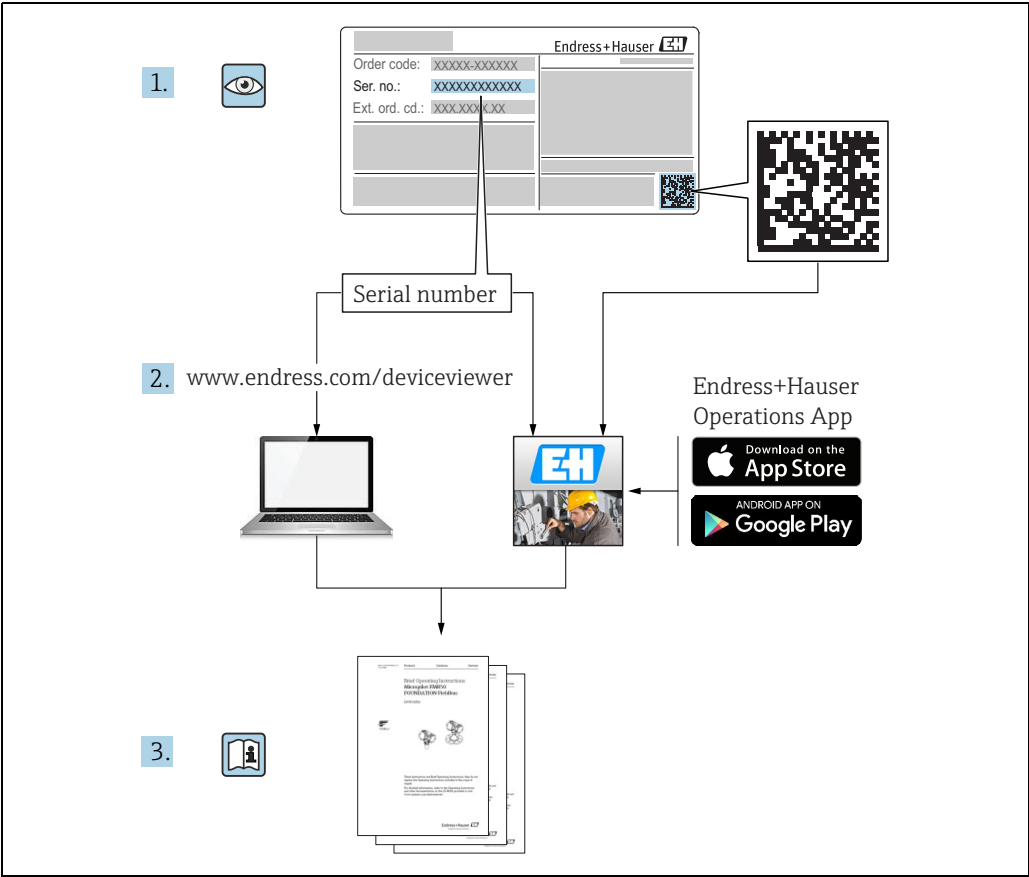


Operating Instructions

Tankvision LMS NXA86

Skin Temperatures





A0023555

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1 Document information

1.1 Target audience for this manual

This manual should support during the installation and maintenance of Tankvision LMS NXA86.

Beside basic PC operating knowledge no special training is needed to perform the Tank Gauging System operations. Nevertheless it is recommended receiving a training on the system by Endress+Hauser.





1.2 Version history

Document version	Valid for SW version	Changes to the previous version
BA01703G/00/EN/01.17	18.0.2 and 18.0.3	Initial version
BA01703G/00/EN/02.18	18.1.1	Compatibility with Windows 10 and Windows Server 2016





1.3 Document function

1.3.1 Used symbols




Safety symbols

Symbol	Meaning
 A0011189-EN	DANGER! This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
 A0011190-EN	WARNING! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
 A0011191-EN	CAUTION! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
 A0011192-EN	NOTICE! This symbol contains information on procedures and other facts which do not result in personal injury.



Electrical symbols

Symbol	Meaning
 A0011197	Direct current A terminal to which DC voltage is applied or through which direct current flows.
 A0011198	Alternating current A terminal to which alternating voltage is applied or through which alternating current flows.
 A0011200	Ground connection A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
 A0011199	Protective ground connection A terminal which must be connected to ground prior to establishing any other connections.

Symbols for certain types of information

Symbol	Meaning
 A0011193	Tip Indicates additional information.
 A0011195	Reference to page Refers to the corresponding page number.
1. , 2. , 3. ...	Series of steps
 A0018373	Result of a sequence of actions

Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
1. , 2. , 3. ...	Series of steps
A, B, C ...	Views
 A0011187	Hazardous area Indicates a hazardous area.
 A0011188	Indicates a non-hazardous location Safe area (non-hazardous area)

1.4 Documentation

1.4.1 Operating instructions

Document number	Instrument	Type of Document
BA00390G/00	Tankvision Professional & LMS	System Configuration
BA00391G/00	Tankvision Professional & LMS	Data Communications Controller
BA00393G/00	Tankvision Professional & LMS	Maintenance
BA01293G/00	Tankvision Professional & LMS	OPC Tank Data Server
BA01294G/00	Tankvision Professional & LMS	OPC TG Client Configuration
BA01654G/00	Tankvision Professional & LMS	System Monitor
BA01700G/00	Tankvision LMS	Installation
BA01701G/00	Tankvision LMS	System Operation
BA01702G/00	Tankvision LMS	Rollover Prediction in LNG storage tanks
BA01703G/00	Tankvision LMS	Skin Temperature
BA01704G/00	Tankvision LMS	LNG Stratification Detection

2 Identification

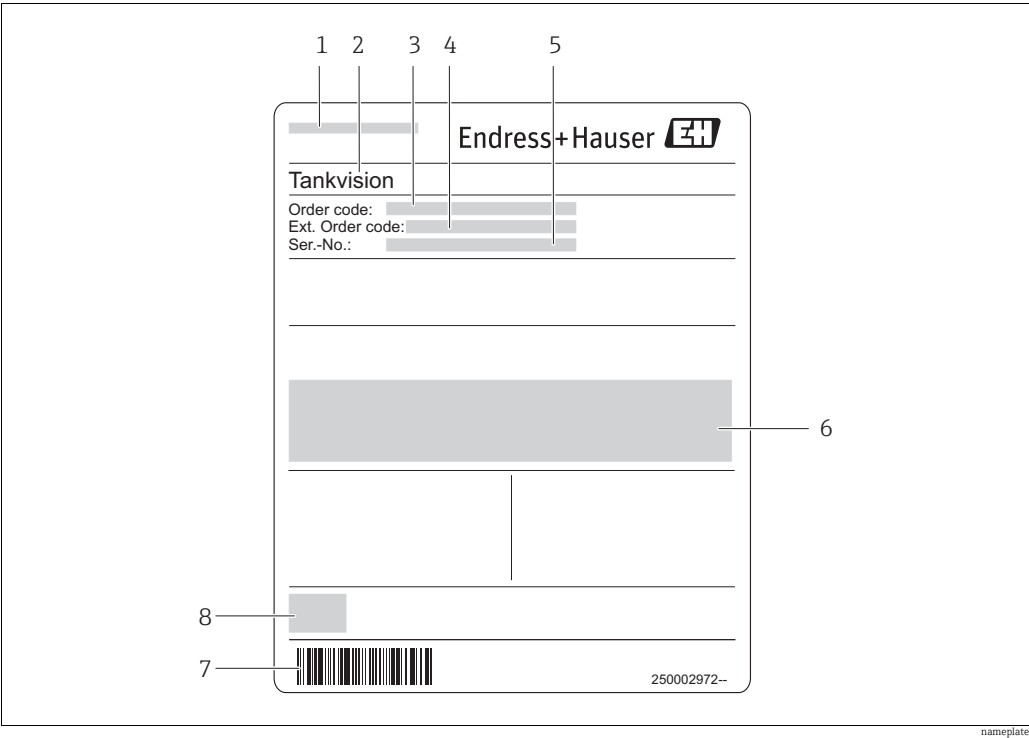
2.1 Product identification

The following options are available for identification of the software:

- Nameplate specifications
- Order code with breakdown of the software features on the delivery note
- Enter serial numbers from nameplates in W@M Device Viewer
(www.endress.com/deviceviewer): All information about the software is displayed.

For an overview of the technical documentation provided, enter the serial number from the nameplates in the W@M Device Viewer (www.endress.com/deviceviewer).

2.2 Nameplate



- 1 Address of manufacturer
- 2 Device name
- 3 Order code
- 4 Extended order code (Ext. ord. cd.)
- 5 Serial number (Ser. no.)
- 6 Certificate and approval relevant data
- 7 Barcode
- 8 CE mark

2.3 Order code and device version



To find out the version of your software, enter the order code indicated on the nameplate in the search screen at the following address:
www.products.endress.com/order-ident

2.4 Device documentation

The information required to retrieve the documentation can be found on the nameplate of the device.



Technical documentation can also be downloaded from the Download Area of the Endress+Hauser web site: www.endress.com → Download. However this technical documentation applies to a particular instrument family and is not assigned to a specific device.

2.4.1 W@M Device Viewer



1. Launch the W@M Device Viewer: www.endress.com/deviceviewer



2. Enter the serial number (Ser. no.) of the device: see nameplate.
↳ All the associated documentation is displayed.

2.4.2 Endress+Hauser Operations App



The *Endress+Hauser Operations App* is available both for android smart phones (Google Play Store) and for iPhones and iPads (App Store).

Via the serial number:



1. Launch the *Endress+Hauser Operations App*.



2. Enter the serial number (Ser. no.) of the device: see nameplate.
↳ All the associated documentation is displayed.

2.5 Registered trademarks

Microsoft®, Windows® and Internet Explorer®
Registered trademarks of the Microsoft Corporation

Modbus®
Registered trademark of the Modbus-IDA, Hopkinton, MA, USA

Java®
Registered trademark of Sun Microsystems, Inc.

Mozilla® Firefox®
Registered trademark of the Mozilla Foundation

Android® and Google Play® are registered trademarks of Google Inc.

iPhone® and iPad® are trademarks of Apple® Inc., registered in the U.S. and other countries.

3 Basic safety instructions

3.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists: must have a relevant qualification for this specific function and task
- Are authorized by the plant owner/operator
- Are familiar with federal/national regulations
- Before beginning work, the specialist staff must have read and understood the instructions in the Operating Instructions and supplementary documentation as well as in the certificates (depending on the application)
- Following instructions and basic conditions

The operating personnel must fulfill the following requirements:

- Being instructed and authorized according to the requirements of the task by the facility's owner operator
- Following the instructions in these Operating Instructions

3.2 IT security

We only provide a warranty if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the device settings.

IT security measures in line with operators' security standards and designed to provide additional protection for the device and device data transfer must be implemented by the operators themselves.

3.3 Designated use

3.3.1 Application

Tankvision LMS is a total LNG Tank Storage and Management solution for Peak Shaving, Receiving and Production LNG facilities. The LMS system has been designed to interface to all instruments commonly found on LNG storage tanks, and to collect and present the instrument data through a range of intuitive graphical user interfaces. A typical LNG Tank will have a wide range of measurement instruments to measure Liquid Level, Liquid Density, Liquid and Vapour Temperature, Liquid and Vapour Pressure, Skin Temperature and much more.

