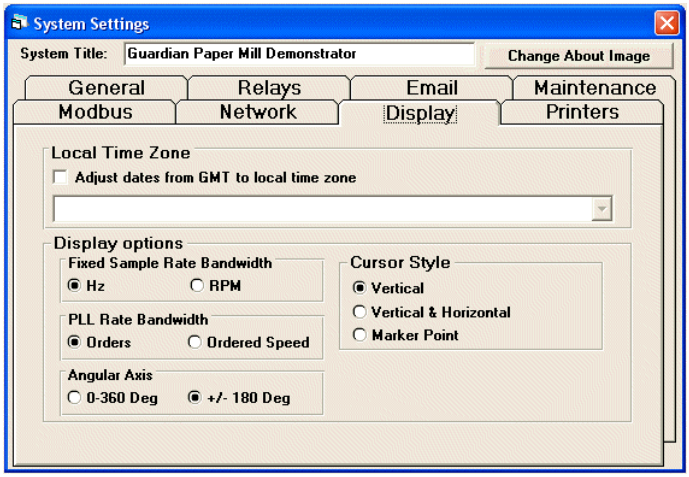


Figure 17. System Settings Display: Display Panel

### Local Time Zone

For ship based systems this allows the dates on which items were logged to be converted to any timezone to aid in reminding users when an associated event took place. For this to work correctly, the Guardian computer must be set for GMT and have daylight saving disabled.

### Display Options

Fixed Sample Rate: Select which units will be used on the X-Axis to represent spectra bandwidth.

PLL Sample Rate: Select to see the X-Axis of *Phase-Lock* enabled spectra displayed as either Orders, or scaled to the running speed of the machine.

Angular Axis: Select to position the trigger point of the shaft on the left axis with the *0-360* ***Option***, or in the centre of the X-Axis with the ***+/-*** *180 Option*.

Cursor Style: Trace cursors may either be a single vertical line, a crossing vertical and horizontal line, or a marker point on the trace.

## Printers Panel

Normally Guardian will use the default printer set up by the operating system, however this option can be changed.

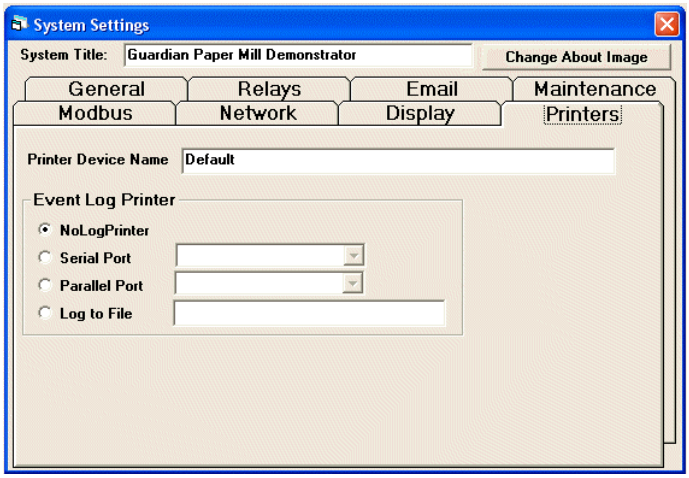


Figure 18. System Settings Display: Printers Panel

Printer Device Name: Enter the name of the device or leave as *Default* to use the default Windows printer.

### Log Printer:

All entries made in the system log can also be redirected to another device if desired, the options are:

Serial Port: Data is sent using 9600baud, no stop bits, no parity, 8 data bits.

Parallel Port: Can only be used in conjunction with a dot-matrix line printer.

File: Enter the full name of the file, entries will be appended to the end.

# Mimic Editing Display

The Mimic Editing Display is used to select bitmaps for each *Mimic Level*, to indicate how each of their Child Levels are to be accessed and to display their status information. There are four types of Mimics that are supported at present:

| | |
|---|---|
| Picture Mimic: | Basic single image representing a single level |
| Network Mimic: | Specialist version of Picture Mimic for Network Status Display |
| Split Mimic: | Two-tier mimic |
| Scroll Mimic: | Two-tier mimic for long machine trains |

Four option buttons take the user through the stages of configuration, it is not necessary to follow them in strict numerical order, and frequent switching between them is often necessary as the design develops.

## Stage 1: Size and Position

The first stage is to select the Mimic images and position them onto the screen display. Guardian does not modify the screen resolution setup by Windows, however you can see how the Mimic Level will look on the target computer by selecting the screen resolution from the drop-down list found to the right of the option buttons. A resolution must be selected before Visual Designer will allow any further editing to be performed.

