

# Contaminometer CM11+



## Ionic Contamination Test System for Electronic Circuit Boards and Components

**USER MANUAL Version 1.40**

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Version 1.3  
Version 1.40

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# PLEASE READ ALL OF THIS MANUAL BEFORE CONNECTING THE MACHINE

## THE MANUAL

This manual is your guide to using your CM11+. It describes how to use and care for the instrument.

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### Hazardous voltage symbol



### Warning

The Warning symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a Warning symbol until the indicated conditions are fully understood and met.

## HEALTH and SAFETY INFORMATION

### Isopropyl alcohol solution

#### Safety Precautions

Provide adequate general and local exhaust ventilation, must not be handled in a confined space without sufficient ventilation. Provide sufficient ventilation during operations which cause vapour formation.

#### Health Hazards and Precautions:

Excessive inhalation of solvent vapours may cause headaches, dizziness and nausea. Suitable local exhaust ventilation should be used to remove solvent vapours from the breathing zone of operators.

Prolonged or repeated skin contact may cause dryness of the skin and dermatitis. The solution is irritating to the eyes. Suitable protective clothing should be worn to prevent contact with skin and eyes.

Eating, drinking and smoking should not be permitted in the work area. Hands should be washed thoroughly with soap and warm water before eating.

#### First Aid:

In case of contact with skin, wash thoroughly with soap and warm water. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

#### Fire Hazards and Precautions:

The solution is highly flammable. It must not be used near naked flames or non-flameproof electrical equipment. Smoking must not be permitted in the working area. Carbon dioxide, alcohol resistant foam or dry powder extinguishers may be used in case of fire.

#### Spillage and Waste Disposal:

Remove all sources of ignition. Spillage should be mopped up with inert absorbent and the waste stored in closed containers for subsequent disposal in accordance with local and national regulations.

## INTRODUCTION

### The Instrument

The Gen3 Systems Contaminometer CM11+ is a workshop and laboratory instrument intended to determine the ionic surface contamination on printed circuit boards and components at any stage of their manufacture or use. The instrument is particularly useful for checking the cleanliness of circuits during and after their manufacture, on their reception at the customer's premises, after soldering and at the final assembly stage. Systematic use of the unit allows sources of contamination to be traced and hence eliminated. Here are some key features:

- Calibrated for IPA/water solutions either 75%/25% or 50%/50%
- Each cleanliness test takes only a few minutes
- Samples can be tested every three to fifteen minutes
- Compact modern design
- Easily replaceable key components
- Complete Self-contained system supplied with all accessories required
- CE Approved

The basic principle of the CM11+ is that the circuit to be tested is placed in an IPA/DI water mixture under carefully controlled conditions. Any ionic surface contamination will dissolve in this mixture, and the conductivity of the solution will therefore increase. The measured increase is converted to practical units by means of a personal computer. The CM11+ is designed for use with a personal computer, running the Contaminometer Terminal software.

The CM11+ provides a simple and foolproof method of determining the cleanliness of printed circuits, without requiring mathematical calculations to interpret the results, and without the instrument itself introducing errors into the measurement. It is designed for the rigours of workshop use, as well as use in the laboratory.

The test piece should be matched to the tank size for optimum accuracy. If the test piece is below the minimum recommended size for the tank and the correct size tank is not available, then use a number of test pieces to bring the area above the minimum level.

## DESCRIPTION OF THE CONTAMINOMETERS

The Contaminometer has been designed to fulfil the requirements of a modern workshop or laboratory, requiring quick contamination measurements.

The theory behind the operation of the Contaminometer is based on the electrical conductivity of water. A value for pure water is approximately  $0.056\mu\text{S-cm}$ , the exact figure being temperature dependent.

When an ionic contaminant present on a circuit board for example, comes into contact with water, this conductivity value will increase due to the dissolution of the contaminant into the water. This figure will therefore be proportional to the level of contamination in the water. If the surface area and the type of contamination are also known it is possible to express the amount of contamination present, as a given weight per unit area of board.

However in practise, it is apparent that not all ionic contaminants are easily soluble in water, particularly those trapped within rosin (present in flux). These contaminants do however have increased solubility in alcohol. For this reason the Contaminometer test solution consists of a mixture of isopropyl alcohol and de-ionised water as opposed to pure water.

To avoid extraneous ionic contamination all wetted items within the instrument are of plastic construction. The instrument is housed in an enclosure that has been designed to withstand the spills of test solution that will occur in normal use.

Readings of contamination are derived from a conductivity cell. The conductivity cell consists of two solid gold wires, wound bifilarly on a rigid polymeric former, a thermistor is fitted into the centre, for temperature measurement. The cell and thermistor are connected to a ballistic double operational amplifier. This is designed to allow maximum precision at very low conductivity values by eliminating all polarisation, Debye-Falkenhagen and reactive errors that conventional conductivity meters are prone to at very low values. The two amplified signals are combined in a small analogue calculator circuit to produce a voltage in relation to the temperature-compensated conductivity value. The function is quite non-linear, so that changes in the low end of the range will produce a significantly greater voltage change than towards the high end.

The pump is a specially selected so that the liquid velocity in the test compartment is fairly high, without creating undue turbulence during the test cycle, ensuring that all contaminants are washed off the printed circuit, even from under SMDs, as quickly as possible. The pump is designed for continuous operation, and can be serviced if required.

## Machine Location

Do not position the CM11+ in a confined room; make sure there is adequate ventilation. The CM11+ should be sited on a workbench that is at a convenient height for the operator.


Remove the CM11/CM12 from its packaging and place it on a bench top. Place the drip tray under the machine so that it drops into its locating position. Plug the supplied power lead into the power input socket on the back left hand side of the unit.

It is strongly suggested that the surface upon which the instrument is placed be tested for tolerance to test solution. The Contaminometer should be placed in close proximity to the computer that will run the Terminal software.

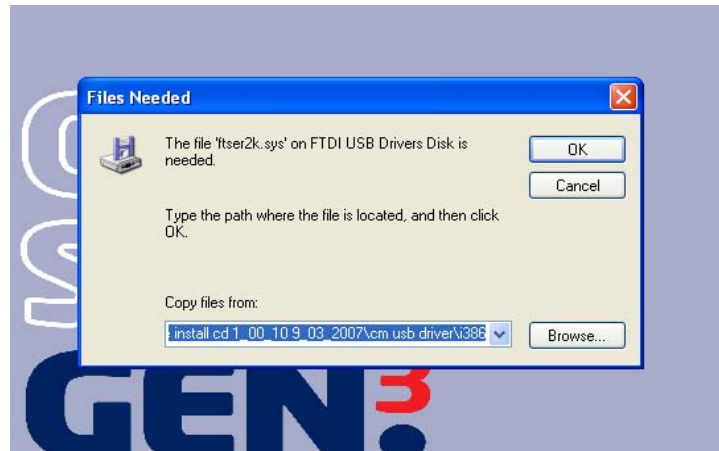
## Installing the Software

**DO NOT connect the USB cable from the PC to the CM11+ until requested to do so - connection at the wrong time will cause the wrong drivers to be installed and the CM11+ will not communicate with the software.**

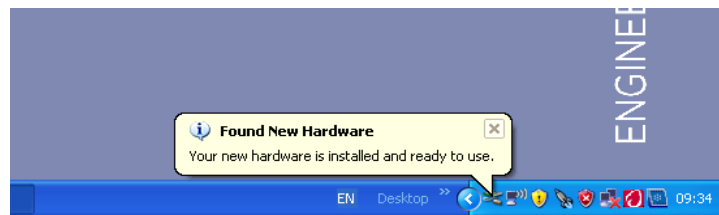
Note: This manual assumes the user is familiar with the operation and control of Microsoft Windows® and of software running under it.

1. Turn on the P.C.
2. Place the software CD into the CD drive.
3. Follow the on-screen instructions.
4. Click the Cmxxse Icon, which has been placed on the desktop, to open the software. 
5. Connect the power lead to the CM11+ and the USB lead between the CM11+ and PC.

6. Turn on the CM11+ - the following dialogue box will be displayed

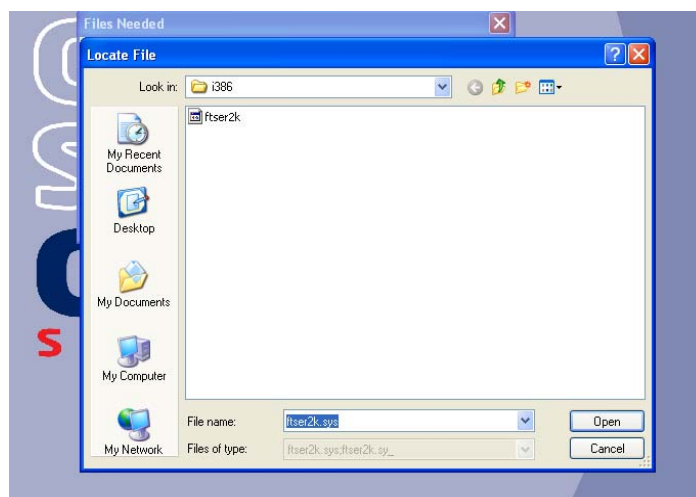


Select OK and the driver installation should begin. When the drivers have been installed the following dialogue box will be displayed.



Now go to section 10.

7. If the Installation of the drivers did not start then select 'Browse' and find the driver in the i386 folder as shown below and then select 'OPEN'

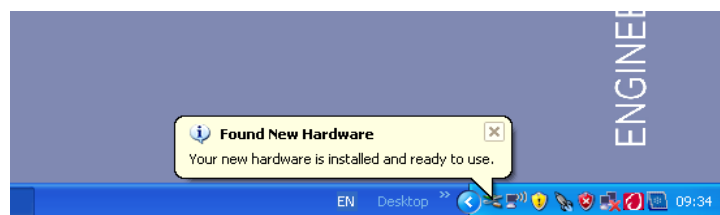




8. Select OK and the driver installation will begin.

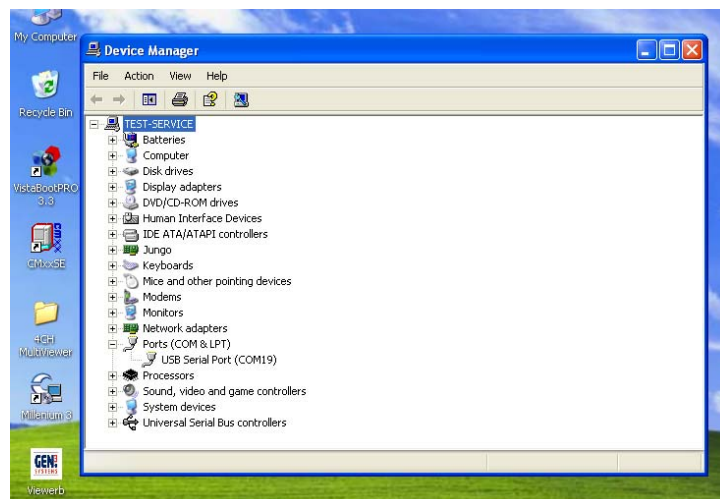


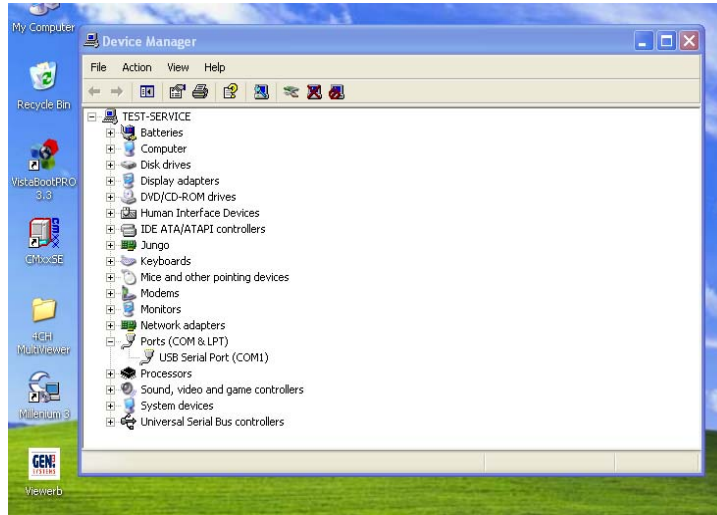
9. When the drivers have been installed the following dialogue box will be displayed.



10. The Comms port that must be used for CM11+ communication is 'Comm Port 1'.

Go into Device Manager and check what Comms port has been selected;  
If it is not comm port 1, as shown in the following dialogue box, change it to comm. Port 1.