Typically each tank would be fitted with an LTD gauge, two further level gauges configured as a Primary and Secondary, and an Alarm Gauge. The LTD gauge is a servo operated unit mounted on the tank roof. The purpose of the LTD gauge is to take accurate profiles of temperature and density throughout the liquid, and whilst not profiling provide continuous liquid level, temperature and density measurement. The Primary and Secondary gauges can be either servo and or radar operated units also mounted on the tank roof. The purpose of these gauges is to provide continuous liquid level measurement, and average liquid temperature measurement. They provide redundancy on the measurement of level and temperature. The average liquid temperature is derived from a multi point temperature sensor device. The alarm gauge is often a servo or radar based gauge configured to provide volt free contact alarm status to an independent system.

An LMS system can operate in a simple standalone configuration or as a fully redundant system where security and integrity are of paramount importance. The LMS system has a

flexible and scalable architecture allowing it to be tailored to a number of different applications easily.

3.4 Workplace safety

For work on and with the device:

- Wear the required personal protective equipment according to federal/national regulations.
- Switch off the supply voltage before connecting the device.

3.5 Operational safety

Risk of injury!

- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Conversions to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers

- If, despite this, modifications are required, consult with Endress+Hauser.

Repair

To ensure continued operational safety and reliability,

- Carry out repairs on the device only if they are expressly permitted.
- Observe federal/national regulations pertaining to repair of an electrical device.
- Use original spare parts and accessories from Endress+Hauser only.

3.6 Product safety

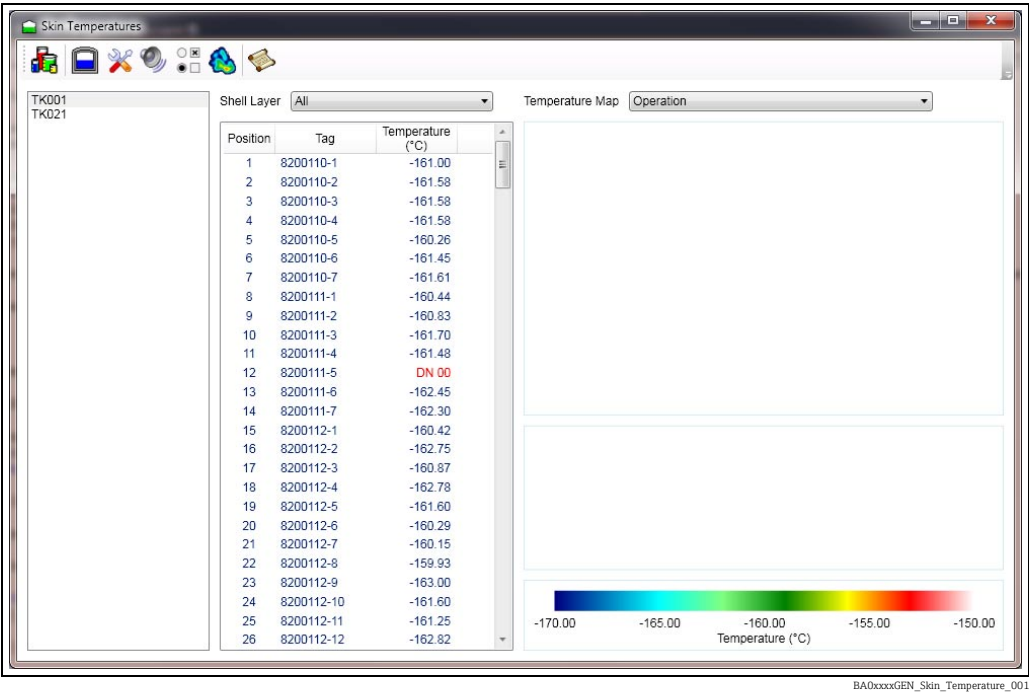
The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

4 Overview

Skin Temperature sensors, located around the base, sides and roof of the LNG tank, are used to detect any anomalies in the shell insulation that may cause a leak of product. They are particularly used during the cool down period of a tank.

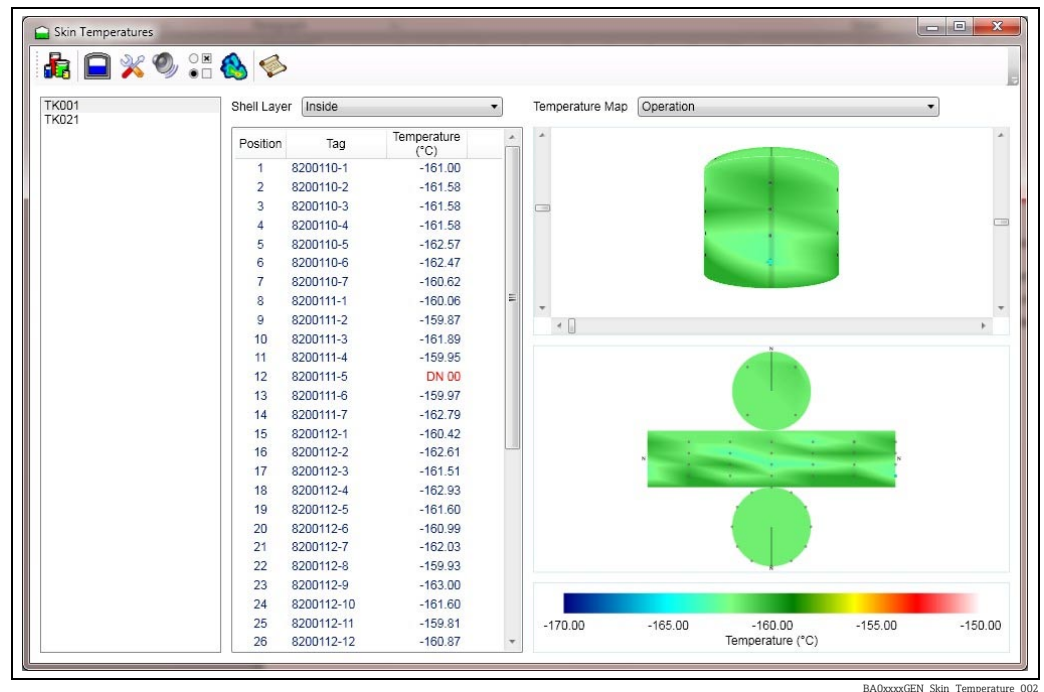
Up to 256 skin temperatures are supported per tank when used in conjunction with MHT TM188 Temperature Multiplexer devices.

The new skin temperature application displays a list of tanks that have skin temperature sensors fitted: **View → Skin Temperatures**.



The main screen (see figure above) is divided into three sections. On the left is the list of tanks that have skin temperature sensors fitted; in the middle is the details of the skin temperature sensors for the selected tank, and on the right is a visualisation of the skin temperature for a specific shell layer.

The visualisation (see figure below) is only present if a specific shell layer is selected in the middle section:



BA0xxxxGEN_Skin_Temperature_002

Tank List

Contains the list of tanks that have skin temperature sensors fitted.

Shell Layer

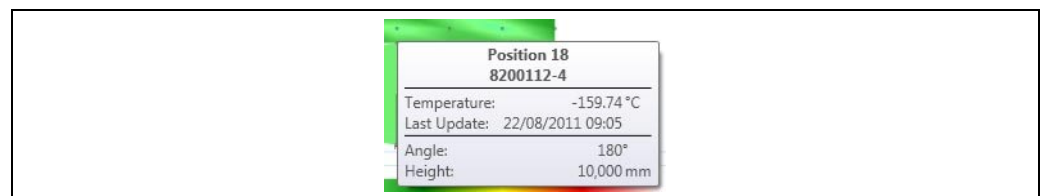
Drop down list contains selection of:

- **All** – All sensors for the tank are listed.
- **All Defined** – All sensors that have a location defined are listed.
- **Specific Shell Layers** – Lists the sensors that are defined as belonging to the specified shell layer.

Visualisation

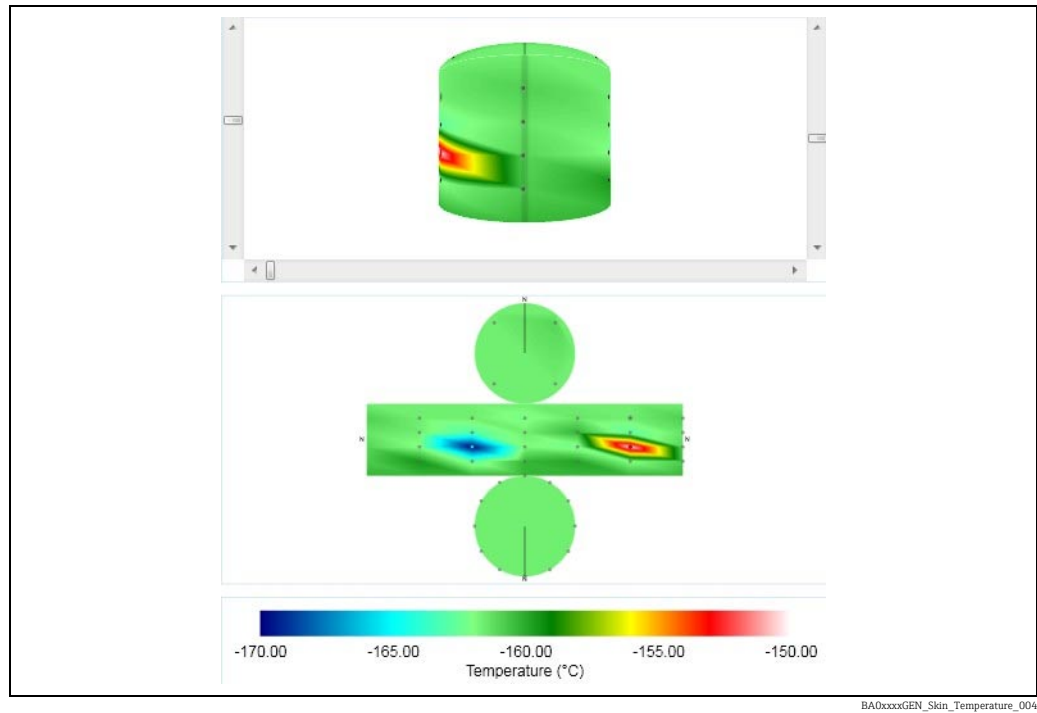
Drop down list contains the temperature maps that can be used to visualise the tank. Upper image is a three dimensional visualisation of the selected shell layer. The user can zoom in and out using the left hand scroll bar, rotate the tank using the bottom scroll bar, and tilt the tank using the right hand scroll bar. The lower image is a two dimensional visualisation of the selected shell layer.

When the mouse is moved over a sensor location (indicated by a dot) more information on the sensor is displayed as shown below.