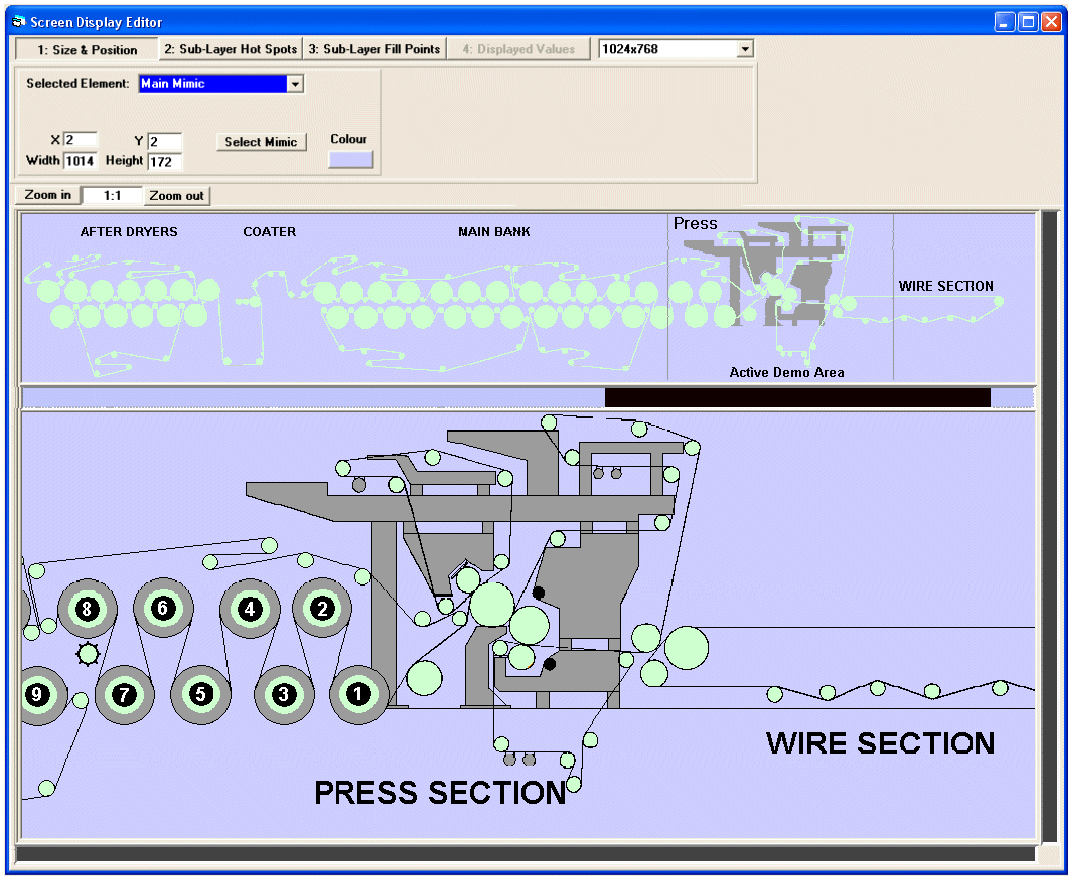


Figure 19. Mimic Editing Display: Size & Position

The Size & Position Panel contains controls to select the mimic image and position it correctly. Adjustments can be made either by typing in new values in the fields, or by using the left mouse button.

Hold the left button down and drag near the edge of the mimic to resize in that direction. Hold the left button down and drag near the centre of the mimic to move the mimic.

The edit fields for size and position remain for all of the other stages for easy adjustment, however mouse operation will be changed according the option button currently selected.

When working with Split and Scroll mimics there is more than one item on the display, therefore use the *Selected Element* drop-down list to select which item is to be adjusted.

The Split mimic has optionally many Secondary Mimics to choose between, in this case a second *Split Level* drop-down list will be displayed to allow the user to select each in turn.

When manipulating the Secondary (Scrolling) Mimic of a Scroll Mimic display, an additional field is displayed to indicate the starting position (offset) which will align with the leftmost edge of the mimic's window.

If a mimic image does not fill the entire area specified, which is common with Secondary Split Mimics, the unused space is filled with a background colour. This colour is drawn onto the **Colour** button, which when clicked will present the standard windows colour selection dialog box for selection.

## Stage 2: Hot-Spots

Hot-Spots are required for every mimic, except the *Main Mimic* of a *Scrolling Mimic Level*.