11. Exit the CM11+ software

12. Remove Software CD

13. Click the Cmxxse Icon on the desktop to open the software.



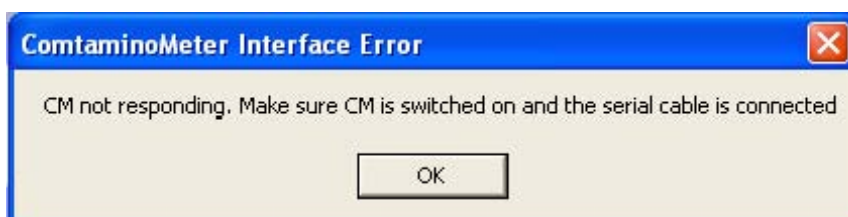
14. Click the "Connect" button in the CM software.



15. The software will then display a message saying that the CM is connected. Click OK.



Note; If an error message is displayed saying that the CM is not connected, click OK, and check the connections to make sure the USB is correctly connected, switch the CM11+ off and then on again, and then click the "Connect" button again.

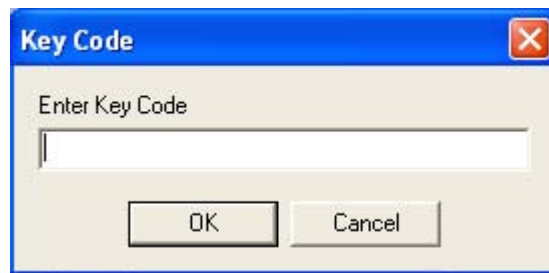


If the problem persists after this, refer to the troubleshooting at the end of the instruction manual.

16. A dialogue box will be displayed will be displayed as follows - Click OK



17. You will then be asked to input the key code, (this number is located on the front of the software CD) enter the number and press OK.

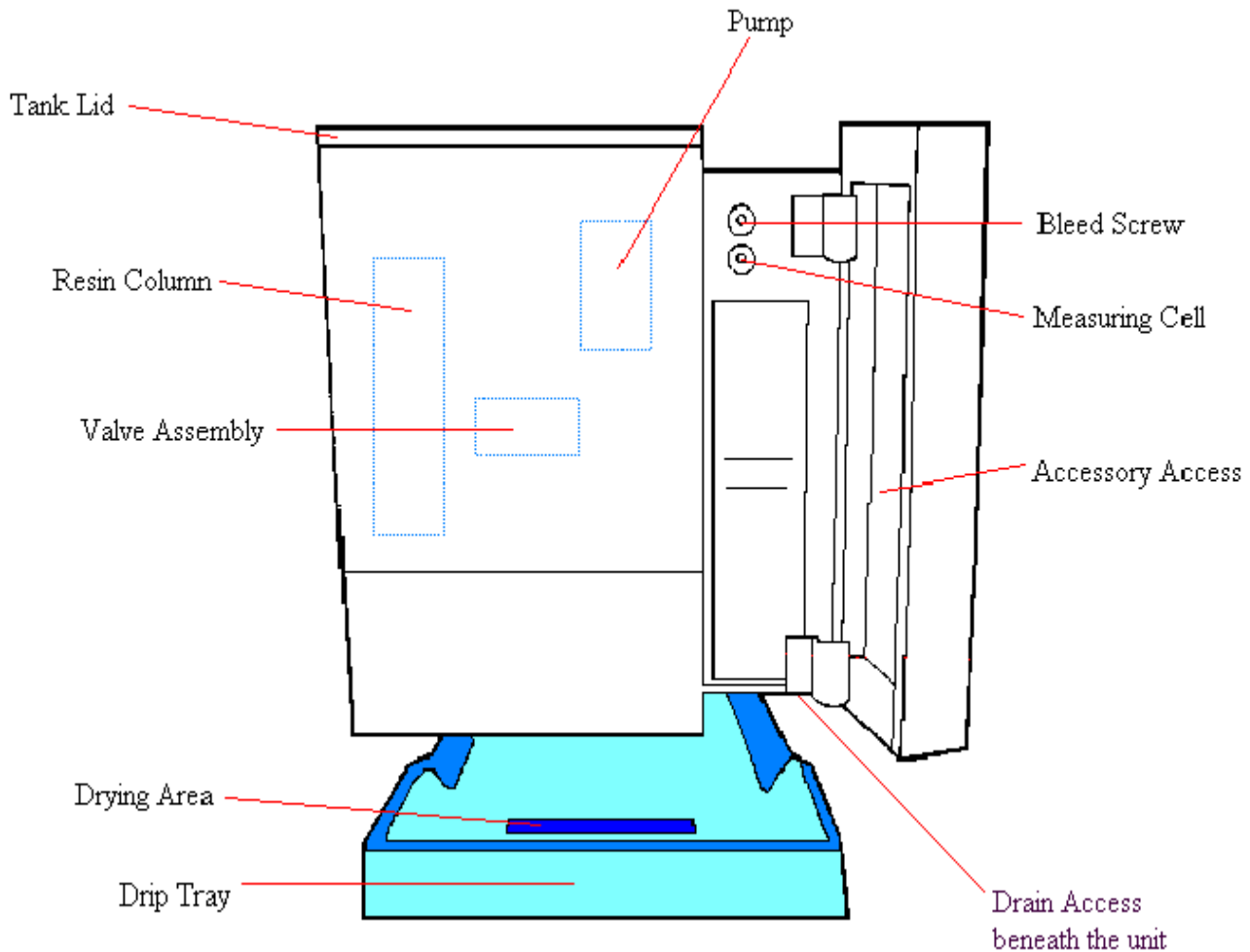


You are now connected to the CM11+.

If an error message is displayed saying that the key code is incorrect, begin the process again from step 14. If the problem persists, contact the supplier of the CM.

**You are now ready to begin using the CM11+ - please ensure that you have read the whole manual before operating the machine.**

## Commissioning/Initialising



Switch on the Contaminometer. Press the 'FILL' button, fill the tank to the '0' line on the tank side glass, this will take approximately 4 litres. Bleed the Re-Gen column by releasing the bleed screw. Switch the unit between 'TEST' and 'REGEN' a couple of times until there is no evidence of air in the system. Re-check the tank fluid level.

To commission the machine, follow the contamination testing procedure that follows in this manual. Run 2 or 3 five minute tests with no PCB's in the tank. This will remove any contamination that has built up in the machine during transportation and remove any air bubble in the pipes.

**WARNING - Do NOT run the CM11+ dry - ensure that the fluid level is correct, failure to do this will seriously damage the pump**

## CM11+ CONTAMINATION TESTING PROCEDURE

Before performing any tests with the CM11+ is important to check the specific gravity of the solution that you are testing with. Place the hydrometer and thermometer supplied with the machine into the tank and measure the temperature and specific gravity of the solution. Compare the reading with the graph supplied at the back of these instructions to make sure the specific gravity of fluid is in spec. If it is not add deionised water or IPA as appropriate.

1. Connect the machine following the instructions detailed earlier in this manual.



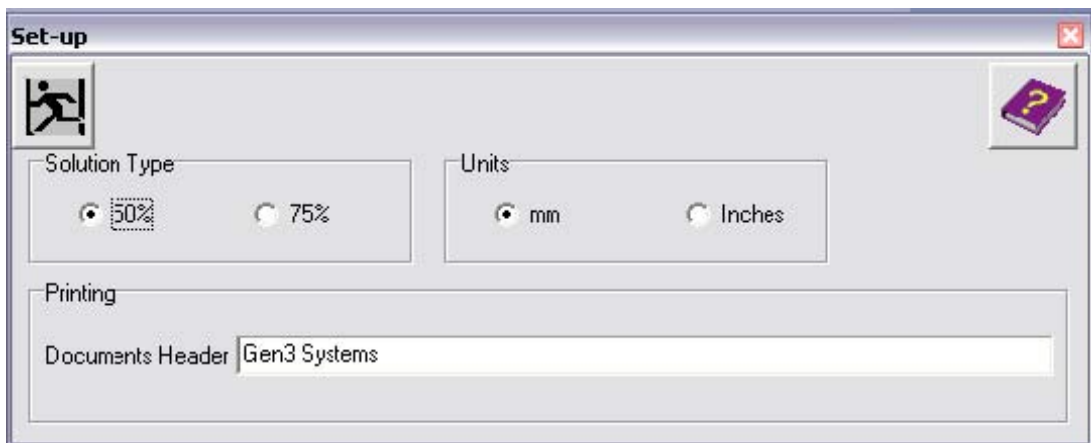
2. Click the "Connect" button in the CM software.

The software will then display a message saying that the CM is connected. Click OK.

You will then be at the main screen for controlling the CM11+ and will need to check that the system set up is as required.



3. Click on the "Set-up System Defaults" Icon on the tool bar.
4. Set the correct solution concentration, the units to use for testing and the document header, which is the title that will appear on the print out of all results from the contamination testing.



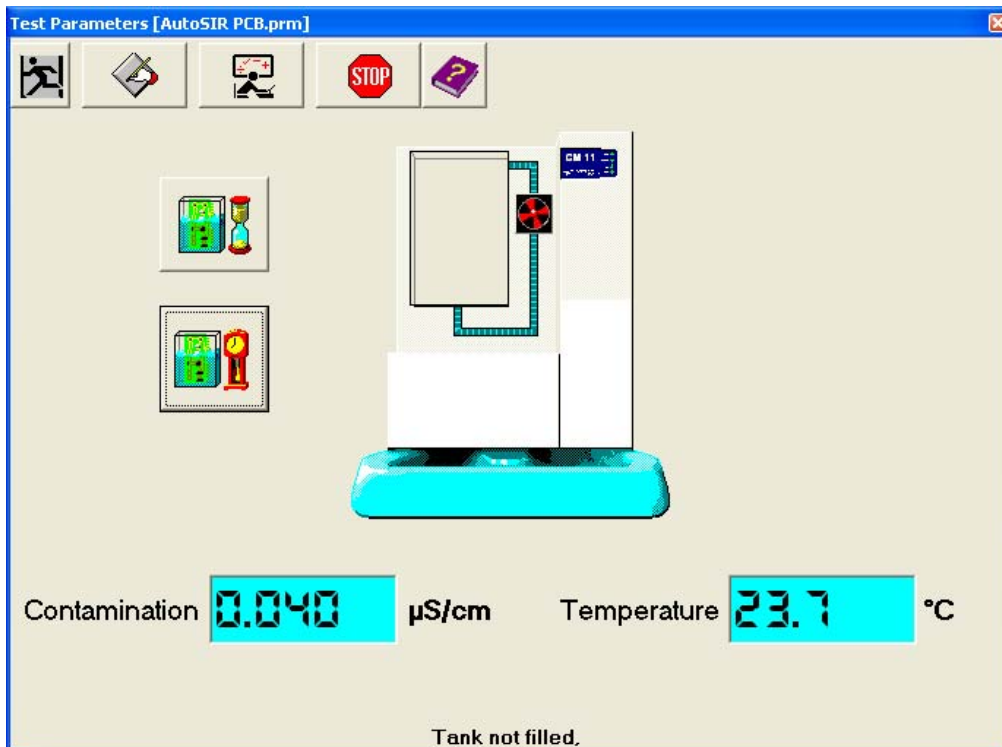
5. When finished - click the "Exit" button.



6. Click on the "Perform Test" Icon.



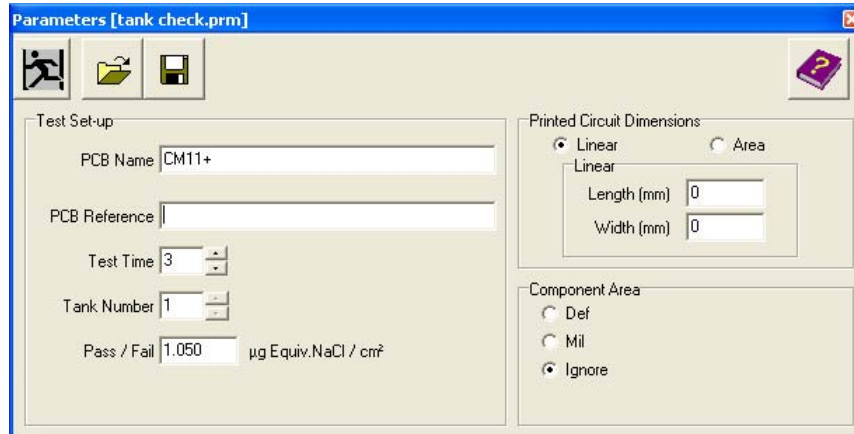
The Test Parameters screen will come up. Wait a few moments for the software to display readings for contamination and temperature before proceeding.