BA0xxxxGEN_Skin_Temperature_003

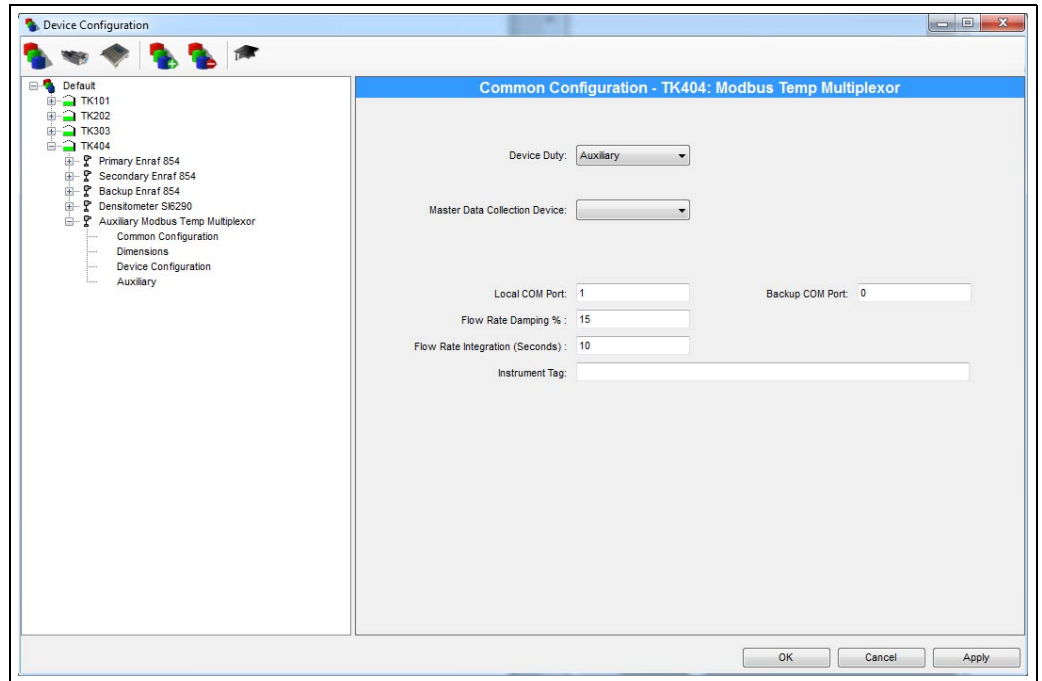
If the status of a sensor indicates that it is invalid, the dot representing the sensor will flash. If the temperature reading for a sensor differs by more than a configured threshold from the average reading of the sensors in that portion of the tank (roof, floor, wall below product level, wall above product level) it is considered to indicate a hot spot or a leak. Hot spots are indicated by the sensor turning red, whilst leaks are indicated by the sensor turning blue as shown below.



If the user clicks on the two dimensional image, the three dimension image is rotated and tilted so that the selected point becomes visible.

5 Configuring

5.1 Gauge Device



BA0xxxxGEN_Skin_Temperature_005

An auxilliary device on TK404 which is the fifth gauge. Device type is Modbus Temp Multiplexor which has a modbus map to pick up the 16 sensor inputs from a TM188 multiplexer.

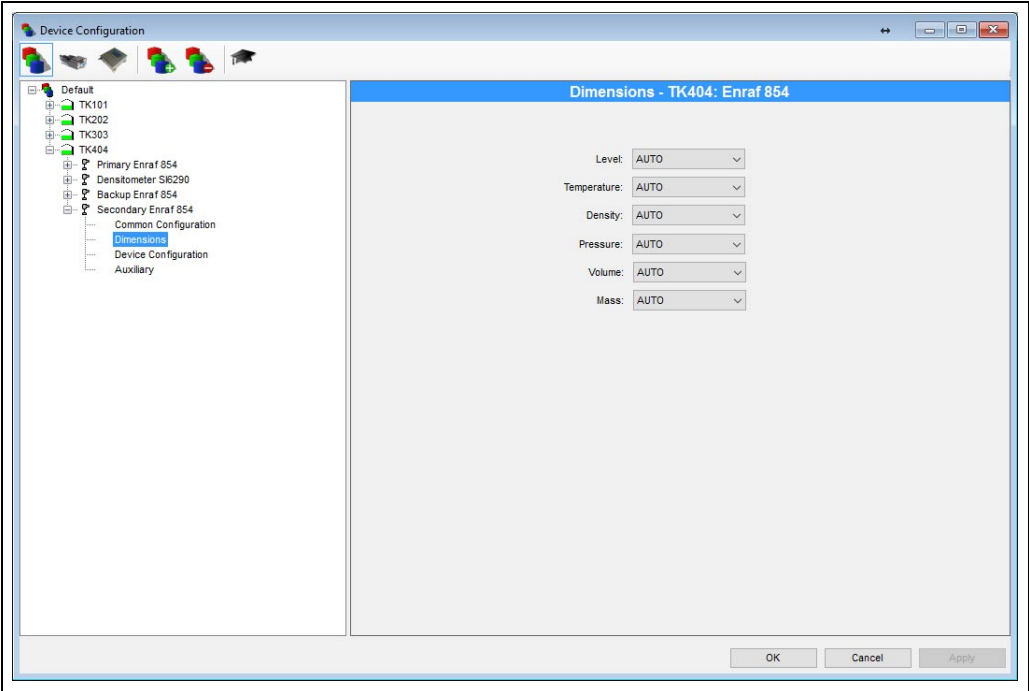
Set up as a Host Modbus device on COM 1 polling for 16 sensor inputs (configuration: 9600 8 none 1 none).



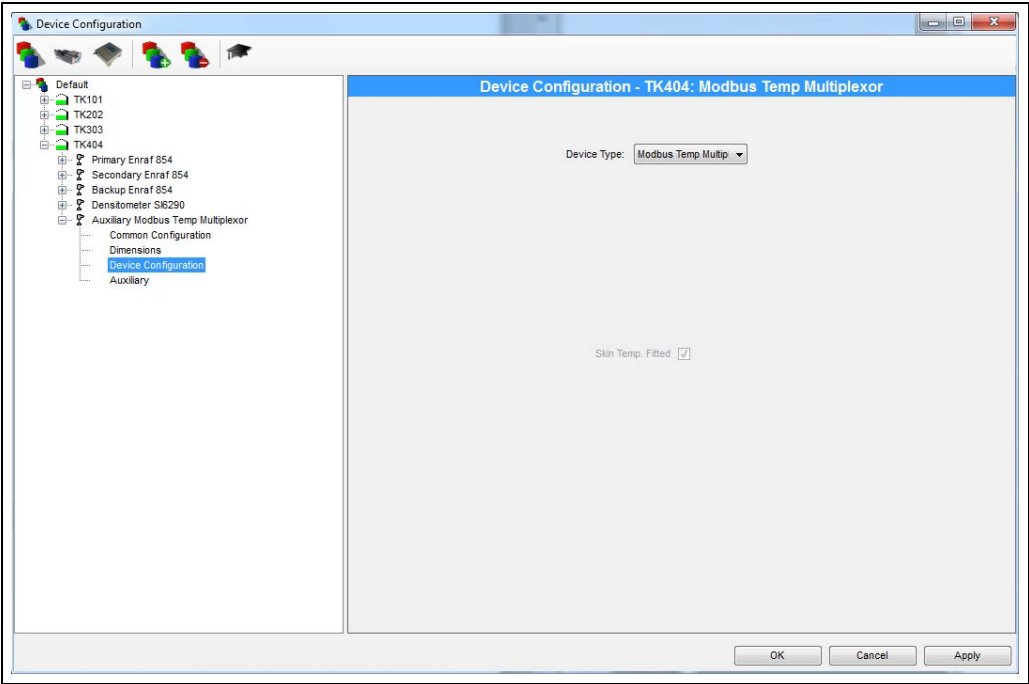
Check the **In use** box for the COM port!



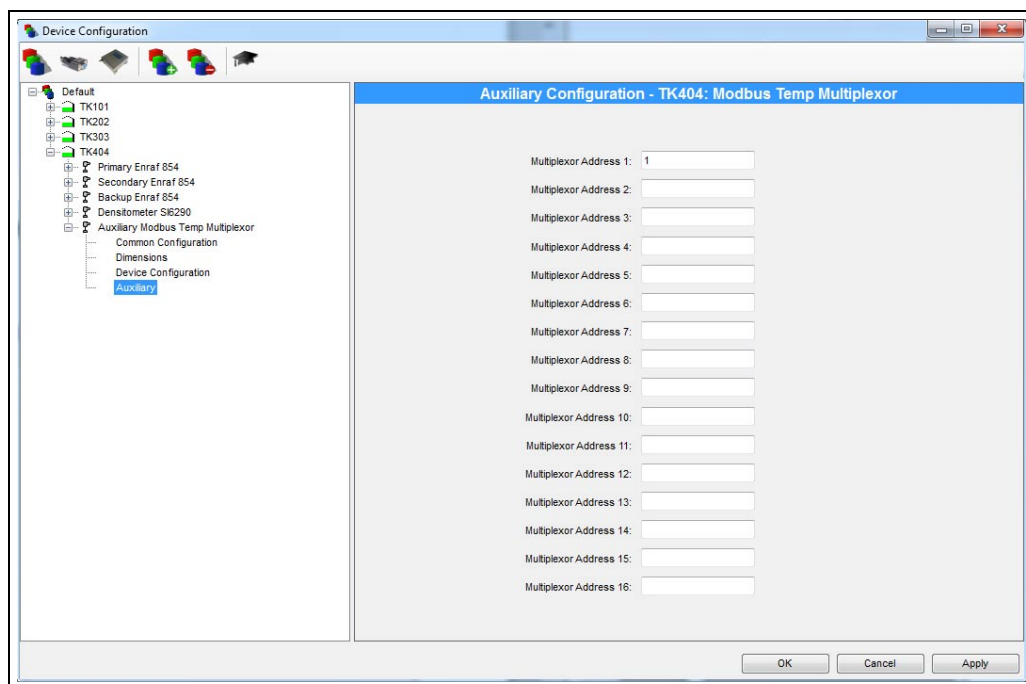
The Background Scan is reduced to 20 seconds from 3 minutes while configuring.



BA0xxxxGEN_Skin_Temperature_006



BA0xxxxGEN_Skin_Temperature_007

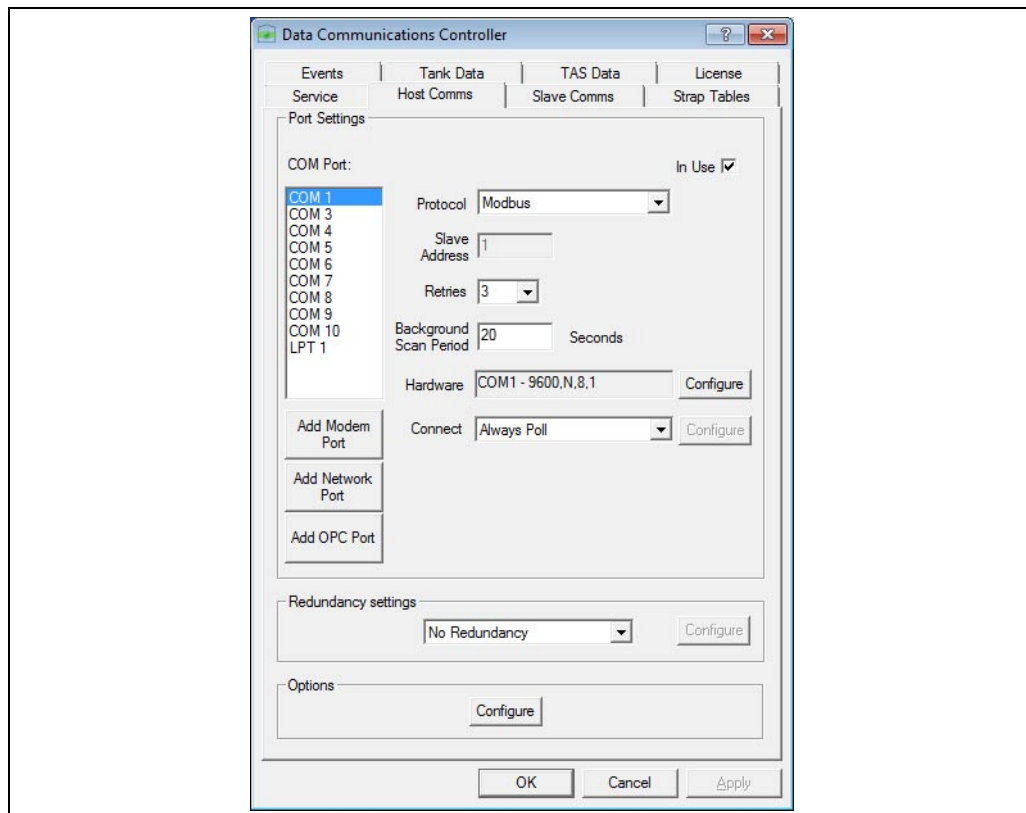


BA0xxxxGEN_Skin_Temperature_008

5.2 DCC Host



It may be necessary to stop/start DCC services to enable a connection.