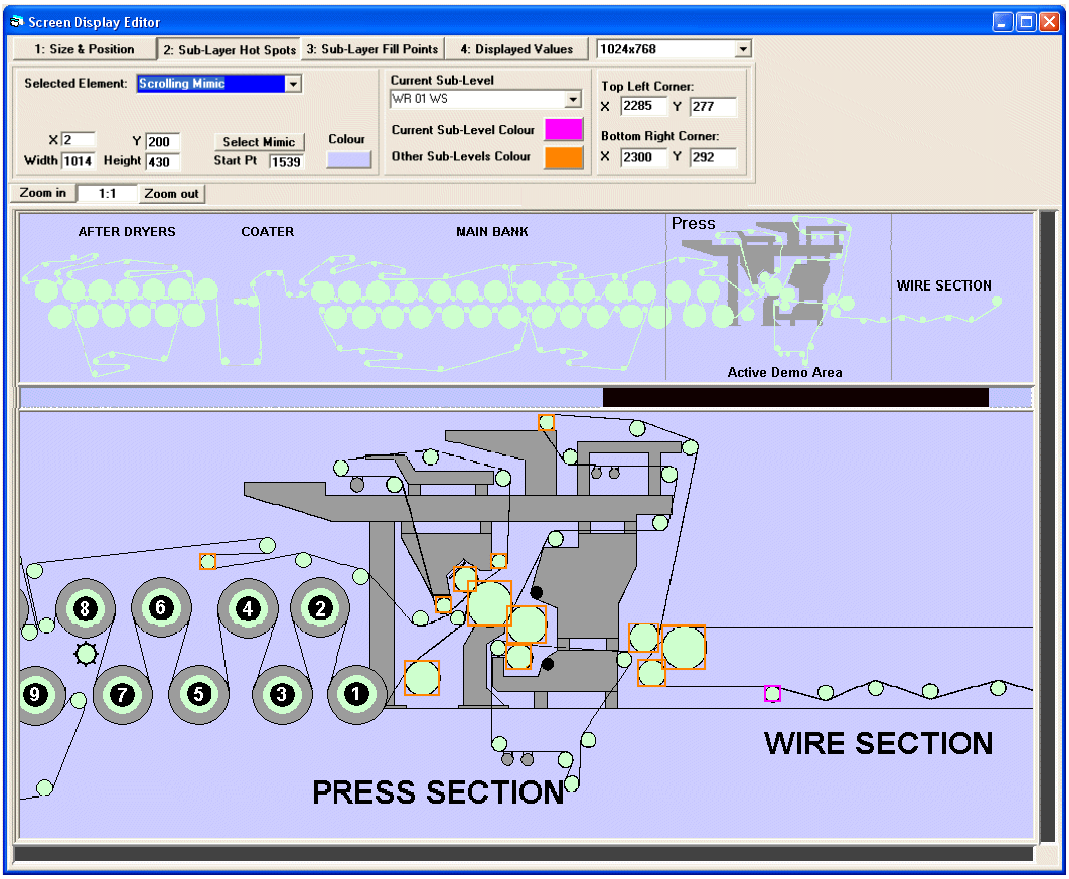


Figure 20. Mimic Editing Display: Hot-Spots

An additional panel is provided to allow each of the child mimics to be selected in turn. All the hot-spots are displayed to allow a developing picture be seen. The colour in which the currently selected level and other levels is drawn can be changed by the user in cases when the mimic image's own colours may not make this clear.

A third panel is also shown. This contains the co-ordinates for the hot-spot. The simplest way of entering these values is to perform a dragging operation with the left mouse button over the area required as the hot-spot. Once this has been performed, fine detail adjustments can be made by altering the numbers in this panel and the results will show in the display.

## Stage 3: Fill-Points

Fill-Points are required for every mimic.