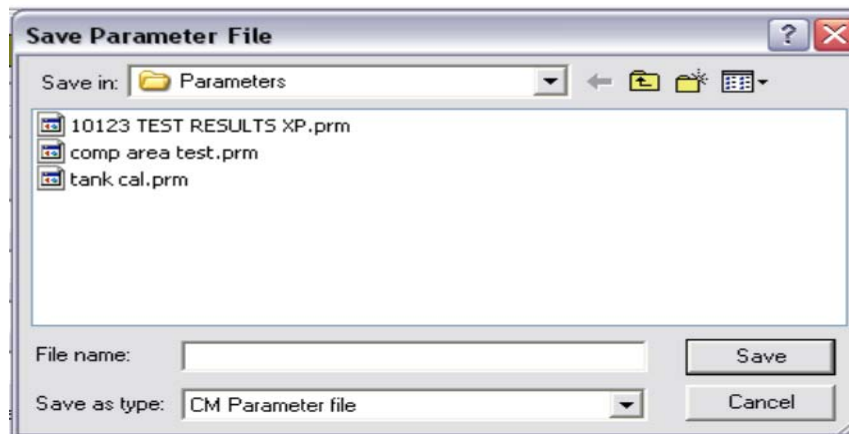
7. Click on the "Select Parameters" icon



8. Input the details for the boards that are being tested, these details will appear on the printout of the results. Select the Test Time required and the pass/fail limit. Put in the dimensions of the PCB, a % weighting can be entered in the Mil and Def standards for the Component Area.



9. Click on the “Save Parameters” icon and save the parameters under an appropriate title.



Note: These parameters can be called up again if you are testing boards of the same size and require exactly the same pass/fail limits and other parameters.

This can be done by clicking the “Open Parameter” Icon in the Parameters screen.



10. Click the "Exit" icon on the parameters screen to return to the testing screen.

11. There are now has two choices to start the testing.

- a "Standard Test" button:



- an "Analyse Test" button:

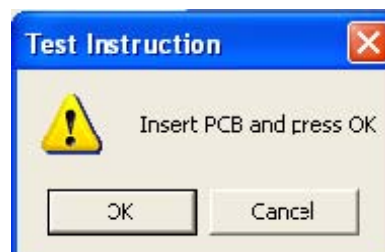


The standard test lasts 3 minutes and the analyse test will use the "Test Time" that the operator specified in the Parameters screen (3 to 15 minutes).

12. Once the operator has clicked the button that is required, the "Parameters" screen will reappear so the operator can check the parameters are correct. Click the "Exit" button. The machine will do the next steps automatically. The testing screen will display what process the CM is performing so the operator can see what is happening. These processes may take a few minutes.

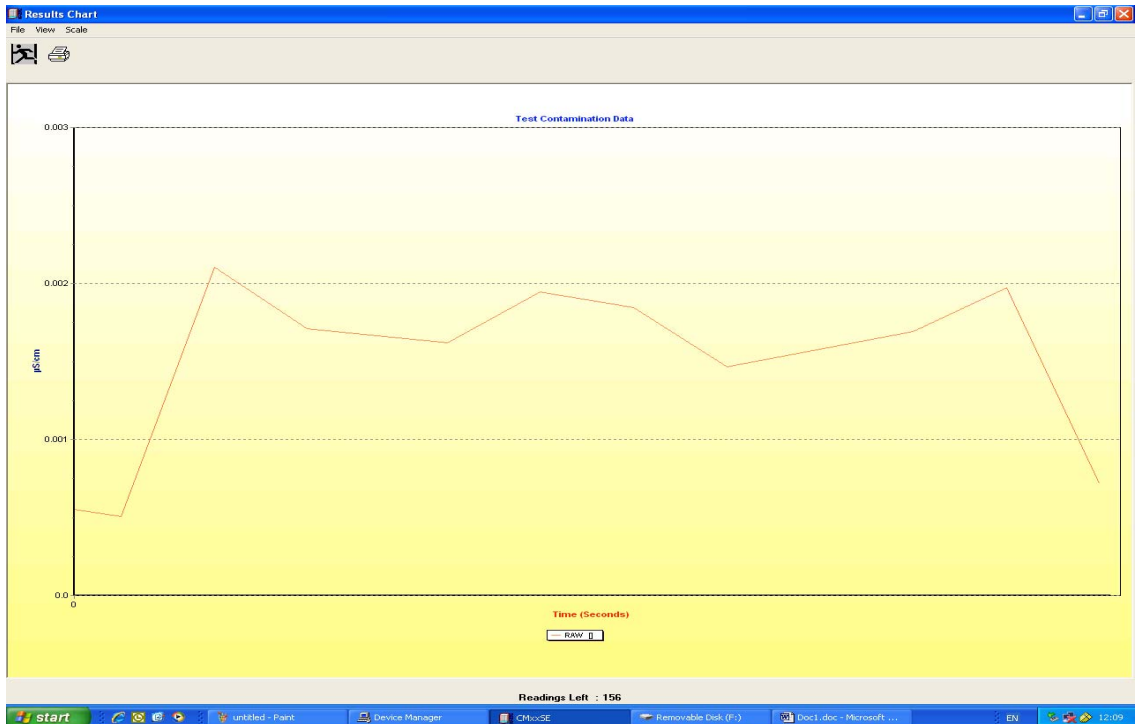
- Regenerated solution until it is down to the necessary level for testing to begin. ( $<0.035\mu\text{S}$  for 75 % solution &  $< .050\mu\text{S}$  for 50% solution)
- Condition the system to make sure there is a constant minimum level of contamination throughout the whole testing system
- Test the contamination level to determine if it is low enough to commence testing
- If not it will regenerate again
- If it is, the offsets will be sampled
- 

You will then be asked to put the board into the tank. - Gently insert PCB into the tank and 'OK'.

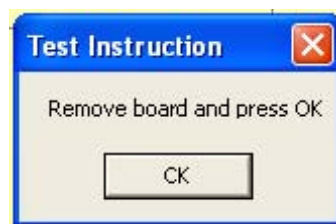


13. A graph will appear showing the contamination that is dissolving off of the board as it is tested. The number of samples left is displayed at the bottom of this screen.

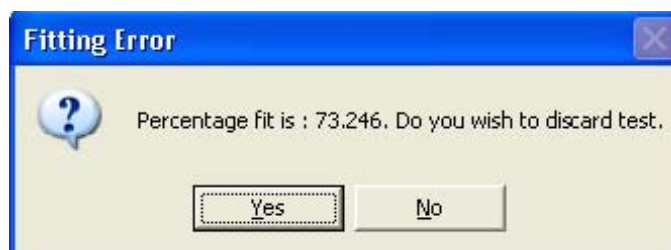




14. After the testing has finished you will be asked to remove the board and then press OK.



The software will then perform a smoothing operation on the graph to put a fitted curve to the data. A dialogue box will come up with the percentage error of the fitted curve.



When asked if the test is to be discarded, click 'No'.

15. The software will then calculate the contamination per cm square that has been taken off of the board and display this as a graph with the fitted curve and addition information about whether the board has conformed to the pass/fail criteria specified by the operator.

16. By clicking the "Print" button, this graph will be printed out.



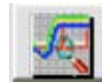
17. Exit this graph by clicking the "Exit" button.

If you would like to view the graph again, click the "Analyse Stored Results" button.  
(This function is available from both the main CM software screen and in the testing screen.)

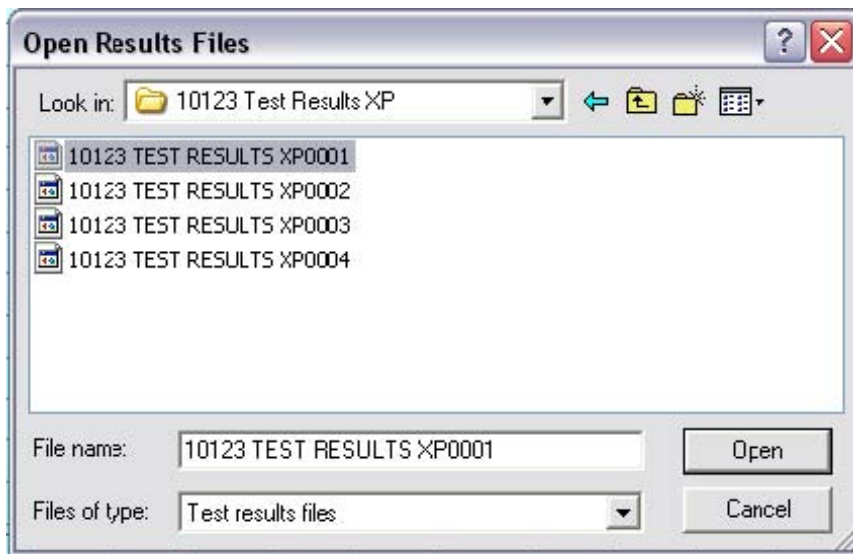


The "Analysis" screen will then appear.

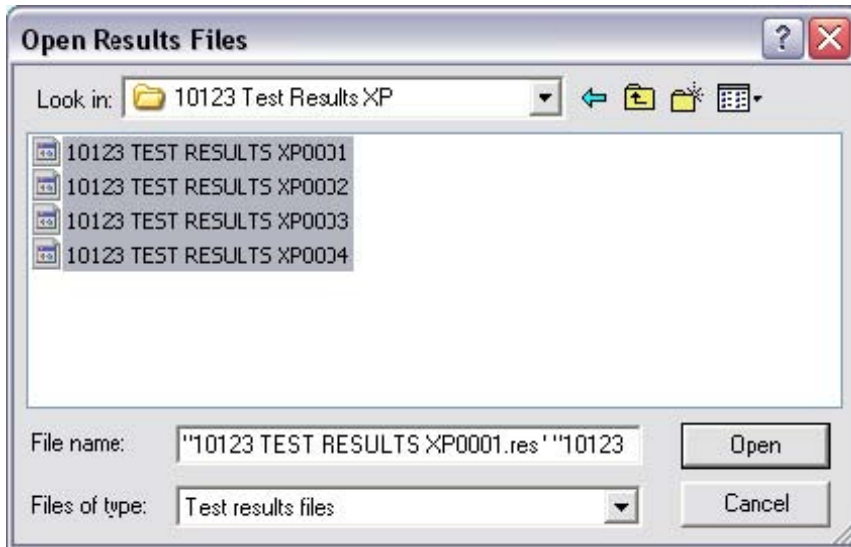
Click on the "Graph Raw Test Results" button



You will then be able to select which graph they want to view in the "Open Results File" screen.



The results will be in a folder that has the same name as the parameters were saved under. It is possible for the operator to view multiple results on the same graph, but only for tests done under the same parameter set.. This can be done by highlighting all the results that are to be viewed in the "Open Results File" screen.



18. When you have finished testing replace the tank lid to stop evaporation of the IPA, exit the software and switch off the CM1 1+.

19. If the CM1 1+ is not going to be used for a while it is recommended to drain the tank;

## MENU SYSTEM

The menu bar, shown along the top of the screen below, provides access to all the functions of the software.



The Menu Bar is accessed by using the mouse. Along the menu bar are the headings Exit, Connect, Parameters, Test, Analysis, Configure and Help.

To select any of these headings move the mouse pointer over the required selection and click.

After a selection is made a drop down menu or a dialogue box may appear giving more choices.

These choices can be selected by moving the mouse pointer over a selection and clicking.

## FUNCTION BY FUNCTION DESCRIPTION

A description is given below of each menu function. More detailed descriptions of testing have been given in previous chapters and are further detailed later on in this chapter.

### The Exit Function

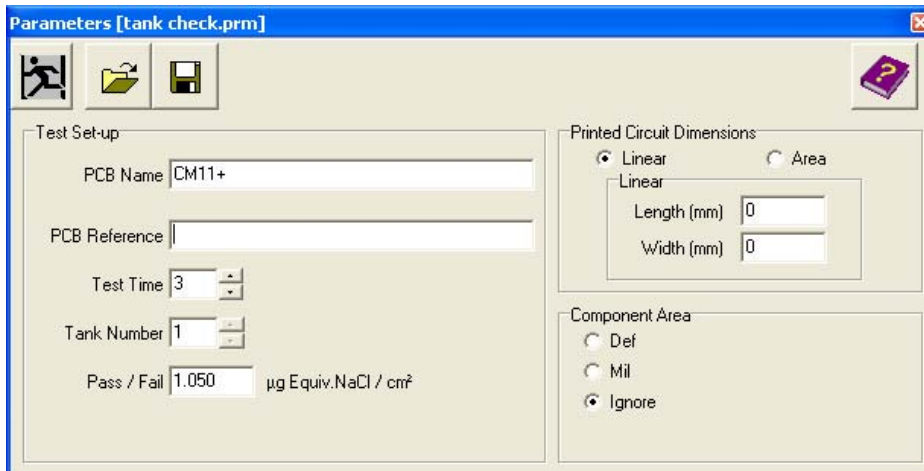
This function allows the software to be exited.



### The Parameters Function

Using either the mouse or the keyboard, enter the parameters to be used in the testing.

This function is selected by pressing the button.