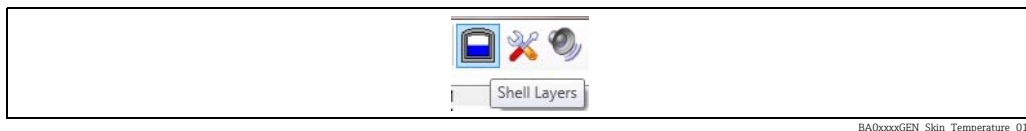
BA0xxxxGEN_Skin_Temperature_009

A crossover serial cable can be used for testing using modsim to simulate the TM188 and RS-232. See Testing section (→ 29).

An RS-485/RS-232 converter or an RS-485 interface card is required for the actual TM188 multiplexer set up as it uses RS-485 for communications.

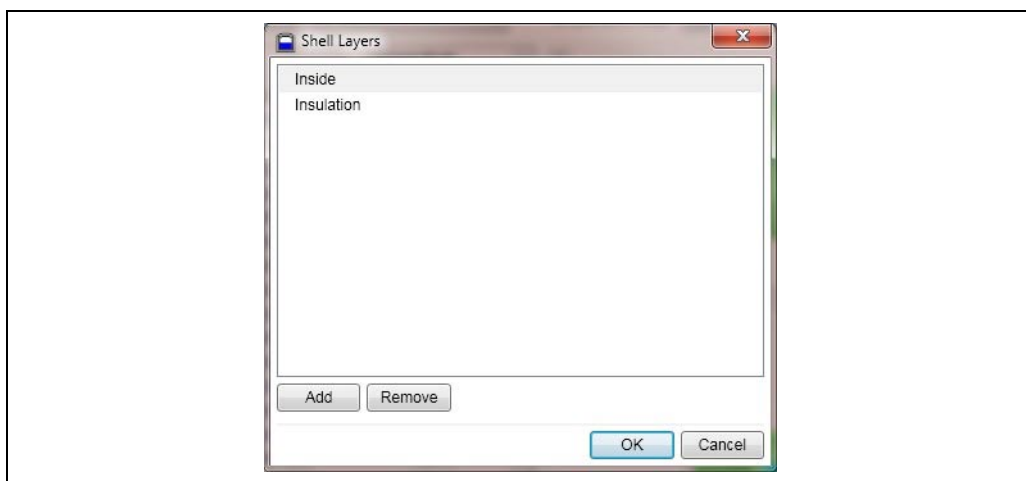
5.3 Shell Layers

The user can configure the names of the shell layers by clicking on the **Shell Layers** button.



BA0xxxxGEN_Skin_Temperature_011

This will display the shell layers configuration screen as shown below:

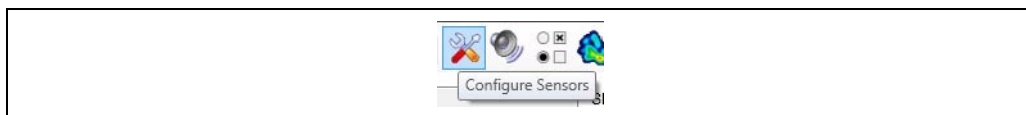


BA0xxxxGEN_Skin_Temperature_011

To edit the name of the shell layer, click on that layer. To add a new shell layer, click the **Add** button. To remove the selected layer click the **Remove** button. To save changes and close the screen click the **OK** button. To close the screen without saving the changes click the **Cancel** button.

5.4 Sensor Configuration

The user can configure the sensors by clicking on the **Configure Sensors** button.

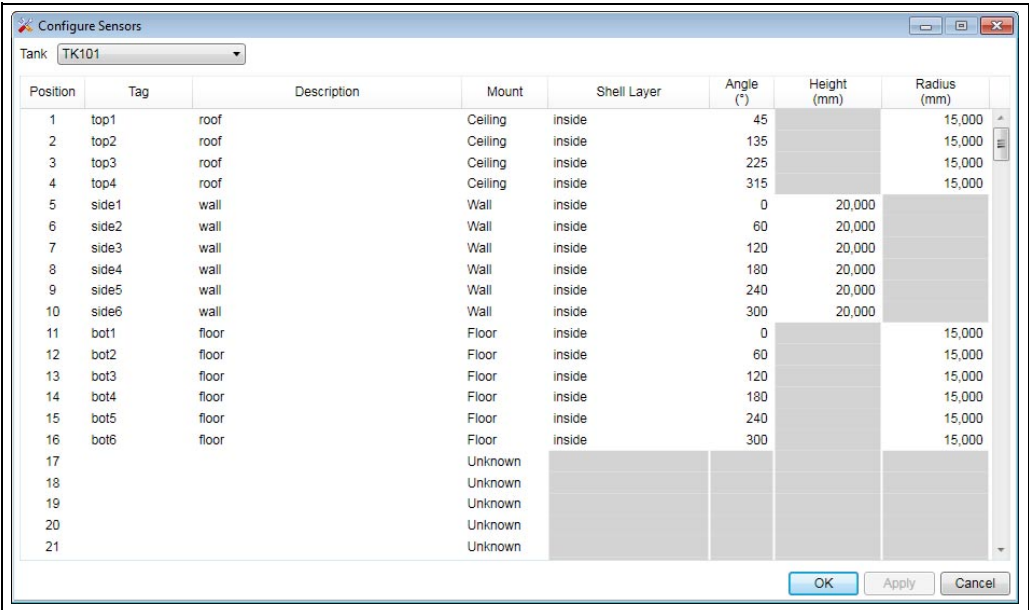


BA0xxxxGEN_Skin_Temperature_012



These can only be configured if there is a data connection – otherwise the sensor positions do not show up.

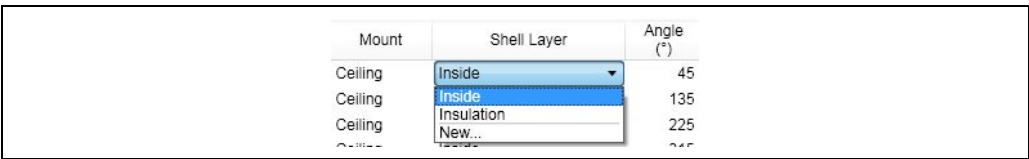
This will display the sensor configuration screen as shown below.



BA0xxxxGEN_Skin_Temperature_013

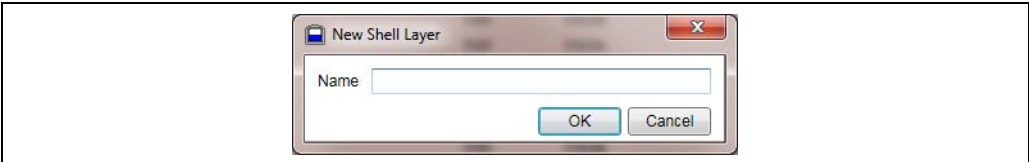
The user can select the tank for which the sensors are to be configured from the drop down list. The list contains only the tanks that have skin temperature sensors fitted. Once a tank is selected, the sensors for the tank are displayed in the grid. The grid contains the following columns:

- **Position** – Index of the sensor. This field is read-only.
- **Tag** – Text field allowing entry of the sensor tag, up to twenty characters.
- **Description** – Text field allowing entry of a full description for the sensor, up to 255 characters.
- **Mount** – Drop down list allowing selection of the location of the sensor (Unknown, Wall, Ceiling, Floor).
- **Shell Layer** – Drop down list allowing selection of the shell layer in which the sensor is located. The list contains all the configured shell layers, plus an entry allowing the user to create a new shell layer:



BA0xxxxGEN_Skin_Temperature_014

If the user clicks on the **New...** entry, the **New Shell Layer** screen is displayed:



BA0xxxxGEN_Skin_Temperature_015

To create the new shell layer, the user should type the name of the new shell layer and then click the **OK** button. The new shell layer will automatically be selected in the sensor configuration screen.

- **Angle** – Text field allowing entry of the angle of the sensor relative to a set starting point for the tank. The set starting point is indicated on the tank visualisation as **N** (North). The angle is considered to be measured clockwise from the starting point (looking down on the tank) and is entered in degrees.
- **Height** – Text field allowing entry of the height of the sensor above the floor. This field is only available when the **wall** mount position is selected for the sensor.
- **Radius** – Text field allowing entry of the distance of the sensor from the centre of the tank in the horizontal plane.
This field is only available when the **ceiling** or **floor** mount position is selected for the sensor.

Each tank may have up to 256 skin temperature positions; however the actual number of temperatures depends on how many multiplexer devices are installed on the tank.

To save the sensor configuration changes for the tank the user should click the **OK** or **Apply** buttons. Clicking the **OK** button will close the screen once the changes have been saved successfully. To leave the screen without saving the changes the user should click the **Cancel** button.

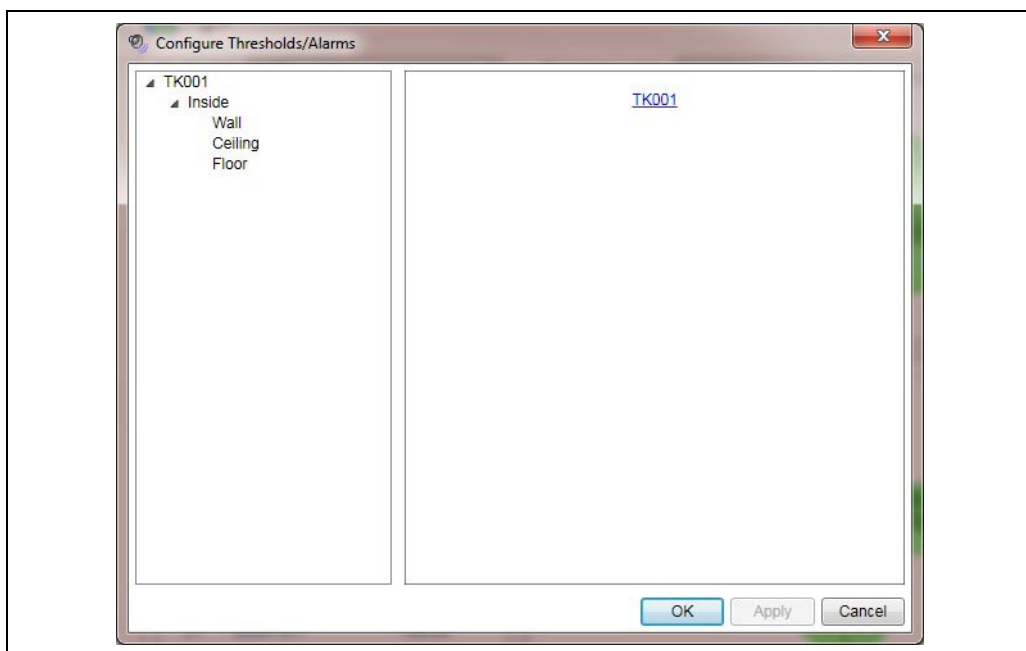
5.5 Configure Thresholds/Alarms

The user can configure the alarms and thresholds for the skin temperature sensors for a tank by clicking the **Configure Thresholds/Alarms** button.