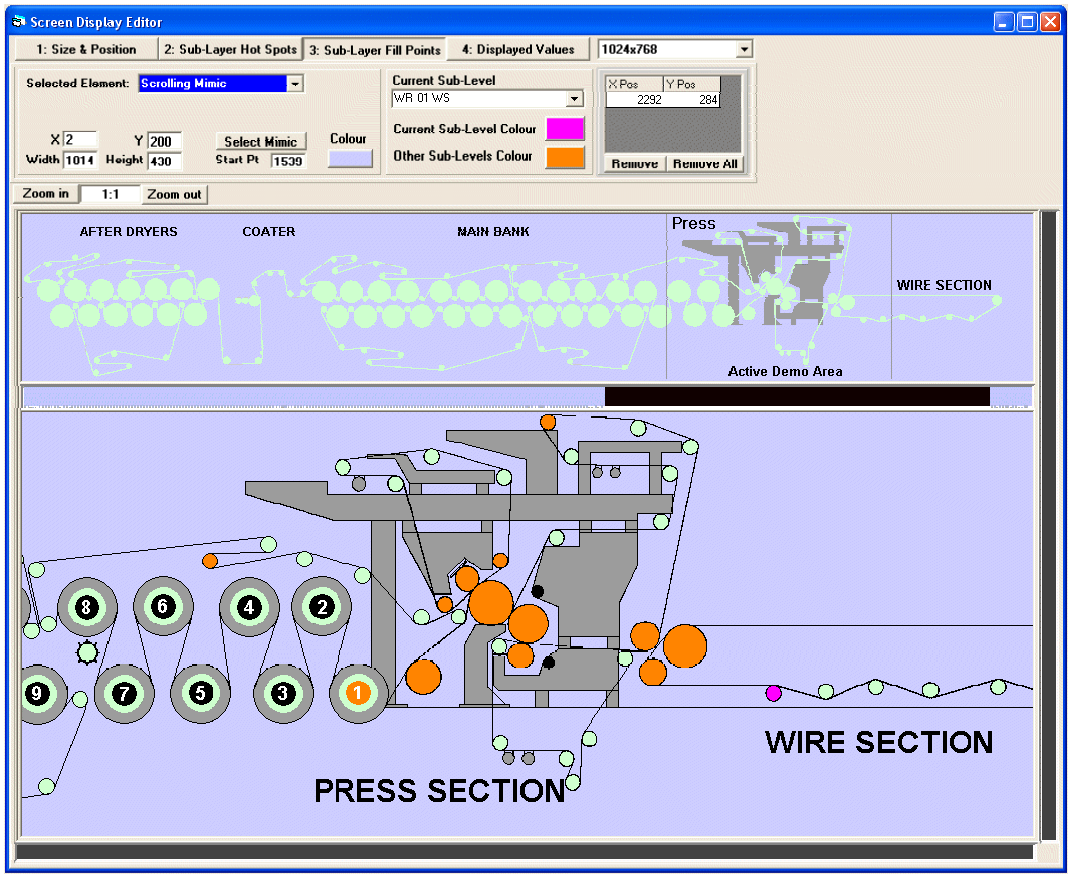


Figure 21. Mimic Editing Display: Fill-Points

The same middle panel is presented as for the hot-spots.

The third panel provides a table of co-ordinates representing the positions on the image that will flood-fill areas within the hotspots with the status colour of the child level. One or more points are required for each child. To create a Fill Point, left-click on the mimic image and a new entry will be added to the table.

If you wish to remove an entry, select it in the table and click the **Remove** button. To clear the entire table and start again, click the **Remove All** button.

## Stage 4: Displayed Values

Displayed values are optional, and can be added to every mimic, except the *Main Mimic* of a *Scrolling Mimic Level*.