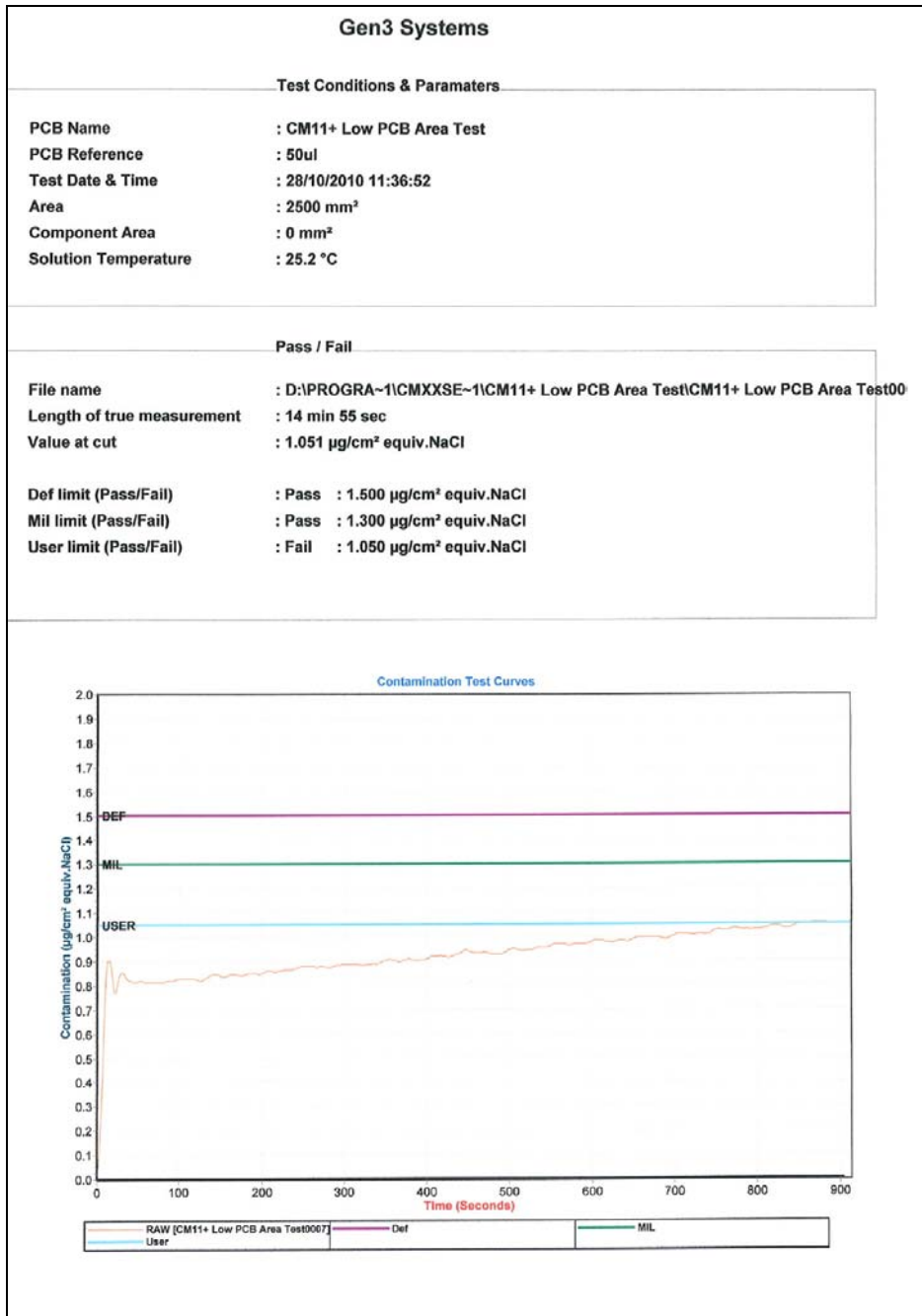


- PCB Name - what you call the board or assembly
- PCB Reference - serial number
- Test Time - from 3 to 15 minutes
- Pass/Fail - enter your limit
- PCB Dimensions - select either Linear or Area
- PCB Dimension - enter dimensions in your selected units
  - See following section on minimum PCB size
- Component Area - select to either ignore or enter the Def or Mil weighting
  - See following section on Component Weighting

## Minimum PCB size

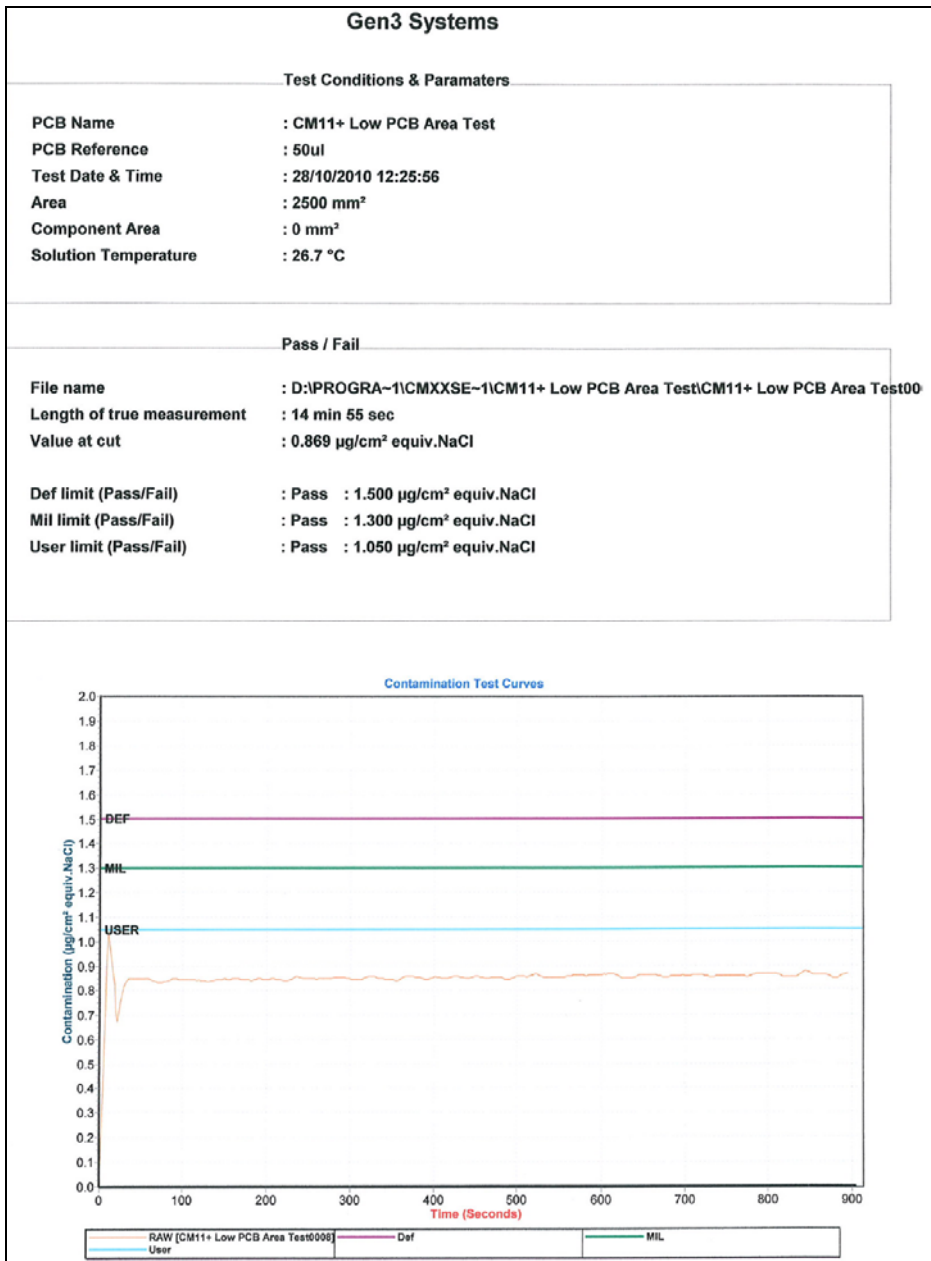
The recommended minimum size for the CM11+ is 25cm<sup>2</sup>.

The major influence in testing very small boards with large tanks is the operating environment; the DI water in the solution will pull ions from the air on the surface of the tank. (If the air is very clean then boards below 10cm<sup>2</sup> have been tested). If the air is not clean then the testing result will show a steady incline as the ions are continually absorbed from the air. Carbon Dioxide is the main contributor to this affect. See graph below.



There are two ways to combat the problem;

- Firstly use more than one board therefore increasing the effective PCB size
- Secondly, a Co2 factor can be entered into the CM firmware - this **must** be done in communication with the distributor or Gen 3 Systems. The following graph shows the affect of Co2 correction to the previous test.



If the environment is causing problems it can be difficult to totally eradicate the problem as the air pollution will vary with temperature and weather conditions

## Component Weighting

The software allows four possible methods of assessing the contamination due to the surface area of components. The first is to ignore it and this is the most conservative method of assessment. The second is to equate the surface area of components to a percentage of the surface area of the PCB, known as DEF, after the defence standard. The third method is to use the American IPC/MIL standard method of assessment; this is based around a software driven algorithm.

Click on the method to use in the Component Area box. If DEF is selected, enter the factor value to be used. This 'weighting' - the estimated area of component coverage on the board, expressed as a percentage.

The software allows a user defined Pass/Fail limit to be entered. This is used, in addition to the MIL and DEF limits already installed, to evaluate the results the unit produces. Type this in the box or if the value is set at zero this feature is turned off.

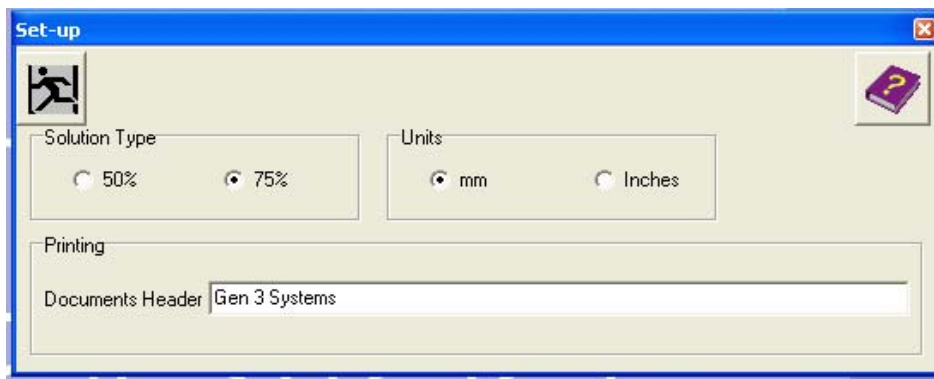
After all the required data has been entered any changes can be made by moving the cursor back to the area to be changed using the mouse. Once all the data is correct select the File command on the dialogue box and save the parameter file.

A screen will now be shown in which a file name must be entered. The file name must be unique.

Then select File and Exit to return to the main menu.

## Configure Function

Selecting this function causes a drop down menu to be displayed. Selecting 'Set-up' from this menu will display the screen below. This screen allows the user to set various configuration values for the software.



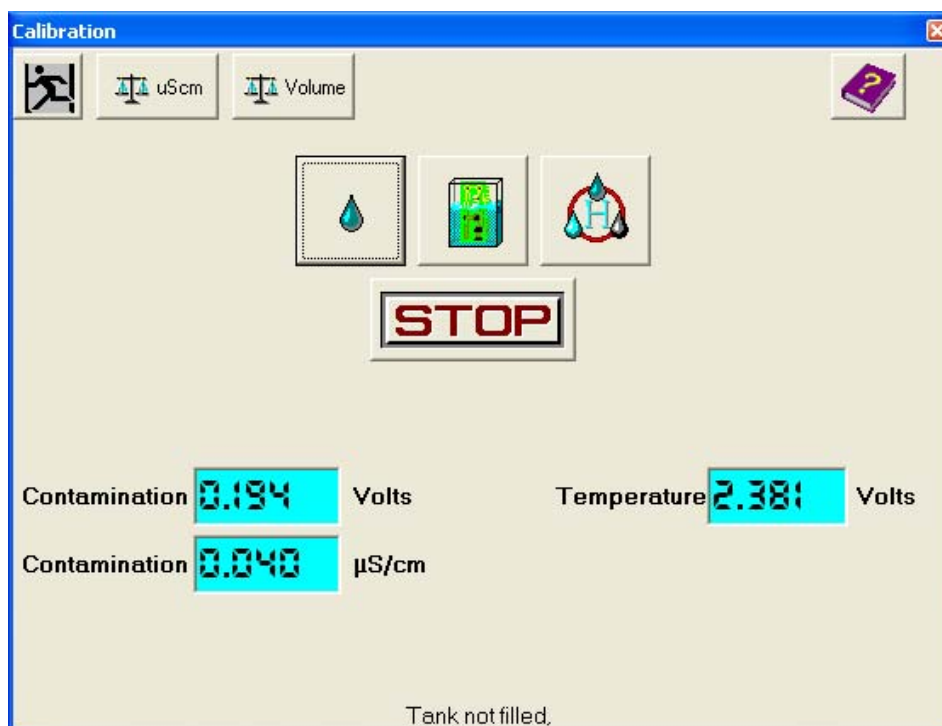
Selecting 'Language' allows a different language to be selected, if the appropriate translation file is included in the software folders.