BA0xxxxGEN_Skin_Temperature_016

This will display the Configure Thresholds/Alarms screen as shown below.



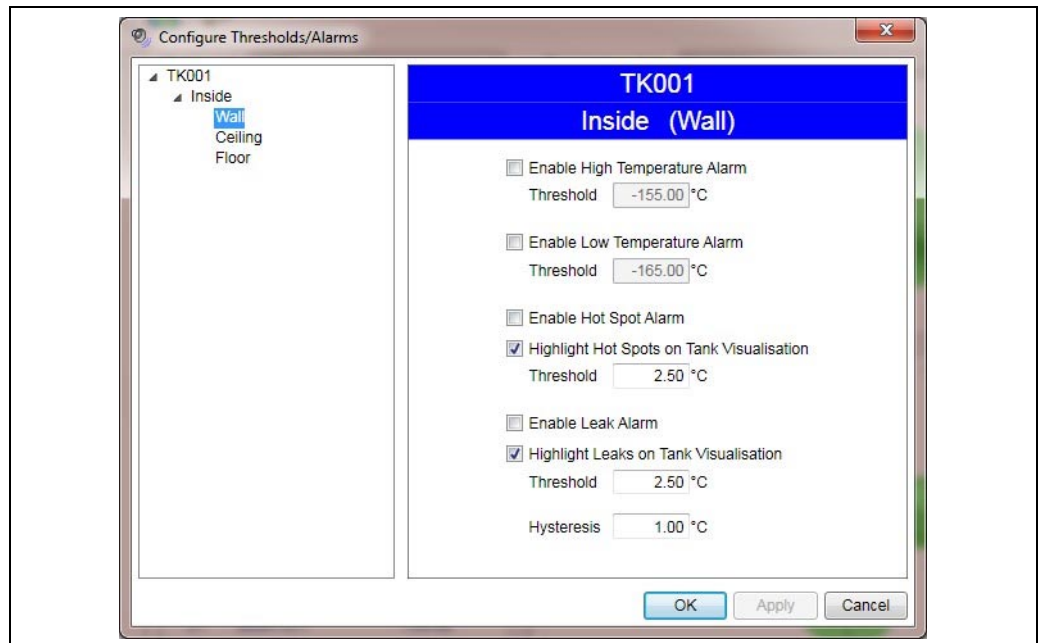
BA0xxxxGEN_Skin_Temperature_017

The tree view on the left hand side of this screen contains a list of tanks that have skin temperatures fitted and have had the skin sensors configured.

Each tank will have sub-entries for the shell layers that contain skin sensors for that tank. Each shell layer will have sub-entries for the mounts that contain skin sensors for that shell layer/tank combination.

If an entry other than a mount location is selected in the tree view, the right hand pane will contain one or more hyperlinks allowing navigation to the sub-entries of the currently selected item.

If a mount location is selected in the tree view, the right hand pane will display the threshold/alarm configuration information for that tank/shell layer/mount combination as shown below.



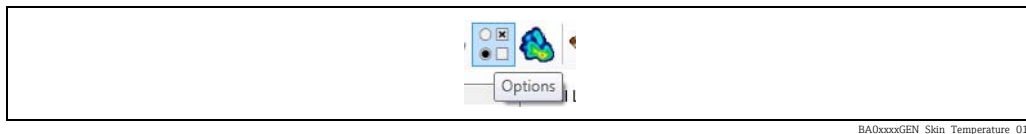
BA0xxxxGEN_Skin_Temperature_018

- **Enable High Temperature Alarm** – Indicates whether a high temperature alarm is to be raised if the median temperature of the sensors in the location rises above the entered threshold.
- **Enable Low Temperature Alarm** – Indicates whether a low temperature alarm is to be raised if the median temperature of the sensors in the location falls below the entered threshold.
- **Enable Hot Spot Alarm** – Indicates whether a hot spot alarm is to be raised if the temperature of a sensor in the location differs by more than the entered threshold from the median temperature of the sensors within that location.
- **Highlight Hot Spots on Tank Visualisation** – Indicates whether a sensor is to be highlighted on the tank visualisation if the temperature of that sensor differs by more than the entered threshold from the median temperature of the sensors within that location.
- **Enable Leak Alarm** – Indicates whether a leak alarm is to be raised if the temperature of a sensor in the location differs by more than the entered threshold from the median temperature of the sensors within that location.
- **Highlight Leaks on Tank Visualisation** – Indicates whether a sensor is to be highlighted on the tank visualisation if the temperature of that sensor differs by more than the entered threshold from the median temperature of the sensors within that location.

The difference between the hot spot and leak alarms is that the hot spots are sensors which are warmer than the median temperature whilst leaks are sensors which are colder than the median temperature. The hysteresis field allows the user to define the margin at which the alarms are considered to be cleared.

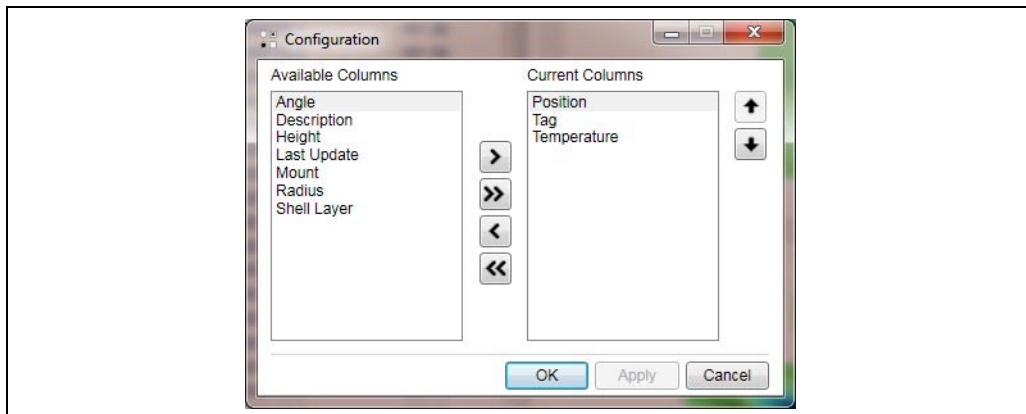
5.6 Options

The user can configure the columns to be displayed for each sensor on the main screen by clicking the **Options** button.



BA0xxxxGEN_Skin_Temperature_019

This will display the Options screen as shown below.



BA0xxxxGEN_Skin_Temperature_020

The user can move the selected column from the **Available Columns** list to the **Current Columns** list by clicking the add column button (>).

The user can move all the remaining columns from the **Available Columns** list to the **Current Columns** list by clicking the add all columns button (>>).

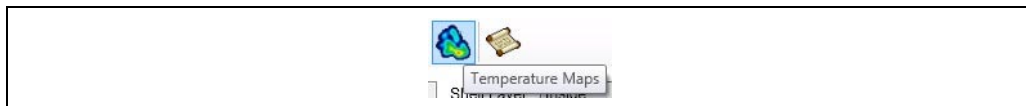
The user can move the selected column from the **Current Columns** list to the **Available Columns** list by clicking the remove column button (<).

The user can move all the remaining columns from the **Current Columns** list to the **Available Columns** list by clicking the remove all columns button (<<).

The user can reorder the current columns list by moving the selected item up (↑) and down (↓).

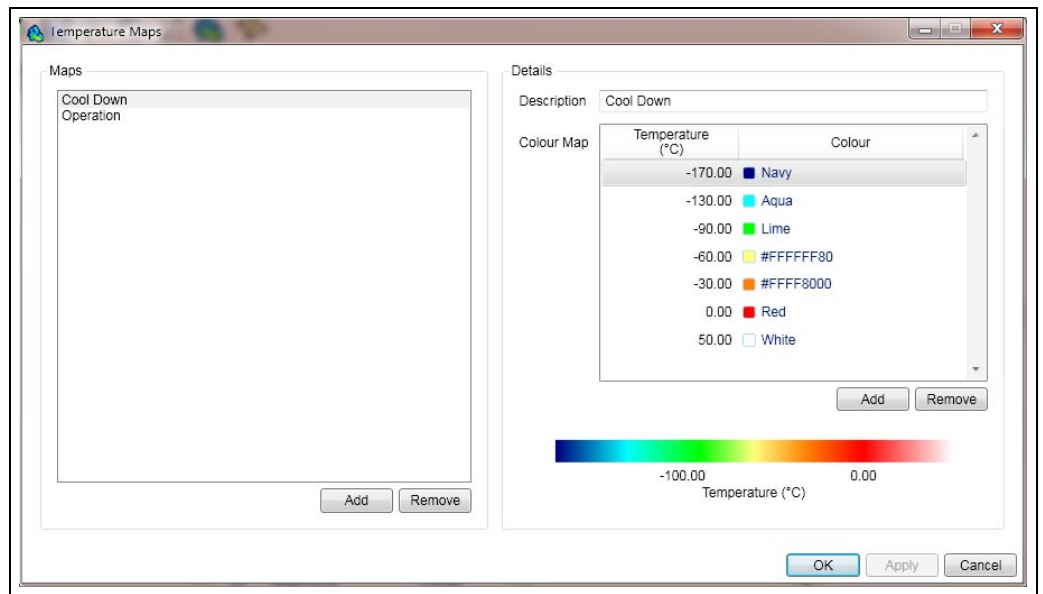
5.7 Temperature Maps

The user can configure the temperature maps used to display the tank visualisations by clicking the **Temperature Maps** button.



BA0xxxxGEN_Skin_Temperature_027

This will display the Temperature Maps screen as shown below.

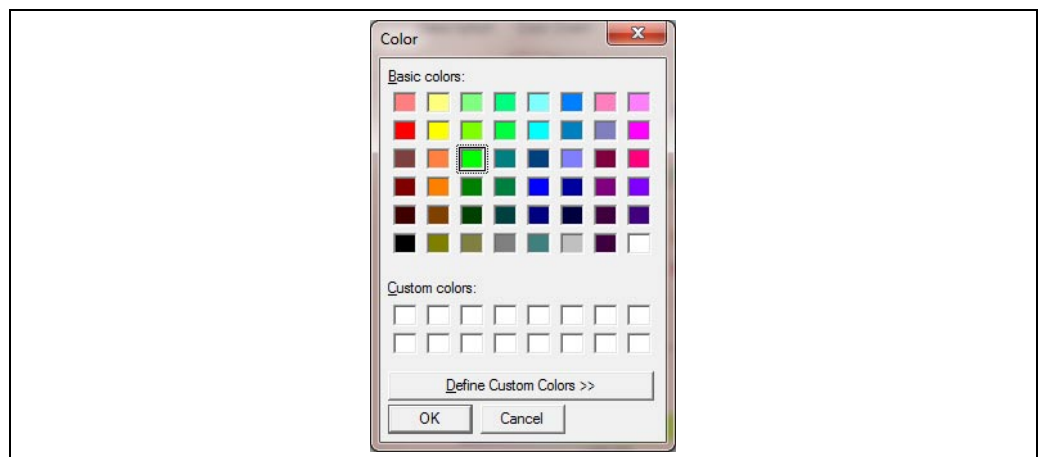


BA0xxxxGEN_Skin_Temperature_028

A list of currently configured maps is displayed on the left hand side of the screen. Two pre-configured maps are included for **Cool Down** and **Operation**. Additional maps can be created by clicking the **Add** button. Existing maps can be removed by selecting them and clicking the **Remove** button.