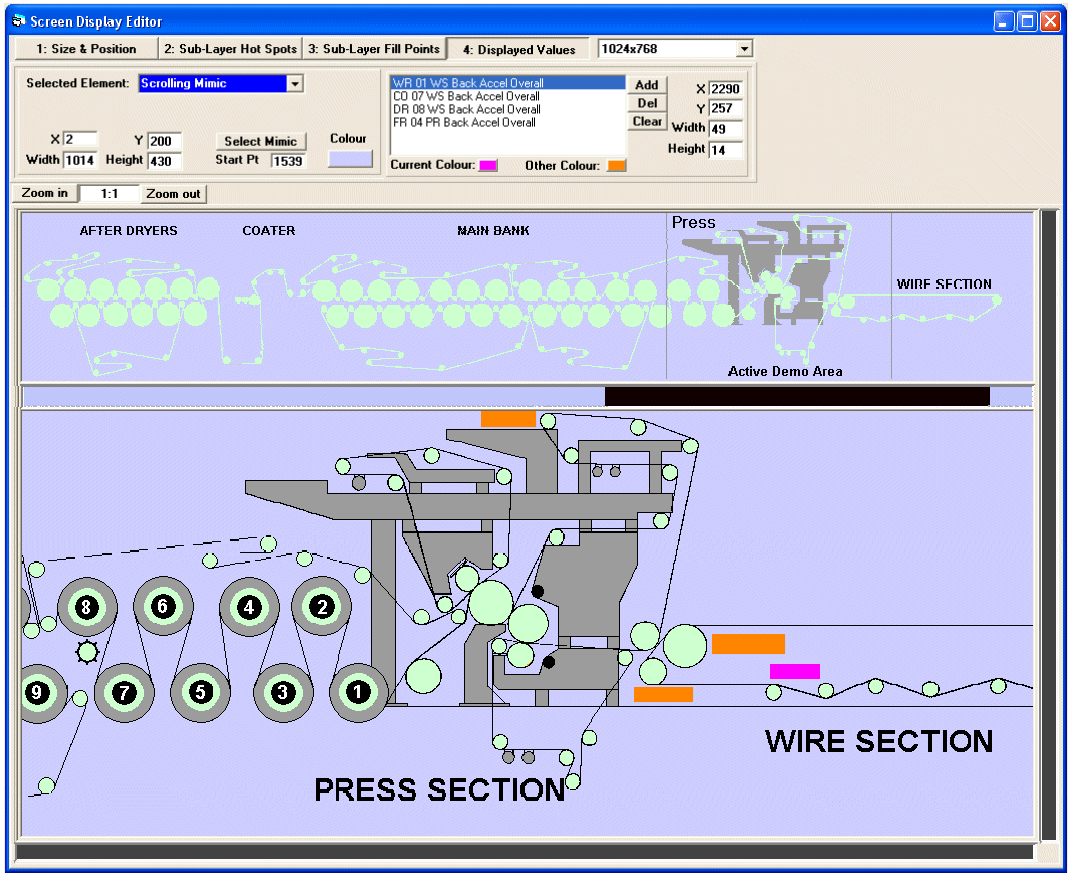


Figure 22. Mimic Editing Display: Displayed Values

The adding of Displayed Values is a two stage process, first the Sub-Measurement has to be selected, and then it is positioned onto the mimic.

To add Sub-Measurements, click the **Add** button, after which the hierarchy will be displayed. Traverse through the hierarchy until the required Sub-Measurement is found and double-click on it. Multiple Sub-Measurements may be added before closing the hierarchy.

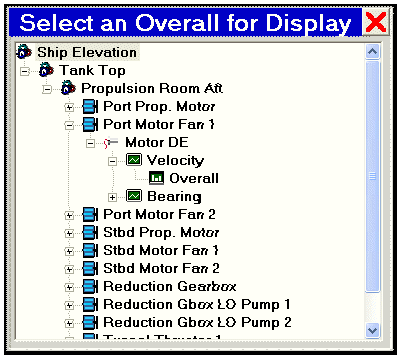


Figure 23. Add Hierarchy for Displayed Values

If a Sub-Measurement was selected by accident, or is no longer needed, select it from the list and then click the **Del** button. To remove all displayed values and start again, click the **Clear** button.

To position the Sub-Measurement's value, select it from the list and using the mouse in the same manner as with the hot-spots, left-drag a rectangular area. The font size used is automatically selected depending on the height of the drawing box, Some trial and error may be required until the correct size is selected for the effect required.

The size and position can be changed in the same manner as the mimic images by either dragging the corner or centre of the highlighted area, or by typing in actual numbers in the edit fields provided.

# Database Verification

The Guardian system allows an endless variety of system layouts to be created,. In order to achieve this variety successfully, there are many rules that, if broken, will cause Guardian Viewer to fail. In order to ensure a database configuration has been correctly created, Visual Designer has a Verification option.

A series of tests are performed, and an error condition is reported with a line *starting <Error XXXX>*, where *XXXX* is a four digit code. Any error will cause problems with Guardian Viewer. Other test operations may return a line starting *<Warning XXXX>*, this indicates an unusual condition which will work in Guardian Viewer but may not be what you intended.

Double clicking on an error or warning will take the user to the cause of the problem.

As part of the ITA check, the memory loading level is displayed. If this reaches 100% the ITA will not accept the configuration and the only solution is to reduce the number of measurement taken, of the number of samples taken in each measurement.

At the end, a summary reports the results of the modules of test as either *Passed* or *Failed*.