Selecting 'System Constants' allows the user to see, but not change, the constants that the machine is working to, such as the language selected and the font size that will be used when printing results.

Selecting 'Calibration' from the drop down menu allows access to the calibration screen, this is detailed below.

## Calibration Function

This function allows calibration and routine maintenance to be carried out and should only be accessed by trained service personnel.



The buttons at the top of the screen are used for entering the machine into different modes of calibration. From left to right they are Contamination calibration and Tank Volume calibration.

**WARNING: THESE BUTTONS SHOULD NOT BE USED BY UNTRAINED PERSONNEL, DOING SO WILL OVERWRITE CALIBRATION COEFFICIENTS IN THE HARDWARE OF THE CM11+, PROHIBITING THE MACHINE FROM FUNCTIONING CORRECTLY.**

At the bottom of the screen are three small displays. On the left side there is a readout of conductivity, in both volts being received by the software and the corresponding contamination in uS/cm On the right is readout of the voltage corresponding to the current temperature of the solution in the tank..



The buttons in the middle of the screen are manual controls for the basic functions of the machine.

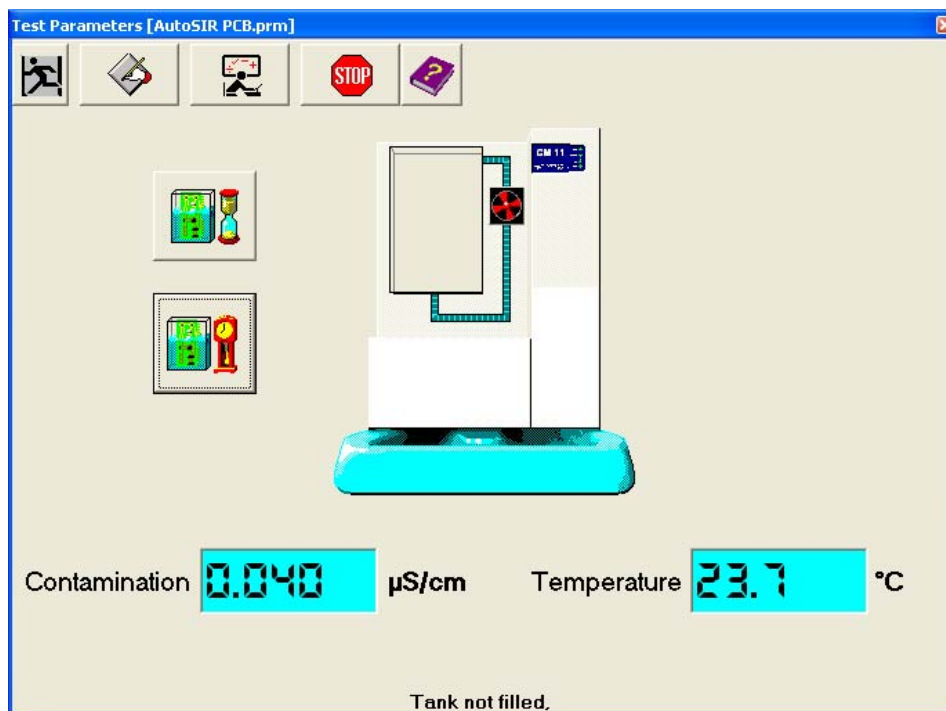
- **Regenerate Solution** pumps the liquid in the tank through the Regen Column in order to remove any contamination by the process of ion exchange.
- **Condition Solution** mixes the liquid in the tank and the system, in order to have consistent levels of temperature and contamination in the liquid.

## Test Function

This function controls the Contaminometer during a contamination test



The Test screen is a mimic of the whole instrument. It carries all the required controls to initiate and control all the testing the Contaminometer is capable of.



At the bottom of the screen are two displays - contamination reading in the tank and the temperature of the solution.

The CM11+ Contaminometer is capable of two types of test. A test running the full time period set in the parameter file ( 3 to 15 minutes), Analytical Test, or a test that runs for 3 minutes the Standard Test. By using a series of curve fitting algorithms (Merit of Fit) the Contaminometer is capable of extrapolating what the result of the test would have been after 15 minutes using the data from the 3 minute test. If a 15 minute test is selected then no Merit of Fit graph is displayed.

If no parameter has been opened then a dialogue box will request a parameter set to use. If a test has previously been carried out, or a parameter set has been previously accessed then this will be suggested as the parameter to use for the test. After this selection the Contaminometer will automatically start the test.

After the test is complete the user will be shown the graph of the result and the data automatically stored in a directory with the same name as the parameter set. Tests may be named with any text allowable in filenames. By default the tests will start numbering at 000 and advance by 1 automatically

## **Merit of Fit**

The Merit of Fit used in the CMxx software is a projection of the contamination value at 15 minutes for the results of tests that are conducted in a shorter in time.

The algorithm analyses the data that has been collected and extrapolates the data set to the 15 minute point. It then compares its extrapolated data with the actual data set and calculates the merit of fit. The value of the merit of fit that is produced is a measure of the level of confidence that the software has on the extrapolated data. Any merit of fit value less than 95% is suspect and should be disregarded and the actual data used. If you look at the results of both data sets on the graph it is generally quite obvious if the calculated value is in error.

The extrapolated data set is calculated from the contamination that is being dissolved off of the sample that is being tested. If the contamination figure is low and has a relatively smooth rate of change then the calculated value is generally good, however if the contamination is high and has a noisy rate of change then the algorithm will have difficulty in its projection and therefore give a low merit of fit figure.

This software function is an aid to the user and does not replace the validity of the actual data collected; the user can ignore the extrapolated data and use the collected data for analysis.

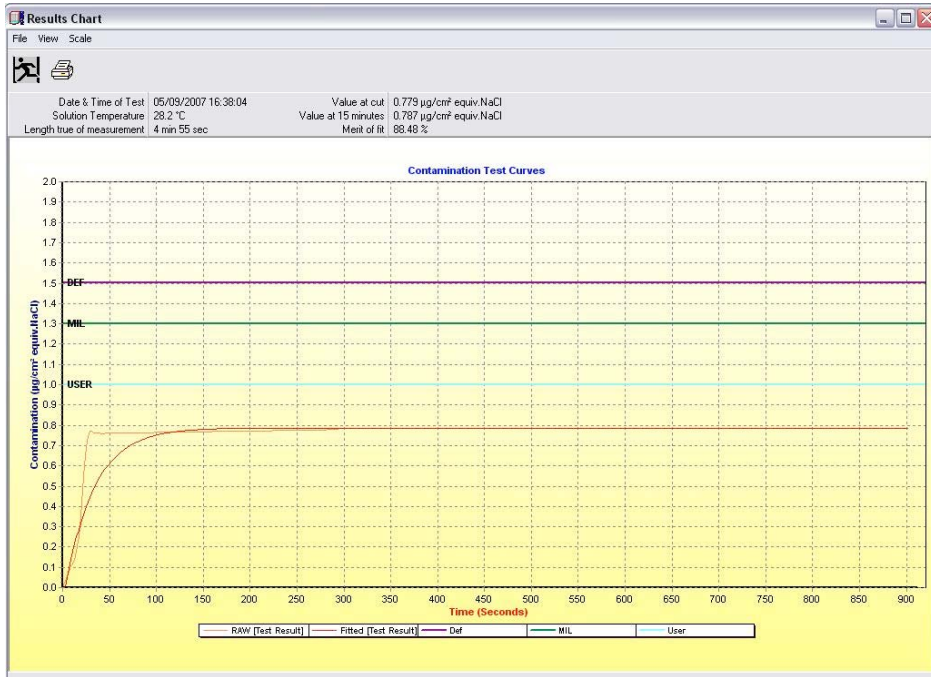
## **Analysis Function**

There are two ways to view the results of the tests that have been done; the first is the standard way as described earlier in this manual, where single or multiple results from tests can be viewed.

Multiple graphs may only be prepared using data obtained under the same parameter set.

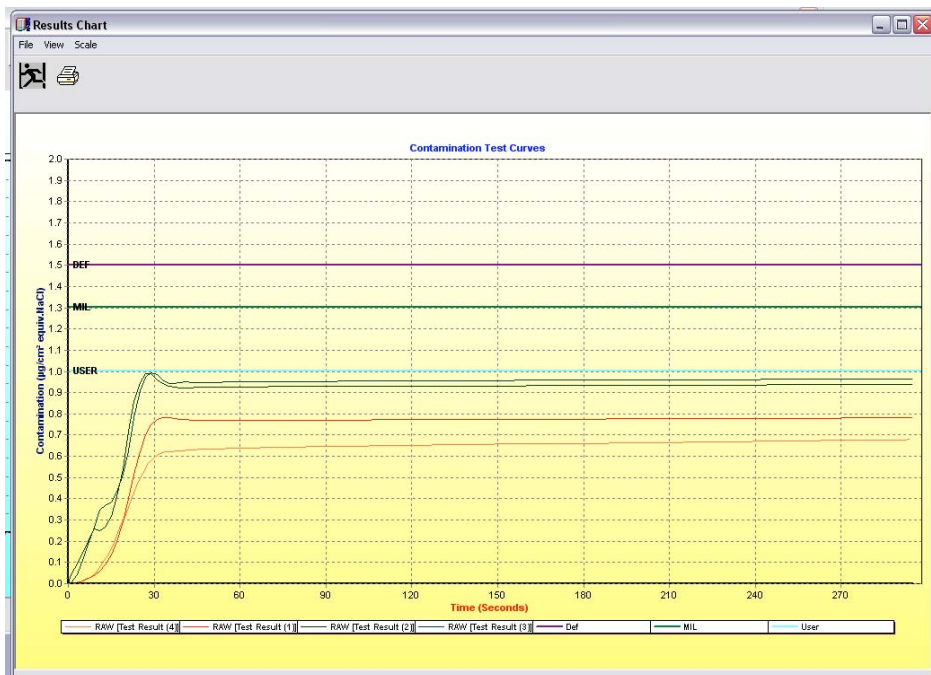
## **Single and Multiple Graphs**

When a single test graph is displayed, the legend at the bottom shows the MIL, DEF and User defined limits, the actual data points obtained from the testing and the fitted curve.



Single Results Graph

When multiple test results are displayed on the same graph, the legend is the same as above detailing colour co-ordinate data lines but does not display the fitted data curves for each set of data.



Multiple Results Graph

## Fitted Curve

The purpose of the fitted curve is to aide in the analysis of data taken during tests. This is achieved by allowing a projection of how the final value will look at the 15 minute mark, even if the actual test time is much shorter. This allows a more efficient testing process and faster throughput because the boards do not have to be tested for quite as long.

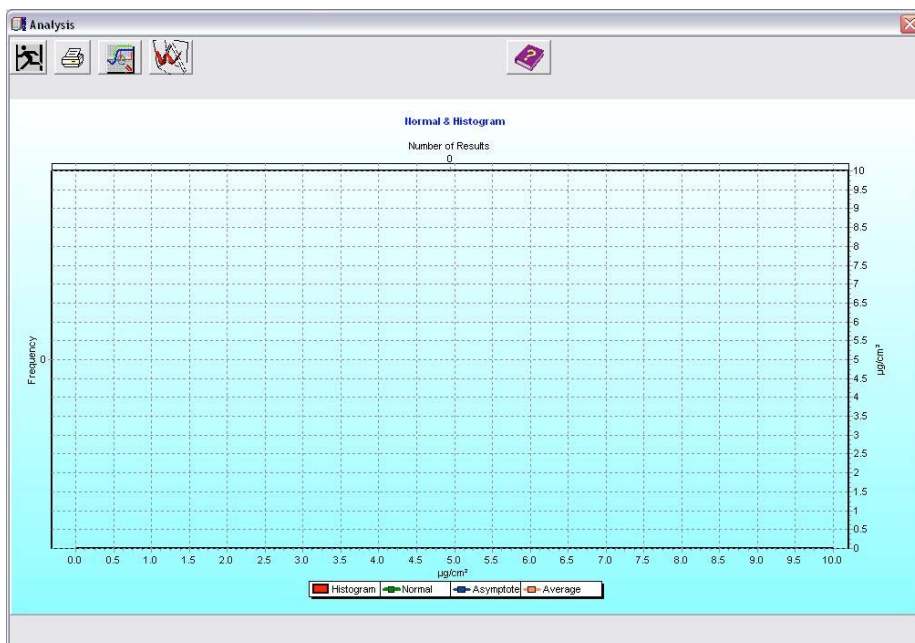
## Historical Data Analysis

The second way of reviewing data is by viewing the results as a histogram. Historical data may only be prepared using test results gained using the same parameter, in the same way as multiple graphs. Select the parameter required as with multiple graphs. Once confirmation of the parameter set has taken place select the number of test results to take account of in the historical data. The sample size is the number of tests from the most current working back chronologically that will be analysed.