Details of the selected temperature map are displayed on the right hand side of the screen. To add new points to the colour map the user can click the **Add** button. To remove an existing point from the colour map the user can click the **Remove** button.

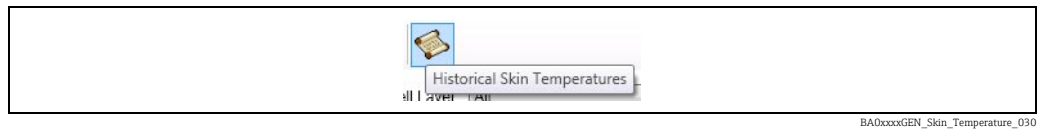
The points in the colour map can be edited to change the temperature or colour. The new temperature can be entered by clicking on the current figure and then typing the new value. The new colour can be selected by clicking on the current colour. This will cause a colour selection screen to be displayed as shown below.



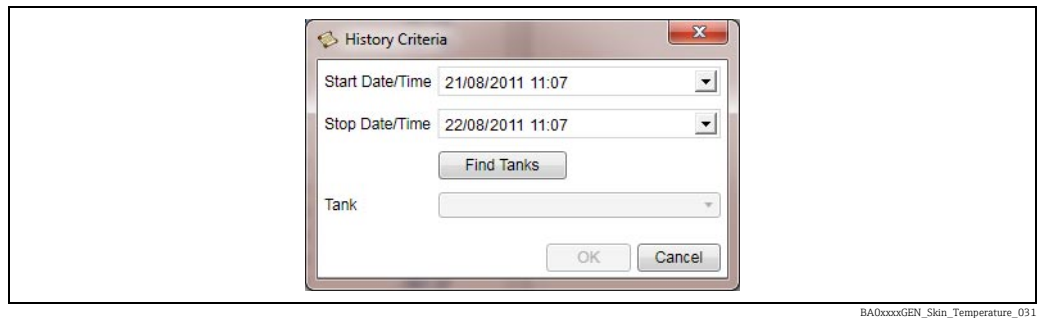
BA0xxxxGEN_Skin_Temperature_029

5.8 Historical Skin Temperatures

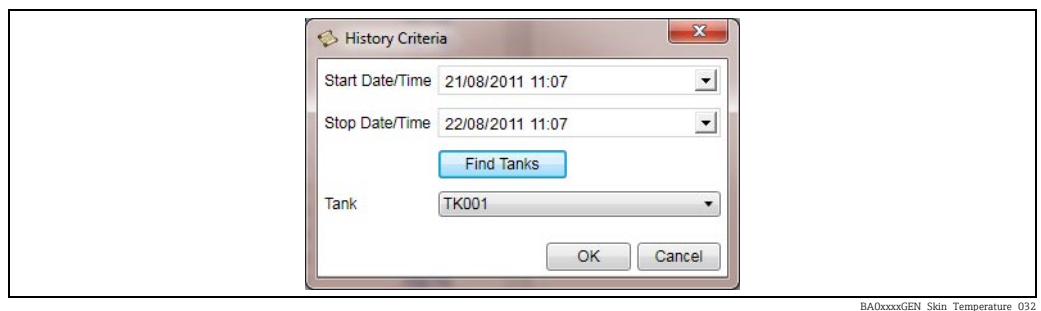
The user can view historical skin temperatures (if they are being trended – see next section) by clicking the **Historical Skin Temperatures** button.



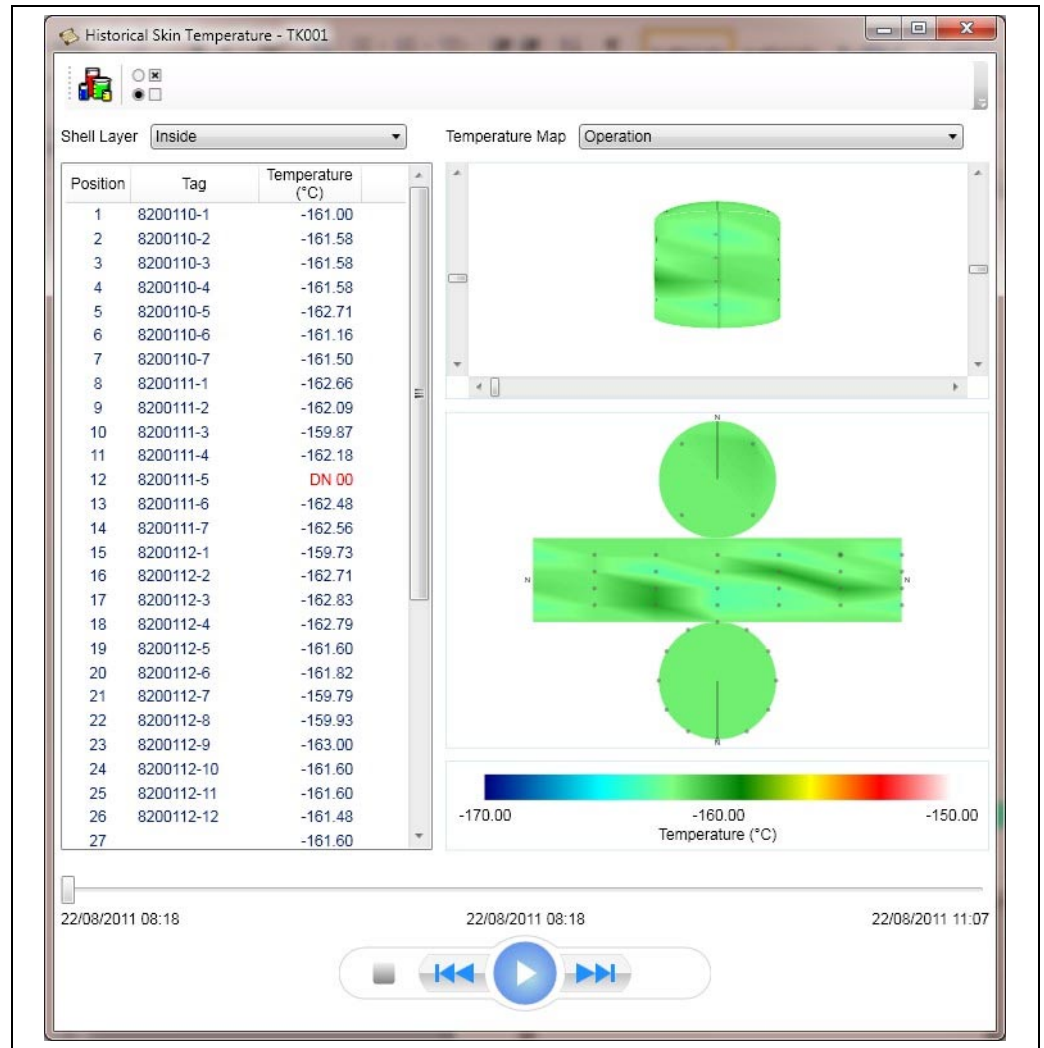
This will display the date/tank selection screen as shown below.



Once the user has entered a **Start Date/Time** and **Stop Date/Time** they must click the **Find Tanks** button to find the tanks for which skin temperature trending data is available between the entered date/times. If trending data is available the tanks list is populated with the relevant tanks and the user is able to select a tank as shown below.



Once the user has selected a tank they can display the historical skin temperature screen (see below) by clicking the **OK** button.



BA0xxxxGEN_Skin_Temperature_033

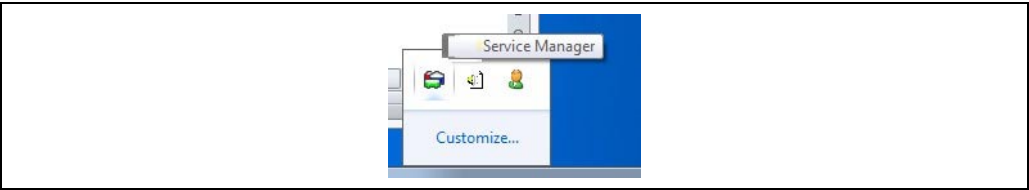
This screen is similar to the main skin temperatures screen with the following differences:

- The only configuration available is to change the columns displayed for the skin sensors. Any configuration data regarding the sensors, shell layers, visualisation thresholds and temperature maps are taken from the main screen.
- There is no tank list. Only the data for the tank selected in the date/tank selection screen is available.
- The date/time for which data is to be displayed can be selected by using the slider control at the bottom of the screen. The data can be animated using the controls below the slider to play, fast forward or rewind the current date selection.

The user can open as many historical screens as they wish. However, all historical screens will be closed when the main screen is closed.

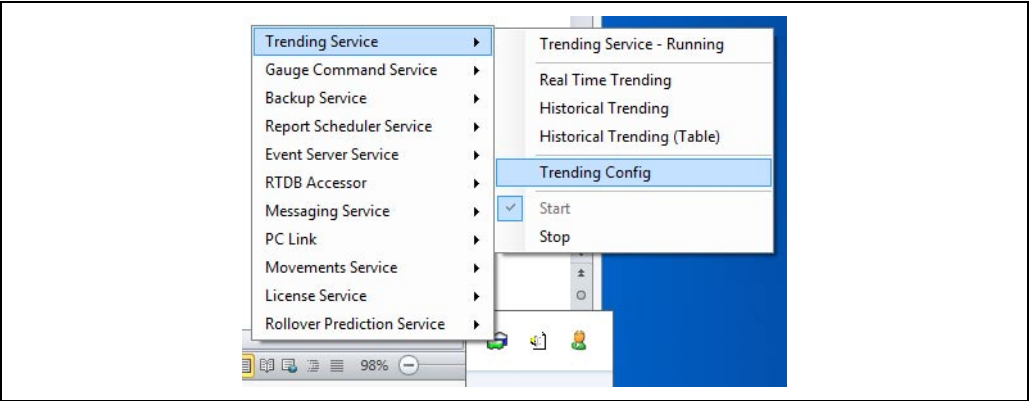
5.9 Trending

It is essential to have trending of Skin Temperatures set up in order to view Historical Skin Temperatures. Right click the service manager taskbar icon as shown below.