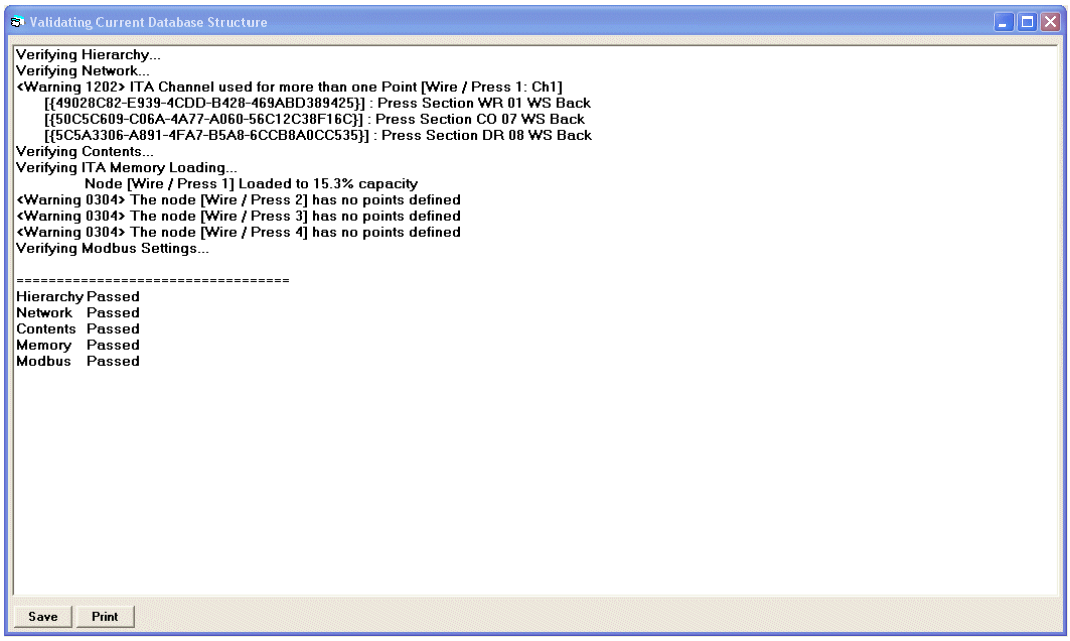


Figure 24. Results from a Verify operation

## Error Code Descriptions

| Code | Description |
|---|---|
| 0001 | System not set for Metric or Imperial measurements |
| 0101 | The layer has been allocated a type of "Not Set". Only the layers immediately below a Scroll Mimic are allowed this. |
| 0102 | The layer does not have any sub-layers, and as it is not a band it must have at least one sub-layer. |
| 0103 | The layer has sub-layers, and as it is a band it cannot have any. |
| 0104 | The layer has a sub-layer of a type that is not permitted. |
| 0201 | The layer has not been allocated a hot-spot, and as a sub-layer of a mimic must have one assigned. |
| 0202 | The layer has not been allocated any fill-points, and as a sub-layer of a mimic must have at least one assigned. |
| 0203 | The Modbus data type and/or direction is not valid, i.e. All non sub-measurements must be of type Status |
| 0301 | The ITA has not been allocated a valid IP address allocated to it. |
| 0302 | The ITA has not been allocated its position in the Network Mimic. |
| 0303 | No image has been selected to be used for network status display |
| 0304 | The measurements assigned to an ITA exceeds its internal memory size. |
| 0401 | The Scroll Mimic has not had an image assigned to its Main Mimic element. |
| 0402 | The Scroll Mimic has an invalid size assigned to its Main Mimic element. |
| 0403 | The Scroll Mimic has not had an image assigned to its Scrolling Mimic element. |
| 0404 | The Scroll Mimic has an invalid size assigned to its Scrolling Mimic element. |
| 0405 | The Scroll Mimic has an invalid size assigned to its Scrollbar element. |
| 0406 | The Scroll Mimic has displayed values that are not its direct descendants. |
| 0407 | The Scroll Mimic has displayed values that have invalid sizes assigned to them. |
| 0501 | The Split Mimic has not had an image assigned to its Main Mimic element. |
| 0502 | The Split Mimic has an invalid size assigned to its Main Mimic element. |
| 0503 | The Split Mimic has an invalid size assigned to its Secondary Mimic element. |
| 0504 | The Split Mimic main mimic has displayed values that are not its direct descendants. |
| 0505 | The Split Mimic main mimic has displayed values that have invalid sizes assigned to them. |
| 0601 | The Split Mimic has not had an image assigned to one of its Secondary Mimic elements. |
| 0602 | One of the Split Mimic secondary mimics has displayed values that are not its direct descendants. |
| 0603 | One of the Split Mimic secondary mimics has displayed values that have invalid sizes assigned to them. |