To analyse data in histogram form it is necessary to have 10 or more results but the results will only be statistically valid if 25 or more results are used.



First click on the "Analyse Stored Results" button

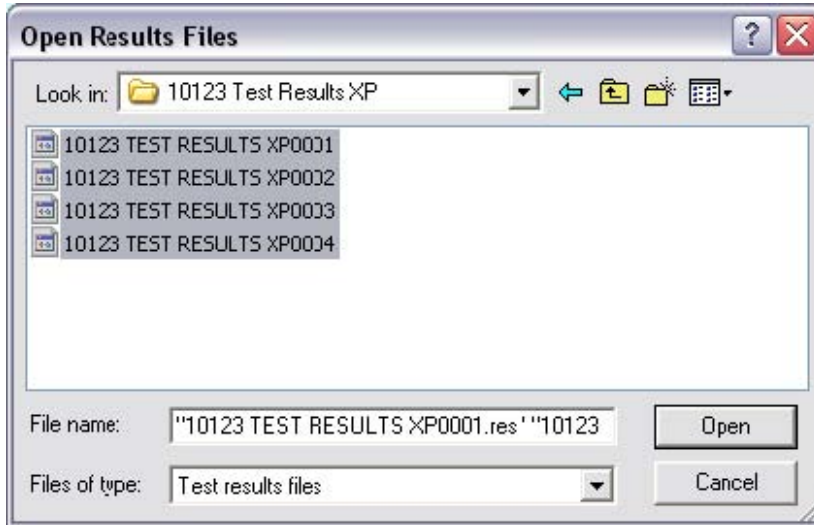


To analyse data in histogram form it is necessary to have 10 or more results but the results will only be statistically valid if 25 or more results are used.

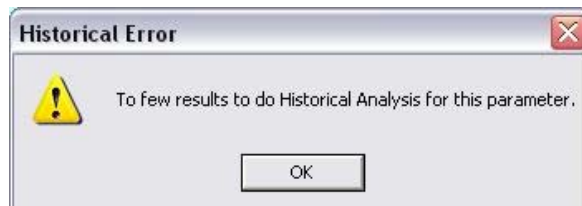


Click the "Analyse Multiple Results" button

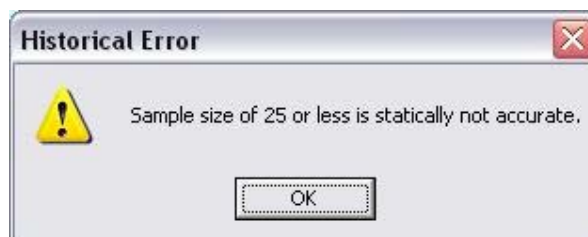
This will open up the same "Open Results Files" window as before



Now select 25 results. If fewer than 10 results are selected, the software will give a warning that there are not enough results to produce a histogram

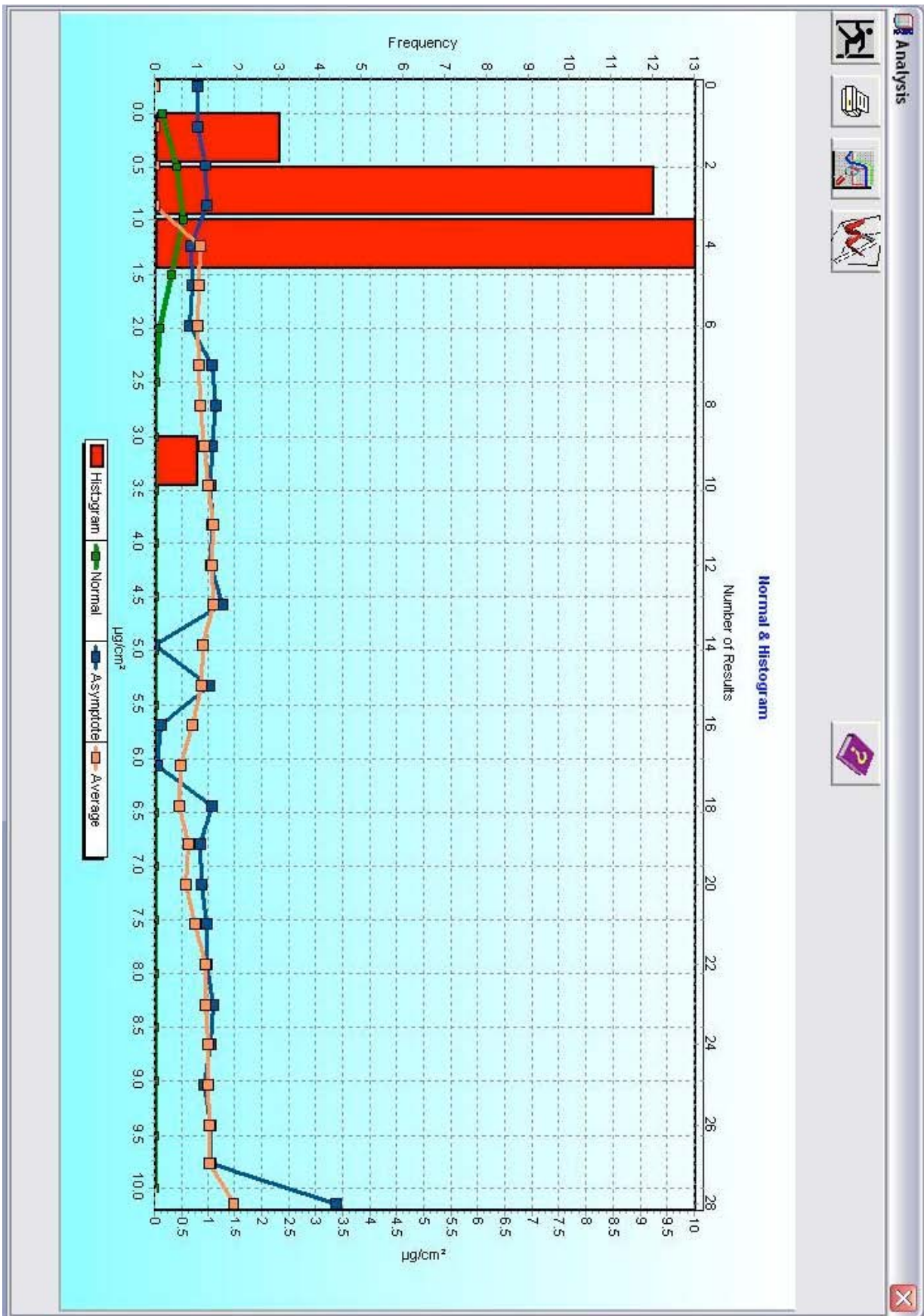


If between 10 and 25 results are selected, a warning that the histogram may not be statistically accurate will appear





The following graph shows the results from 29 tests have been put into a histogram.



The red bars represent the how many of the raw results are between certain values, and these can be read using the left hand axis and the bottom axis.

In this example, 3 results have a final contamination of value between 0.0 and 0.05ug/cm<sup>2</sup>, 12 results have a final contamination value of between 0.5 and 1.0ug/cm<sup>2</sup>, 13 have 1.0 and 1.5ug/cm<sup>2</sup> and 1 has a final contamination value of between 3.0 and 3.5ug/cm<sup>2</sup>.

The blue line on the histogram represents the final contamination of the asymptotes of the results. The asymptote value is provided by the fitted curve that is applied to the raw data. This curve is to project the final contamination of a board after 15mins, if the test has been run for less than 15 minutes. Using the top and right hand axis it can be seen that the asymptote of the fitted curve on the 21st result has a value of 0.900ug/cm<sup>2</sup>, and the asymptote of the 28th result is 3.357ug/cm<sup>2</sup> (these values can be found by hovering the curser over the result, the values are displayed in the top right hand corner of the graph).

The orange graph is the running average of the results. From this example, the average contamination of the results at the 11th test is 1.063ug/cm<sup>2</sup> and 0.628ug/cm<sup>2</sup> at the 19th test. Again, hovering the curser over the results will display the values in the top right hand corner. The green line on the results is the normal distribution curve of the data and ideally should have a standard deviation of 1. This will allow the user to see if there are any skews within the data. In this case there are not.

As with any statistical analysis, the more results you have, the more accurate the analysis will be.

## Graph Options and Functions

Whether single or multiple graphs are chosen there is a set of common ancillary functions. The Print option prints the current graph on the screen. In addition to the graph, data regarding the current parameter set is also printed. An example printout is below. The scale that the graph is displayed on can be changed by selecting the appropriate one from the drop down menu in the tool bar at the top of the graph window. Right clicking on the graph brings up a menu with several options. 'Copy' on this menu moves a copy of the current graph view to the Windows Clipboard, for use in other programs.

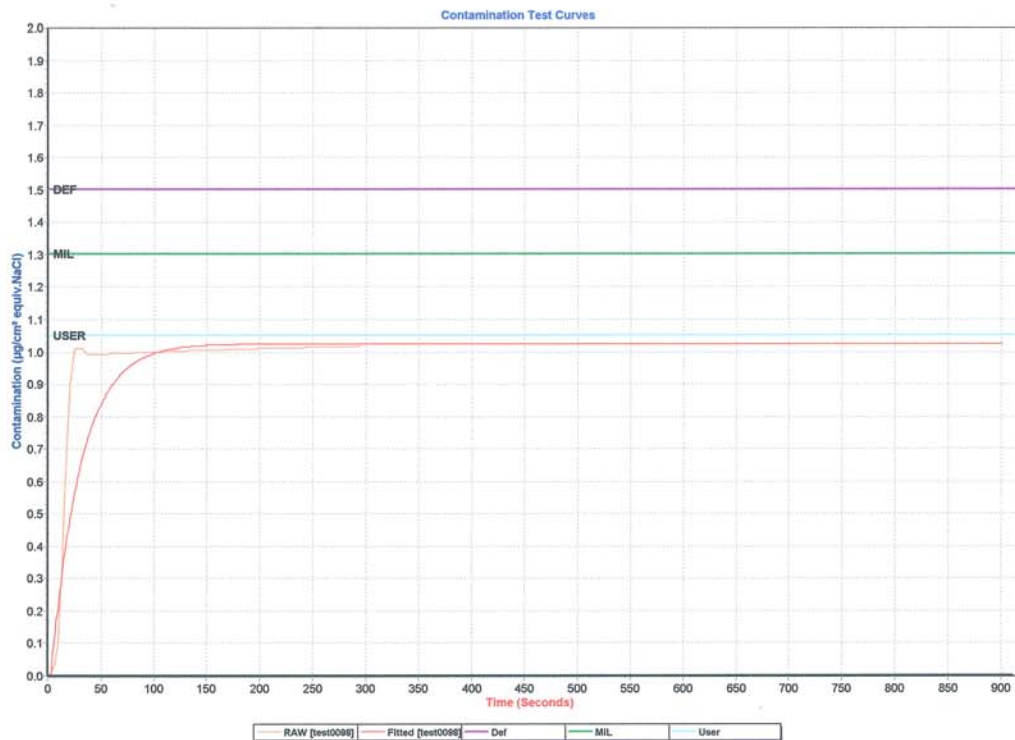
## Gen3 Systems

### Test Conditions & Parameters

PCB Name : test  
PCB Reference : test  
Test Date & Time : 22/10/2008 14:48:42  
Area : 87500 mm<sup>2</sup>  
Component Area : 0 mm<sup>2</sup>  
Solution Temperature : 25.4 °C

### Pass / Fail

File name : C:\PROGRA~1\CMXXSE~1\test\test0098.res  
Length of true measurement : 4 min 55 sec  
Value at cut : 1.017 µg/cm<sup>2</sup> equiv. NaCl  
Value at asymptote : 1.025 µg/cm<sup>2</sup> equiv. NaCl  
Def limit (Pass/Fail) : Pass : 1.500 µg/cm<sup>2</sup> equiv. NaCl  
Mil limit (Pass/Fail) : Pass : 1.300 µg/cm<sup>2</sup> equiv. NaCl  
User limit (Pass/Fail) : Pass : 1.050 µg/cm<sup>2</sup> equiv. NaCl  
Merit of fit : 86.6 %



Example of Contamination Test Printout from CM Software



## CHOICE OF TEST SOLUTION

The test solution employed in the Contaminometer is always a mixture of iso-propanol (2-propanol, isopropyl alcohol) and water. The ideal iso-propanol is 99.7% Reagent Grade 2-propanol. Contaminants in this alcohol namely water and low alcohols such as methanol, are unlikely to cause problems. Water should be the purest obtainable and de-ionised. The ideal water is that which has undergone the softening phases. The result of these phases is water with conductivity of less than  $0.1\mu\text{S-cm}$ . Using tap water should be avoided as the presence of impurities will; reduce the life of the solution and the regeneration resin.