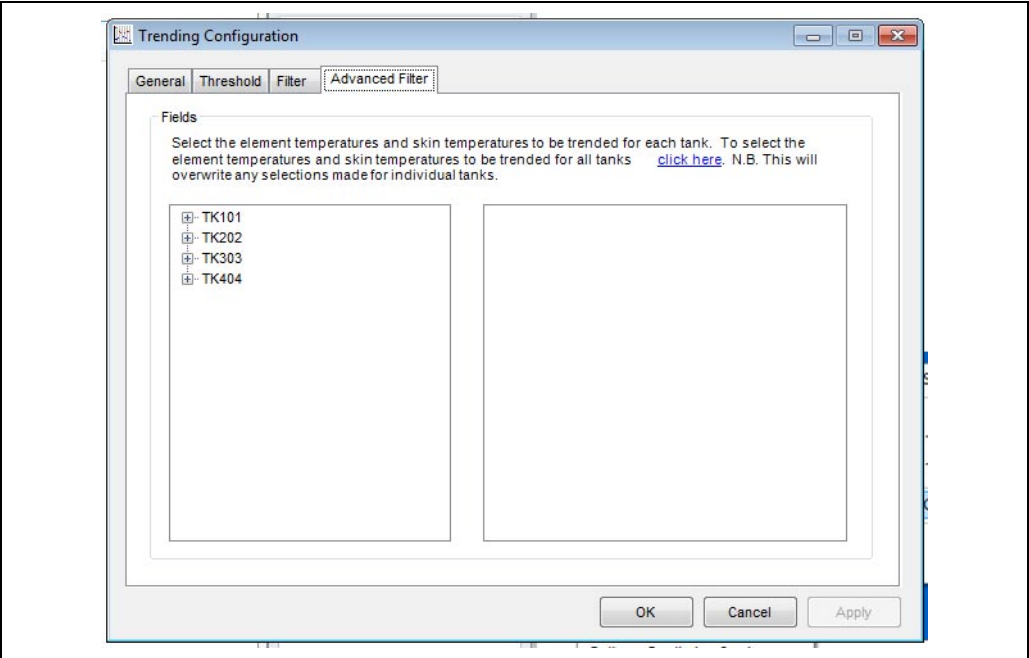
BA0xxxxGEN_Skin_Temperature_034

Select **Trending Service** → **Trending Config** in the pop-up menu as shown below.



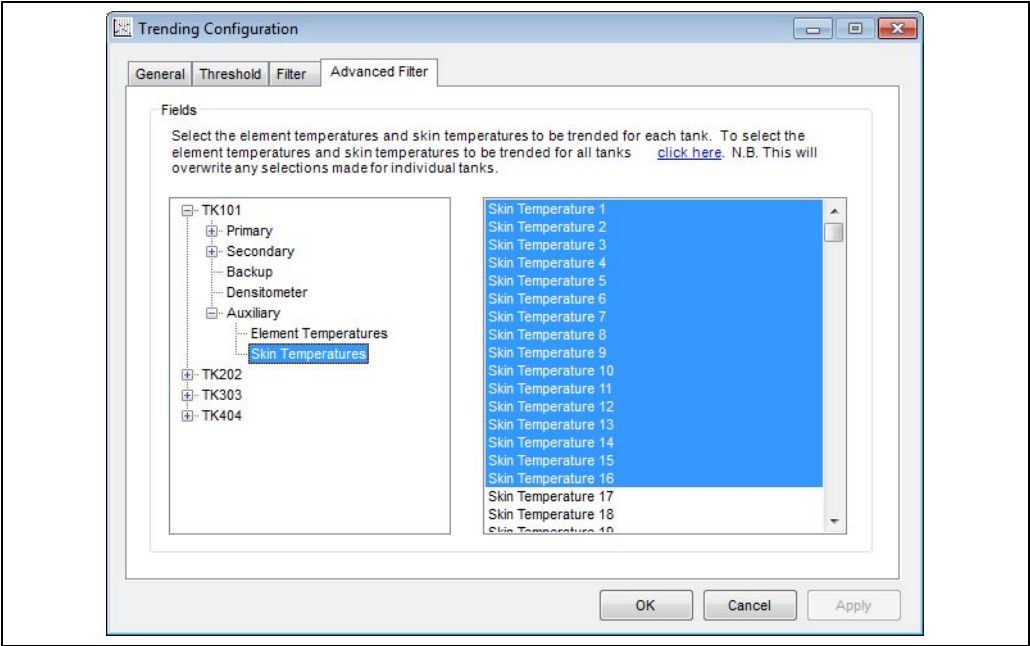
BA0xxxxGEN_Skin_Temperature_035

Once the screen (see below) opens, select the Tank required.



BA0xxxxGEN_Skin_Temperature_036

Select **Auxiliary** and then **Skin Temperatures** then highlight the desired sensors as shown below.



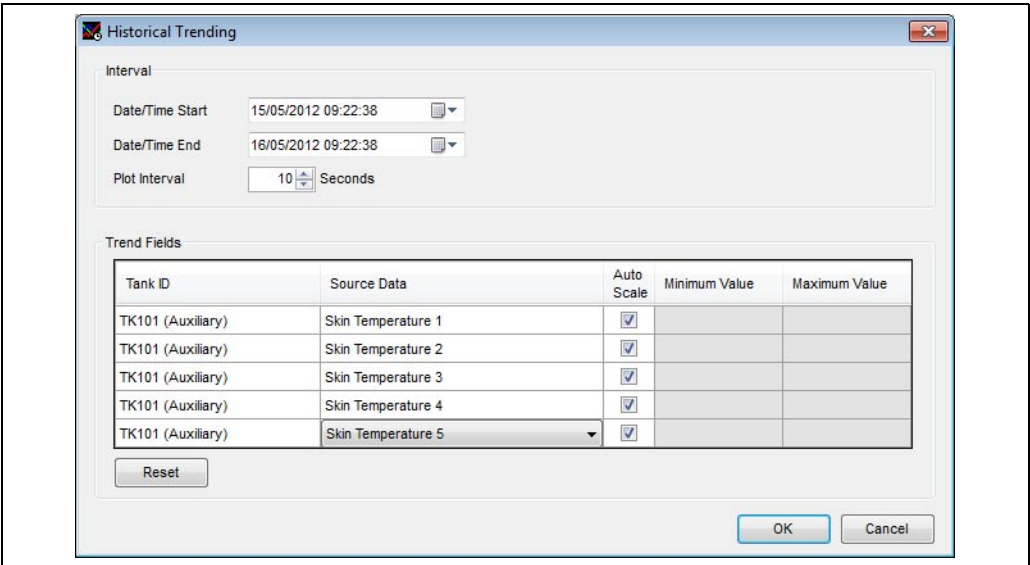
BA0xxxxGEN_Skin_Temperature_037

Enter Historical Trending using the shortcut bar icon.



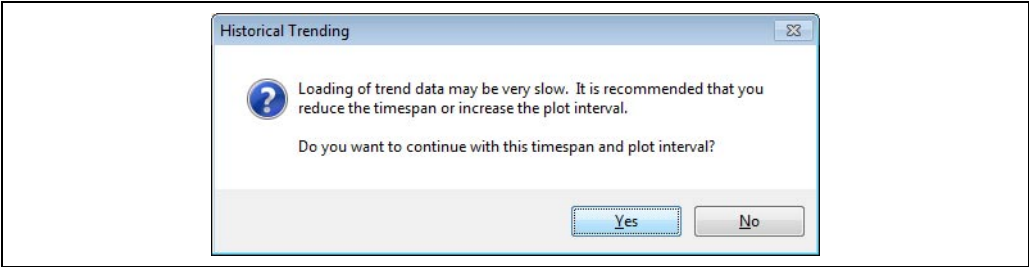
BA0xxxxGEN_Skin_Temperature_038

Configure the **Tank ID** and the **Source Data** as shown below.



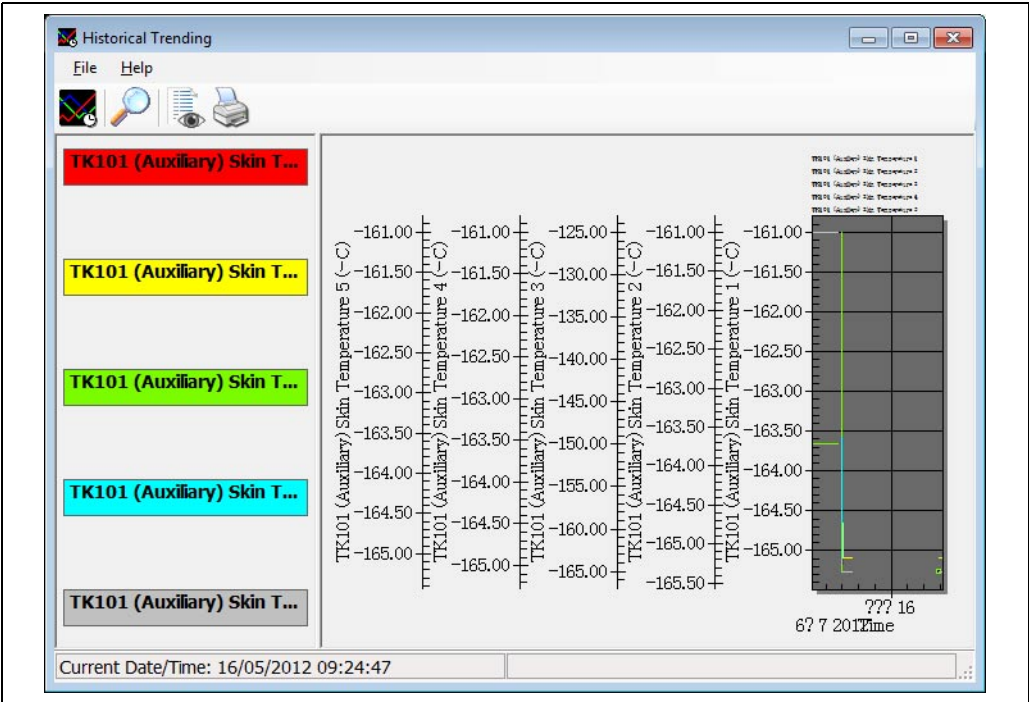
BA0xxxxGEN_Skin_Temperature_039

There may be a warning after clicking the **OK** button as shown below.



BA0xxxxGEN_Skin_Temperature_040

Click the **OK** button again.
Check that the skin temperatures have been recorded and are shown in the trend as shown below.



BA0xxxxGEN_Skin_Temperature_041

It will now be possible to view Historical Skin Temperatures.

5.10 TM188 Comms Details


The data measured by the TM188 is exposed through a contiguous block of registers. These registers can be requested using Function 3 or 4.
The mapping of the temperature data is described in the table below:

Register Address	Data Item	Data Type	Range
0	Temperature 1	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
1	Temperature 2	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
2	Temperature 3	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
3	Temperature 4	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
4	Temperature 5	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
5	Temperature 6	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
6	Temperature 7	Signed 16 Bit Integer	-200.0 °C to +140.0 °C

Register Address	Data Item	Data Type	Range
7	Temperature 8	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
8	Temperature 9	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
9	Temperature 10	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
10	Temperature 11	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
11	Temperature 12	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
12	Temperature 13	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
13	Temperature 14	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
14	Temperature 15	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
15	Temperature 16	Signed 16 Bit Integer	-200.0 °C to +140.0 °C
16	Temperature 1 Status	Signed 16 Bit Integer	See Note Below
17	Temperature 2 Status	Signed 16 Bit Integer	See Note Below
18	Temperature 3 Status	Signed 16 Bit Integer	See Note Below
19	Temperature 4 Status	Signed 16 Bit Integer	See Note Below
20	Temperature 5 Status	Signed 16 Bit Integer	See Note Below
21	Temperature 6 Status	Signed 16 Bit Integer	See Note Below
22	Temperature 7 Status	Signed 16 Bit Integer	See Note Below
24	Temperature 8 Status	Signed 16 Bit Integer	See Note Below
24	Temperature 9 Status	Signed 16 Bit Integer	See Note Below
25	Temperature 10 Status	Signed 16 Bit Integer	See Note Below
26	Temperature 11 Status	Signed 16 Bit Integer	See Note Below
27	Temperature 12 Status	Signed 16 Bit Integer	See Note Below
28	Temperature 13 Status	Signed 16 Bit Integer	See Note Below
29	Temperature 14 Status	Signed 16 Bit Integer	See Note Below
30	Temperature 15 Status	Signed 16 Bit Integer	See Note Below
31	Temperature 16 Status	Signed 16 Bit Integer	See Note Below

5.10.1 Status and Scaling

Temperature Status is expressed in two different ways:

1. When the Temperature measurement is valid, the value field will contain the temperature in degrees Celsius, scaled as shown, and the Status field will contain -1 (FFFF hex.).
 Not used in LNG.
2. If a temperature input goes open circuit or over-range, the value field will contain a hexadecimal value of 7FFF. A short circuited or under-range temperature input will give a hexadecimal value of 8000.