| | |
|---|---|
| 0701 | The Picture Mimic has not had an image assigned to its Main Mimic element. |
| 0702 | The Picture Mimic has an invalid size assigned to its Main Mimic element. |
| 0703 | The Picture Mimic has displayed values that are not its direct descendants. |
| 0704 | The Picture Mimic has displayed values that have invalid sizes assigned to them. |
| 1201 | The Point is not allocated to an ITA-1, and due to its type must do so. |
| 1202 | The Point is not allocated to an ITA-1 or ITA2, and due to its type must do so. |
| 1203 | The Point is not allocated to an ITA2, and due to its type must do so. |
| 1205 | The Point is not allocated to any ITA node, even is not active it must do so. |
| 1206 | The Point has not been allocated a signal channel number, and due to its type must be. |
| 1207 | The Point has an invalid sensitivity allocated to its first signal path i.e. Zero. |
| 1208 | The Point has an invalid sensitivity allocated to its second signal path i.e. Zero. and as it is an orbit this is not allowed. |
| 1301 | The Measurement is allocated to the wrong type of point for the type of measurement it is configured to take. |
| 1302 | The Measurement is using Time Synchronised Averages without a synchronising trigger pulse. |
| 1401 | The Sub-Measurement has a pair of invalid settings for its range property. |
| 1402 | The Sub-Measurement has been allocated the process of Virtual, however its measurement type does not support this. |
| 1403 | The Sub-Measurement has been allocated a frequency domain process, however its measurement type does not support this. |
| 1404 | The Sub-Measurement has been allocated an orbit process, however its measurement type does not support this. |
| 1405 | The Sub-Measurement has been allocated the process of Time Domain Average, however its measurement type does not support this. |
| 1406 | The Sub-Measurement has been allocated a time domain process, however its measurement type does not support this. |
| 1407 | The Sub-Measurement has been allocated a P-A process, however its measurement type does not support this. |
| 1408 | The Sub-Measurement has been allocated an invalid process. |
| 1501 | The variable has been assigned a sum-measurement to obtain its value, the sub-measurement no longer exists in the hierarchy. |
| 1502 | The equation is syntactically incorrect, load it into the equation editor and click the test button to find out why. |

Table 2. Error codes and their description

| **Code** | **Description** |
|---|---|
| 0304 | The ITA has no points assigned to it. |
| 1201 | An Eddy probe is using an ITA-1, to allow this its input voltage must be divided by 2 |

| | |
|---|---|
| | and the point scaled accordingly. |
| 1202 | Two points use the same ITA node and channel number, this may be correct but needs to be checked. |
| 1303 | The measurement has been defined to use the trigger, but the trigger channel assigned is invalid. |
| 1401 | Two bands use the same Modbus ID, this is likely to be incorrect in most cases. |

Table 3. Warning codes and their description

# External Data Interface Display

Guardian can be configured to supply its status and Sub-Measurement values to an external system over a Modbus link. The configuration for the physical link and how it is serviced is set up within the *System Settings Display*, whereas the actual data to be passed is configured here.

The fist operation is to select all the Levels that will make up the interface. To do this, click the **Add** button, after which the hierarchy will be presented. Traverse through the hierarchy and double-click on any item that it is to be added. Once all selections have been made, close the hierarchy.

If a level has been added by accident or is no longer needed, select it from the list with a single click, and then click the **Delete** button.

The **Sort** button is used to reorder the entries by ascending *ID* number.

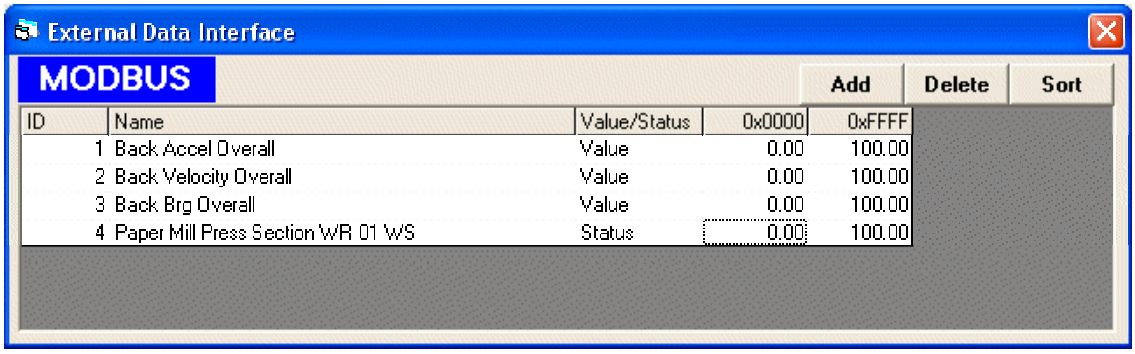


Figure 25. External Data Interface Display

### ID

A ID number in the range 1 to 65535 identifies each item of information. The external device that will be making the requests from Guardian will probably allocate this number.

### Value/Status

In addition to the actual value of a *Sub-Measurement Level*, the current status of any level may also be requested. To select between these two options, click on the current Value/Status and type "*S*" for status or "*V*" for value. To accept the change press the **Enter** key or click elsewhere in the table.

### 0x0000 / 0xFFFF

The value is passed across the Modbus link scaled into the range 0 to 65535. To do this the numerical values that these two endpoints represent have to be entered.