Any proportion of 2-propanol from 25% to 75% (by volume) can be used, according to the specific requirements, but National and International standards generally specify either 50% v/v or 75% v/v solution. For this reason, software for only these proportions is available.

It is important, when mixing the solution that the required volume for each component is measured out separately before mixing. This is due to the different density properties of the liquids

### Which solution?

If working to IPC/MIL standards a 75% solution is required.

To otherwise select which test solution to use it is necessary to know a little about the constituents of the solution.

The function of the water is to ensure a dissociation of ions taken into solution by the solvent action of the 2-propanol. It is the presence of these dissociated ions which increases the conductivity of the test solution. As pure 2-propanol is a non-ionic hydrophilic solvent, its presence does not influence the reading except insofar as it "dilutes" the water bearing the dissociated ions. The conductivity of the solution, for a given weight of ions, is therefore lower with the presence of the solvent, and the greater the quantity of 2-propanol, the lower will be the conductivity. The greater the proportion of 2-propanol, the lower will be the sensitivity of the instrument. On the other hand, the greater the proportion of 2-propanol, the greater will be the solvency of the solution.

The choice of the test solution to be employed is therefore a compromise between the sensitivity of the measurement and the power to dissolve as many kinds of contamination as possible.

However, the conditions governing the dissolution of the contaminants in the Contaminometer are very different from those of the MIL specification. As discussed above, higher alcohol content will reduce sensitivity but increase solvency. Thus the use of 75% solution is not necessarily the best choice for use with the Contaminometer. In light of this it has emerged that when employing immersion methods in particular, working with a 50% solution gives a much better compromise between the sensitivity and the solvency. This 50% solution is also specified by the UK DEF-STAN 00-10/3 standard whose referee method is virtually identical to the Contaminometer principle.

# INTERPRETATION OF THE RESULTS

## Contaminometer Method of Operation

It is not possible to give hard and fast rules as to the suitability of any given cleanliness level for any type of application, as measured with the Contaminometer. Each user will have to establish the maximum tolerable cleanliness level for printed circuit boards under the worst case climatic conditions.

## Standards

There are currently two basic standards to which software for the Contaminometer conforms. These are the American standard MIL-P-28809, herein referred to as the MIL standard and the British standard DEF-STAN 0010/3, herein referred to as the DEF standard.

## MIL-P-28809

Several similar associated versions of the MIL-P-28809 have evolved since its initial proposal more than fifteen years ago. One such version MIL-P-28809A, developed for assemblies before conformal coating, is discussed below. This is an important edition as it allows for an estimation of the surface area of the components mounted on the board, which earlier versions did not. Tests performed on boards mounted with DIL ceramic components, illustrated contamination on the components to be about 10% of that over the area of the circuit board. For this reason it is acceptable to add up to 10% of component surface area to the area of the board. The Contaminometer uses this theory by weighting the estimation of component surface area by a factor of 0.1.

The referee method for the MIL standard involves the projection of a test solution onto both sides of the circuit board for testing. The residue of this solution should then be passed through a polythene funnel and collected in a polythene container, 10ml for each square inch of board. The process must continue for at least one minute. Finally the resistivity/conductivity of the resulting test solution should be measured using the appropriate equipment. The MIL-P-28809A standard defines the area of the board as the area of both sides in addition to the estimated area of components mounted on the board. It specifies that the test solution must consist of 75% by volume of iso-propanol and 25% by volume of distilled water. For the test to be valid the resistivity of the solution must be greater than 6M<sub>-</sub>cm at the beginning of the test and greater than 2M<sub>-</sub>cm at the end.

It is important to note that while undergoing this process, the test solution may pick up some ionic contaminants such as Carbon Dioxide and other ionogenic gases, present in the surrounding air. The presence of these contaminants and other unavoidable factors will influence the accuracy of the test. As a result of this small calculations have been made taking these factors into account and a figure, referred to as the lowest theoretical level, has been calculated. This figure is defined as the lowest possible contamination level which would cause the resistivity to fall to 2M<sub>-</sub>cm, the result being 1.298 $\mu$ g/cm<sup>2</sup>. The reference temperature used was 20°C, fixed according to International Standards.

It is important to note that there is no practical fixed limit in the MIL Standard. However, as a result of these calculations, it can be said that a Contaminometer measurement below  $1.3\mu\text{g}/\text{cm}^2$  will pass any test performed using the referee method. It is important for this reason to use the  $1.3\mu\text{g}/\text{cm}^2$  eq. NaCl line to measure a pass or fail when working to the MIL standard.

### **DEF-STAN 00-10/3**

In contrast to the MIL Standard, the DEF Standard is a more recent publication. It therefore has the obvious advantage of further developments in technology and thus a greater understanding of the scientific principles underlying the subject. The referee for the DEF Standard uses a 50% isopropanol/distilled water test solution and involves full immersion of the board. Measurements are made using conductivity techniques and the conversion from conductivity to contamination uses a scientific formula, as opposed to start and finish figures. This theory is quite close to the theory implied by the Contaminometer itself.

The DEF Standard also compensates for component surface area, weighting of up to 10% of the component surface area may be added. In the DEF Standard the Ministry of Defence has specified a limit level defined as a global value for all applications, fixed at  $1.5\mu\text{g}/\text{cm}^2$  eq. NaCl measured using the referee method. Although this value is slightly higher than the theoretical MIL standard limit, it is still quite tight.

Many large companies have developed standards, which are much more severe than the theoretical limit.

In summary Contaminometer measurements using the theoretical level of  $1.3\mu\text{g}/\text{cm}^2$  eq. NaCl line as a pass or fail, will pass any test using referee methods for either standard.

## MAINTENANCE AND TROUBLESHOOTING

### Maintenance

The CM11+ requires very little maintenance, keeping it clean and ensuring any fluid spillage is cleaned up is all it requires on a daily basis.

### Full System Calibration

It is recommended that the CM11+ has a full calibration and the resin changed once a year. If the CM11+ has very heavy use or is used as a board cleaner, then the resin will require changing more often. It will be apparent when the resin needs changing, as the time required for regeneration will increase.

### Calibration Check

The system calibration can be checked using the Gen3 Systems Calibration Test Solution, CM1-022. To check the calibration, set up a parameter with the PCB area shown in the table below and run a normal test. When the software asks for the PCB to be inserted, inject the appropriate volume of calibration test solution as dictated by the table below. Repeat this testing procedure 5 times and the average contamination reading for the 5 tests should be +/- 0.05. If the reading is outside this range contact your local service centre.

CMxx	PCB Area	Injection Volume
CM11	87500 mm <sup>2</sup>	1750uL
CM12	87500 mm <sup>2</sup>	1750uL
CM11+	100000 mm <sup>2</sup>	2000uL

### Checking the solution Specific Gravity

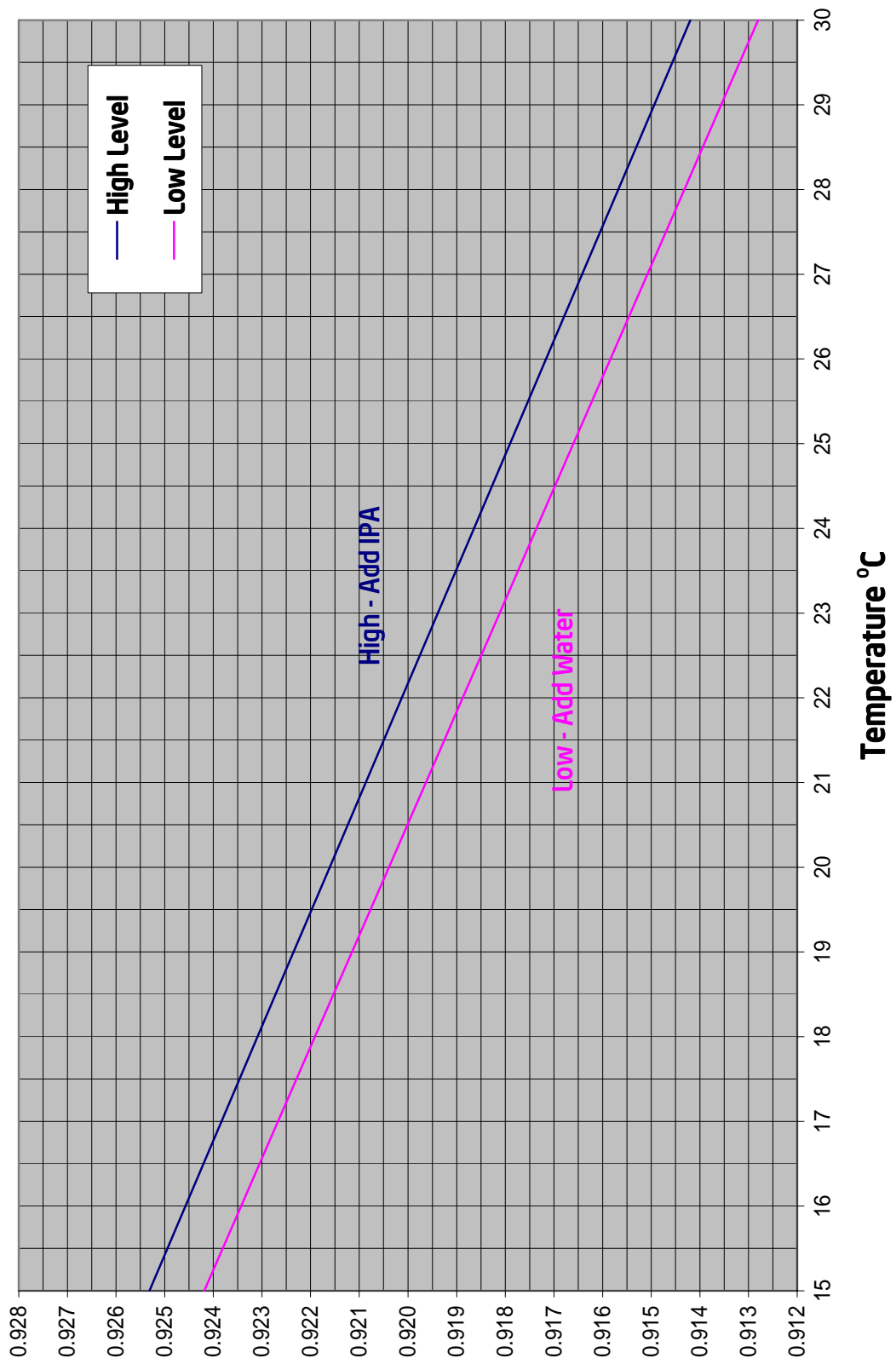
The density should be checked at least once a day, before using the Contaminometer.

This is done by densitometry, using the hydrometer and thermometer supplied in the unit. For a 50% 2-isoproponal solution, the density should be  $0.919 \pm 0.020$  at 20°C. For a 75% solution, the density should be  $0.858 \pm 0.020$  at 20°C. For other temperatures, consult the graph on the Next page of this manual.