The host system can therefore use either of the above techniques to determine whether there is a temperature fault on any of the input channels.

The scaling of the temperature values is degrees Celsius (°C)×100. Therefore there is an implied two decimal places of resolution in the temperature value.

5.10.2 Modbus Initialisation

Data values within the Modbus Input Registers are initially set to "zero" with status set to "Data Not Ready". Once measurement of the RTD's has commenced, the register values will be frequently updated to reflect the current data values and status read from the RTD's.

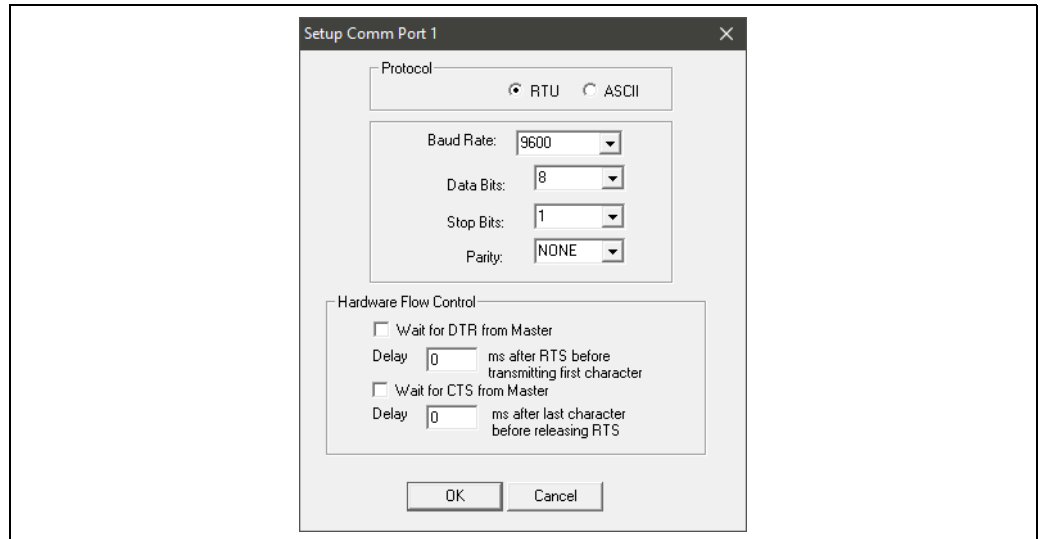
5.10.3 Exception Responses

The TM188 supports the use of Function Code 04 "Read Input Registers" and Function Code 03 "Read Holding Registers". Requests for any other Function Code will result in an Exception Response 01 "Illegal Function".

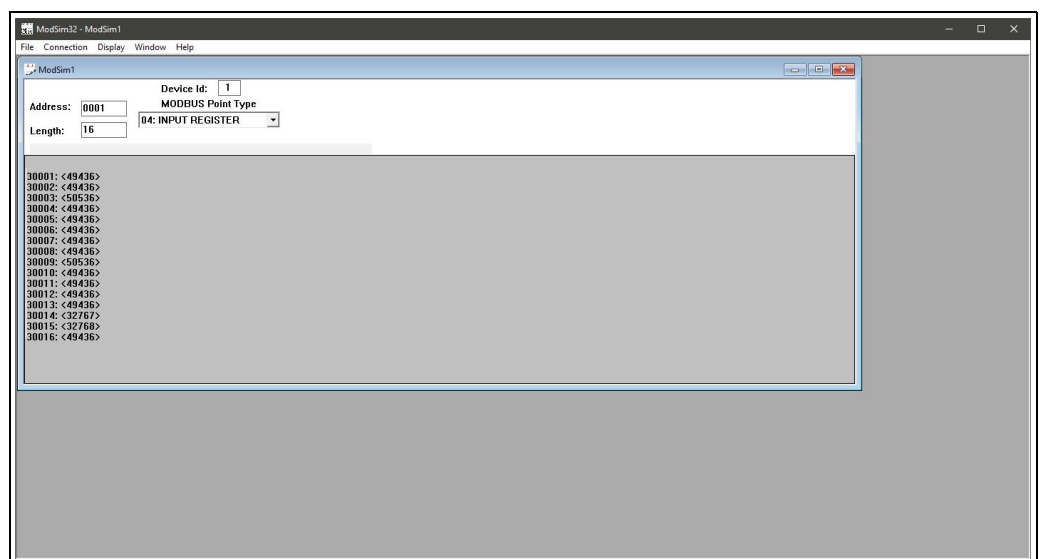
Requests for Input Registers which include any address outside the range detailed above will result in an Exception Response 02 "Illegal Data Address".

6 Testing

The application can be tested using a cross over serial cable and a suitable Modbus simulator software package to simulate the TM188 Multiplexer. The screen-shots below are taken from the ModSim32® software package.



BA01703GEN_Skin_Temperature_047



BA01703GEN_Skin_Temperature_048

The outputs shown on the input registers are in decimal but due to the negative numbers appear as odd looking positive numbers.

- 49436 is -16100 (/100 = -161 deg C) - the normal LNG storage temperature
- 50536 is -15000 (/100 = -150 deg C) - a hot spot
- 32767 is 7FFF hex - temperature input goes open circuit or over-range
- 32768 is 8000 hex - temperature input goes short circuited or under-range

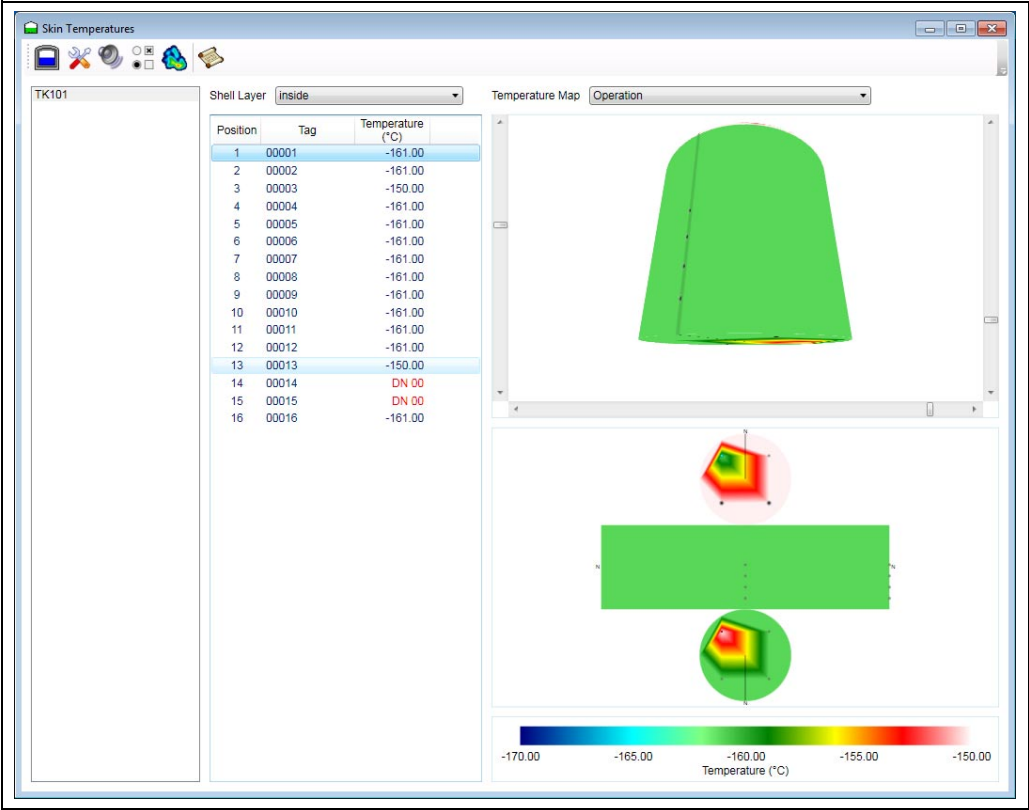
The scaling of the temperature values is degrees Celsius (°C)×100. Therefore there is an implied two decimal places of resolution in the temperature value.

The results from this test are shown in the figure below.

Notice the difference in the hotspots caused by the 2 non working sensors on the tank ceiling. (sensors order; 4 floor 6 wall 6 ceiling)

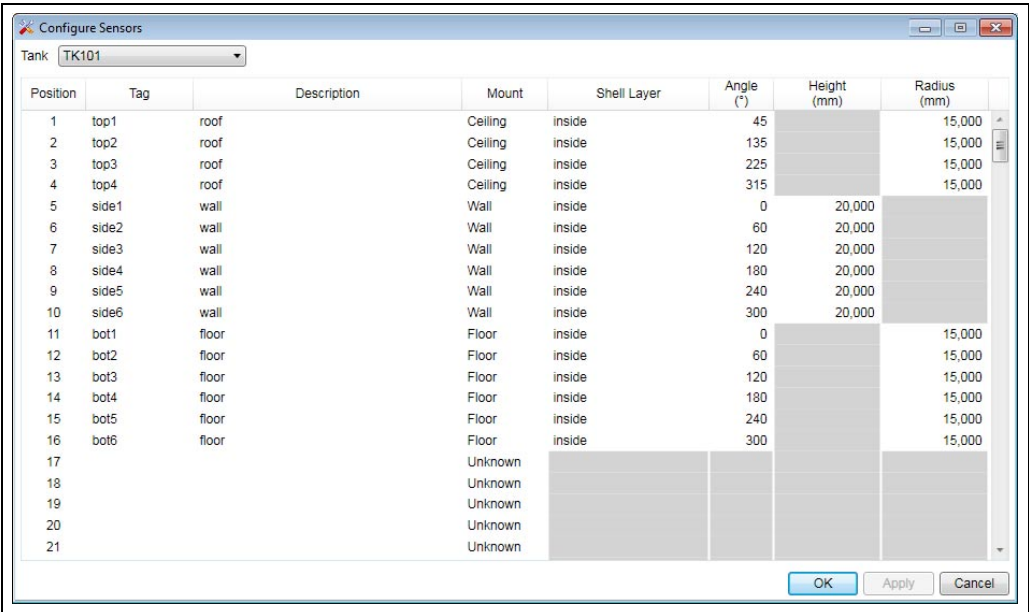


Set the Tank Capacity Table for TK101 to: level 28550 mm Volume 55411.874 m3 (Chattanooga dimensions).



BA0xxxxGEN_Skin_Temperature_045

Example sensor config 4 ceiling 6 wall and 6 floor shown in the figure below.



BA0xxxxGEN_Skin_Temperature_046

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