In the case of Status request, the status is converted into a number in the range 0 to 100 as follows:

| | |
|---|---|
| Off Status | 0 |
| Normal Status | 11 |
| Alert Status | 51 |
| Alarm Status | 81 |

# Equation Editor Display

The *Equation Editor Display* is used by three elements of the Visual Designer system:

Virtual Measurements

Measurement Don't Log When conditions

Sub-Measurement alarm limits

In each case the end result is a numerical value based on the current values from other *Sub-Measurement Levels, constants* and mathematical formulae. In the case of the *Don't Log When* condition, any result other than "*0*" will stop the logging.

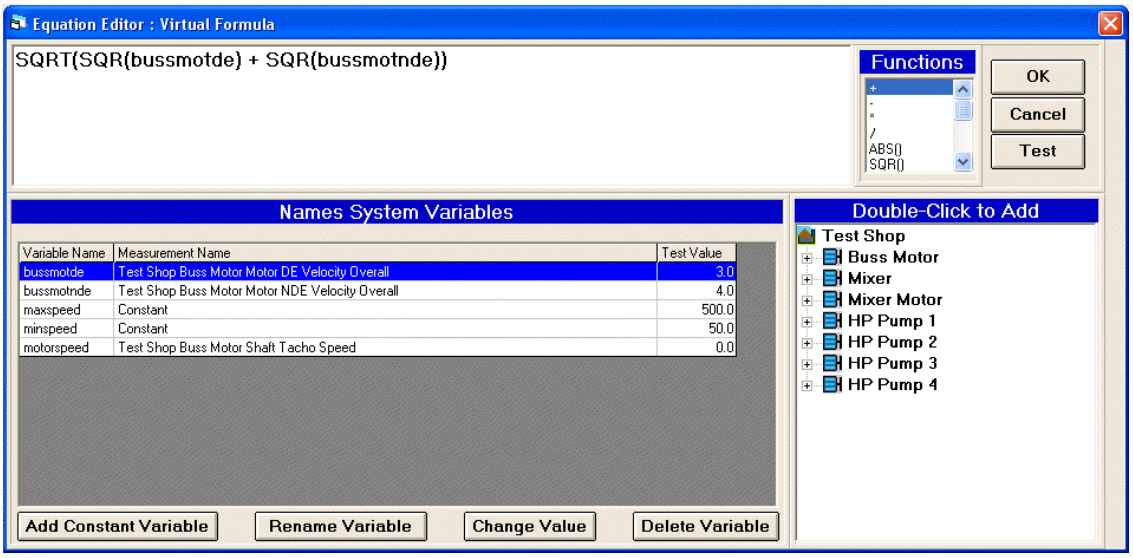


Figure 26. Typical Equation Editor Display

The equation editor display is split into several sections. In the top left is the edit field into which the equation is typed. To its right is a list of the available mathematical functions that may be included into the equation for reference, and at the far right are buttons to accept the new equation, reject it or to test it out.

Below the equation edit field is a table of variables. These are user defined and can be either a constant value, or the value of a sub-measurement. Buttons below the table allow for constants to be added to the table and for existing members to be manipulated. To the right of the table is the hierarchy. Double clicking on a sub-measurement adds a new variable to the table for that sub-measurement.

## System Variables

As mentioned above the equations consist of variables. The most obviously useful is the sub-measurement variable, which will use its current value in the evaluation of the equation. Numeric constants are also allowed, however it may be more meaningful to assign the number to a constant variable. Doing so allows the value to be changed in one place rather than having to edit each equation.

Variable names can be up to 20 characters in length, and can consist of letters or digits. Variables must be in lower case and must start with a letter.

Each variable has a Test Value assigned to it. For a constant this is the value that will be used in the equation, for a sub-measurement variable this is used during the testing process of the equation.

The Rename, Delete and Change Value buttons use the currently selected variable in the table as their focus. If a variable is renamed an option to replace all of its occurrences within all the Guardian equations is offered.

## Editing the Equation

The equation is edited in the same manner as any other edit field. However, there are some important points to note:

- All variables should be typed in lower case
- All Functions should be typed in upper case (The editor can detect and fix some mistakes automatically)
- While spaces are not required, they will be inserted automatically when the equation is first displayed and will assist in its understanding.
- Only the functions listed in the list to the right of the edit field are valid and understood.
- There are no evaluation preferences e.g. whether “*” is performed before “+”, therefore brackets should be used when there could be any doubt.

## Testing the Equation

The **Test** button performs two operations, firstly it verifies that the equation is syntactically correct, and then it evaluates the equation using the Test Values entered for each of the variables. The result, or the description of the error will be displayed.

Note that clicking the **OK** button also checks the syntax and will not allow an invalid equation to be saved. The equation may subsequently become invalid if a variable it depends on is renamed or removed.