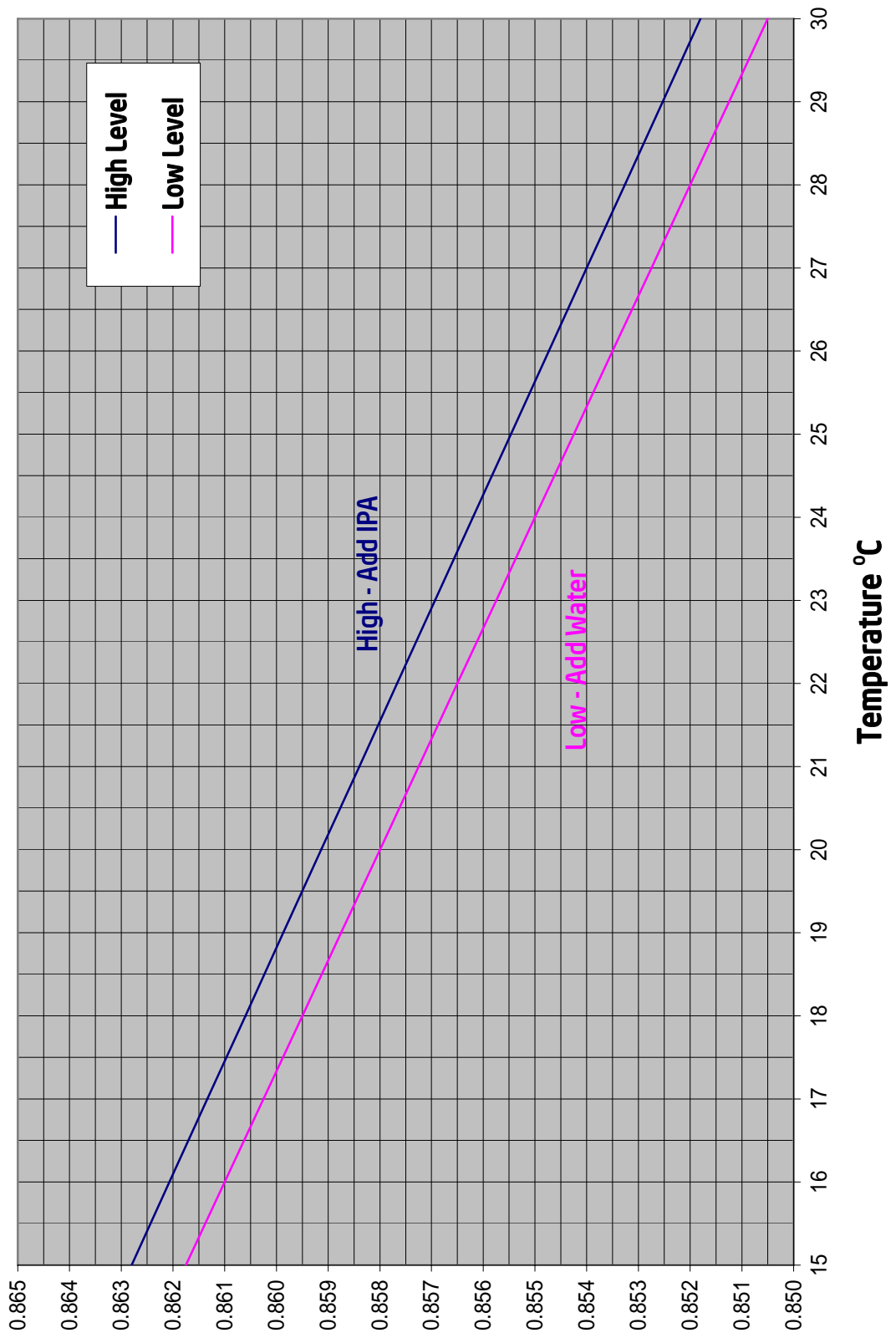
If the reading, at any time, falls outside these ranges, it can be brought back into specification by adding either IPA or DI water, depending on whether it is required to reduce or to increase the specific gravity.

The density can be checked by using a hydrometer and at the same time measuring the temperature. Put the instrument into TEST mode for a minute or so before measuring, to ensure homogeneity of the solution.

### 50% Specific Gravity Chart



## 75% Specific Gravity Chart



## Solution Cleanliness

The presence of very small quantities of non-ionic contamination in the test solution does not seriously affect its accuracy. However, if it is visibly cloudy or coloured when poured into a 50 mm diameter measuring cylinder, when viewed downwards, it may be advisable to completely change the solution. As far as possible, empty all the compartments of the Contaminometer, pour in some fresh solution and let it circulate. After a few minutes, discard it and fill the apparatus again with fresh solution. It should be noted that non-ionic contaminants likely to be found in the solution are generally denser than water. There is therefore a real risk of adding too much alcohol with density correction, reducing the sensitivity and the precision still further. Change the solution every twelve months, regardless of the use.

Each test will contaminate the solution with non-ionic contaminants, which will be only partially eradicated during regeneration. As such they may accumulate and eventually cause problems of both an electrical and mechanical nature. Electrically this may result in a change in the electrolytic characteristics of the solution. Mechanically this may alter the density, resulting in inaccurate proportions when the density is corrected. Impurities such as dust particles are generally retained in the filter, however smaller particles may pass through and remain in the solution adding to these problems. Thus it is very important to change the solution regularly.

The presence of excessive dust and debris on the test PCBs may eventually block the filter in the top of the regeneration column. This will result in long regeneration times and the poor flow can be detected by the presence of poor suction at the top right-hand tank outlet.

## The Measuring Cell

The measuring cell should be cleaned every twelve months, this be done at the same time as the system calibration and changing the solution. The cell consists of two gold wires wrapped around a plastic former, these are used to measure the conductivity and as such it is very important that they be kept clean. After emptying the instrument to change the solution, remove the connector from the measuring cell and slowly unscrew the cell. Gently withdraw it from the instrument. Clean the gold wires and the former by scrubbing with the toothbrush supplied saturated in clean solution. Check that there are no fibres or other foreign bodies caught in the wires, particularly at the outer end, by examination through a 10X magnifier before re-assembly. If a foreign body is trapped in this way it will simulate a very high conductivity forcing the machine to remain in regeneration. Cleaning in this way will also remove any contamination not visible to the human eye, present on the former or wires.

**Note; this operation should only be carried out by properly trained service personnel.**

## Checking the resin

The resin life in the instrument is long, provided that they are not allowed to dry out. When fresh the resins are amber, and they may turn slightly reddish as they approach the end of their useful life. However, the true test as to their exhaustion is when it is no longer possible to obtain a suitably low conductivity in a reasonable length of time. Only Gen3 Systems resin columns should be used, as many types do not have suitable technical characteristics and some disintegrate in alcohol mixtures. If this should occur, the pumps and valves will be damaged. It is recommended that the resin be changed at least once a year, even if it is still apparently functional.

Note; the regeneration column in the machine is designed to be refilled with fresh resin. The resin may be obtained from Gen3 Systems, under part number CM 0169. (2.5 Kg Bag). The CM11+ column takes 3 bags to refill the column. Extreme care should be exercised when emptying and refilling the columns.

Any spilt resin MUST be cleaned up immediately as any resin split onto the floor will cause the surface to become extremely slippery.

## CM11+ Technical Overview

### Fuses

Fuses should only be replaced with exact equivalents.

The fuses for the CM11+ are located on the front panel of the machine. These are as follows:

3.15A, Quick Acting (F) LBC - Glass Bodied. 5 x 20 mm Breaking Capacity @ 250Vac

The manufacturer is Littelfuse, part number 02173.15MXP  
alternatively they can be sourced from RS, part number 541-4426

Changing the fuses should be done with the CM11+ turned off and unplugged from the mains power supply. A small flat head screwdriver should be used to slip out the fuse holder from the filter. The fuses can now be replaced.

### Electronics Tray

There are NO user serviceable parts in the electronics enclosure and it should NOT be opened by the customer. Any access should only be by a Gen3 Systems Engineer or a recognised distributor.

This compartment has a fan forcing air into it causing positive pressure to expel any alcohol fumes.



## Pump and Valve compartment

There are NO user serviceable parts in the pump and valve compartment. Any access should only be by a Gen3 Systems Engineer or a recognised distributor.

## Reservoir and Drip Tray compartment

There is access to this compartment via the front door. Access should be for checking/changing fluid and general cleaning and be performed by trained operators only.

The drip tray will collect any spillage or over flow that may occur.

## Replacement Parts

Replacement of any part of the CM11+ should be done by either a Gen3 Systems Engineer or a recognised distributor of the CM11+. The part/s being replaced should be obtained from Gen3 Systems.

## TROUBLESHOOTING

Fault	Action
Conductivity reads 0.00 in Diagnostic Screen	Air is trapped in the measuring cell- Bleed air from system. Measuring cell disconnected or faulty Faulty main PCB
Conductivity reading falls during the test.	Solution is leaking past the regeneration valve Faulty regeneration valve CTS 3101
Conductivity reading does not decrease in regeneration mode	Air trapped in the pump or valves - Bleed air from system Regeneration resin exhausted - replace resin Regeneration column filter blocked - Confirm by checking flow rate and clean filters Solution has leaked in to measuring cell - Replace measuring cell and calibrate
No communication between instrument and PC	Faulty connection - Check USB connection. Check comm port setting in configuration screen
Pump runs continuously	Faulty main board Faulty power driver module
All switch LEDs illuminated	Faulty main board

## Connection Problems

If the CM is not connecting properly the operator should firstly ensure that the USB cable is connected correctly and that the machine is switched on.

There maybe a problem to do with the software looking at the wrong communications port, this can be altered by the following procedure:

Right click on "My Computer" icon and select "Properties" from the drop down menu.

When the "Properties" menu appears go to the "Port Settings" tab and click on the "Advanced..." button.

Change the "COM Port Number" from whatever it is to "1". Ignore the message next to the "1" saying that it is in use, Click OK.

An error message will then appear saying that the port is in use and that changing the settings may affect other devices. Disregard this and click "Yes" to continue.

Click OK in the "Port Settings" tab, this will return you back to the Device Manager.

Click on "Scan for Hardware Changes" icon on the tool bar. All the icons will disappear up and then drop back down again.

The USB Serial Port icon should now read (COM1). If so then the change has been made successfully, if not the repeat procedure.

Once this is completed open the CM software again, switch on the CM11+ and connect.

The Problem should be fixed, if it is not contact your dealer and they will assist you.

## AFTER SALES SERVICE

### Guarantee

The Contaminometer is guaranteed for 12 months from the date of delivery against any defect in materials or construction.

Except where purchased as part of a system, Gen 3 Systems warrants your hardware product against defects in materials and workmanship for a period of one year from receipt by the end user (proof of purchase required). If Gen3 Systems receives notice of such defects during the warranty period, Gen 3 Systems will either, at its option, repair or replace products, which prove to be defective. Gen3 Systems will either, at its option, repair products, which prove to be defective on a return to base or on-site basis.

If this product was purchased as part of a Gen 3 Systems system in a co-ordinated shipment or as a system add-on, it is warranted against defects in material and workmanship during the same period as the Gen 3 Systems system.

Service contracts are available from your local Gen 3 Systems Sales and Support office for coverage beyond the warranty period.

### Exclusions

The above warranty shall not apply to defects results from: improper or inadequate maintenance by customer; customer-supplied software or interfacing; unauthorised modification or misuse; operation outside of the environmental specifications for the product; operation of non supported media; or improper site preparation and maintenance.

Users should note that the guarantee is rendered invalid by:

- Accidental or deliberate damage
- Fair wear and tear
- Use of liquids other than 2-isopropanol/water mixes
- Use of an alcohol content of greater than 75%.
- Use of resin columns other than those supplied by Gen3 Systems or their accredited distributors
- Connection to a power supply other than that shown on the label
- Damage due to transport.

### Warranty Limitations

Gen 3 Systems makes no other warranty, either expressed or implied, with respect to this product. Gen 3 Systems specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Some states or provinces do not allow limitations on the duration of an implied warranty, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the one year duration of this written warranty. This warranty gives you specific legal rights, and you may also have other rights, which may vary from country to country, state to state, or province to province.

## Obtaining Service within the Warranty Period

If your hardware should fail during the warranty period, read the Troubleshooting chapter in this guide, then contact your local Gen 3 Systems/Gen 3 Systems Distributor and arrange for repair of the product. Retain proof of purchase in order to obtain warranty service.

## After the Warranty Period

If your hardware should fail after the warranty period, read the troubleshooting guide, and then contact a Gen 3 Systems or a Gen 3 Systems Distributor for details of the services available.

If you have a Gen3 Systems Maintenance Agreement; request service under your agreement.

## SPARE PARTS AND CONSUMABLES

Prepared solution to meet the requirements of Contaminometer measurement is available;

The part number ordering information for Contaminometer solution is as follows:

2-Isopropanol		50%	75%	100%
5 litres		CM0163	CM0168	CM4-105

Calibration Test Solution	CM1-022
Hydrometer 50%	CM8201
Hydrometer 75%	CM8207
Resin Column (CM11+)	CM1460N
2.5Kg Bag of Resin	CM0169

For other spares or parts please contact your Gen 3 Systems distributor or Gen 3 Systems Ltd.

## REGULATORY NOTICES

Pollution Degree IEC-664-1 has established four degrees of pollution severity:

The CM11+ is rated as having Pollution Degree 2.

PAT Testing - The CM11+ is defined as having Class 1 insulation.

## TECHNICAL SPECIFICATION

Measurement range:	0.01- 30ug/cm <sup>2</sup> NaCl equivalence (auto-ranging)
Sensitivity:	<0.25% of measurement range
Precision & Repeatability:	Better than ±2% of range for maximum PCB surface
Solution:	50% or 75% v/v reagent grade 2-propanol in de-ionised water
Tank Size	300 mm x 250 mm x 38 mm
Liquid volume:	3.5 litres
Power supply	110-240VAC, 50/60Hz
Current rating:	1.5A
Weight:	Approx. 21kg
Computer requirements:	Any suitable PC with Windows® XP, Vista® or Windows® 7.
Computer Interface	USB
Overall dimensions:	Width: 390 mm x Depth: 360 mm x Height: 525 mm
Operating Temperature Range:	15 - 30°C

The reduced range for the operating temperature for the CM11+ is due to the flammable liquid used in the machine.