Canongate DensiCheck TX

Intrusive Density Transmitter

User Manual

S-348-D

Contents

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1 INTRODUCTION

This manual has been written for the installation and User Setup of the DensiCheck TX supplied with software versions V3.18 and above, and the setup program DtxComms V3.02.

The DensiCheck TX is a rugged industrial instrument for in-line measurement of concentration. It is simple to install and operate. The intrusive sensor comes pre-calibrated with up to two calibration sets, is.

The instrument is self-contained with a signal processing unit, a stainless steel ultrasonic sensor and a temperature sensor. The concentration is provided as a proportional 4..20mA signal. Provision is made to accept a no-flow or product selection digital input signal and to output high and low digital alarm conditions. The concentration and temperature values are also available on the serial RS 232 and 485 communications link.

The standard sensing element has typically a 316 stainless steel ANSI flange process connection. The standard sensor is suitable for continuous temperatures of up to 110°C and withstanding 150°C for a maximum of 5 minutes at any one time.

The DensiCheck TX can be supplied in a standard industrial version or an ATEX certified version suitable for potentially explosive atmospheres.

1.1 Principle of Operation

The velocity of sound through a liquid is a measurable physical property, related to molecular volume, compressibility and temperature. These parameters in turn are dependent on the nature of the liquid and of any solutes present. Therefore, by measuring the speed of sound through a liquid and temperature the instrument can determine the product concentration.

The DensiCheck TX calculates sound velocity by measuring the time taken for a pulse of high frequency ultrasound to cross the gap in the sensing element. A high-speed electronic counter measures the transit time accurately, giving sound velocity resolution of better than 0.1 m/s.

Standard instruments are fitted with platinum resistance thermometer providing automatic temperature compensation.

1.2 ATEX Certification

The ATEX certified DensiCheck TX comprises sections that are separately certified. The enclosure is certified Exd and is either directly mounted on or connected via a flexible conduit to a certified Exmb sensor. There are 2 enclosure types, the standard being certified Exd IIB. The other is certified Exd IIC. Enclosure and sensor carry individual approval labels.

Exd IIB Enclosure

Marking	EC Type Examination Certificate
Ex d IIB T5 Gb F II 2G T5 (-20°C≤Ta≤60°C)	Baseefa13ATEX0047

Exd IIC Enclosure

Marking	EC Type Examination Certificate
Ex d IIC T5 Gb F II 2G T5 (-20°C≤Ta≤60°C)	Baseefa13ATEX0047

Ultrasonic Sensor

Marking	EC Type Examination Certificate
Ex mb IIC T5 Gb F II 2G T5 (-20°C≤Ta≤60°C)	Baseefa03ATEX0087X

SPECIAL CONDITIONS FOR THE USE OF Exd DensiCheck TX

1. The supply to the unit must be limited by a fuse rated at no more than 250V 250mA and having a breaking capacity of not less than 1500A in accordance with EN60127 or EN60269.

2. The enclosure screw cover and mating enclosure threads are precisely dimensioned to meet certification requirements. Both cap and mating enclosure threads must be protected from damage when separated.

3. The electrical entry threads of the Exd enclosure form a potential flamepath and are precisely dimensioned. The utmost care should be taken not to damage the threads.

4. When mounting the enclosure in a potentially explosive atmosphere only Exd IIC certified cable glands must be used with or without the interposition of an Exd IIC thread adaptor. All unused enclosure openings must be fitted with an Exd IIC certified plug which must be marked with an IP66 rating.

5. The Exd enclosure should be earthed by means of either the internal or external earth screw.

6. Exposure to direct sunlight should be such that the heat gain due to adsorption of radiant energy does not cause the enclosure temperature to exceed the maximum stated for the equipment. In addition, heat conduction from the process or environment must not cause the enclosure or sensor to operate outside of the stated ambient temperature limits.

7. The screw cover, cover O ring and enclosure threads and faces must all be clean prior to final closure. A small amount of non-setting grease may be applied to mating threads and the O ring. Ensure that the grease used is compatible with the enclosure material, cover O ring and the location in which the DensiCheck TX is installed.

8. The screw cover should be carefully mated with the enclosure and should rotate smoothly by hand until the machined faces tend to compress the O ring. To close the cap more securely use a bar, such as the edge of a spanner, across the screw cover castellations.

9. The screw cover is prevented from opening by a locking grub screw.

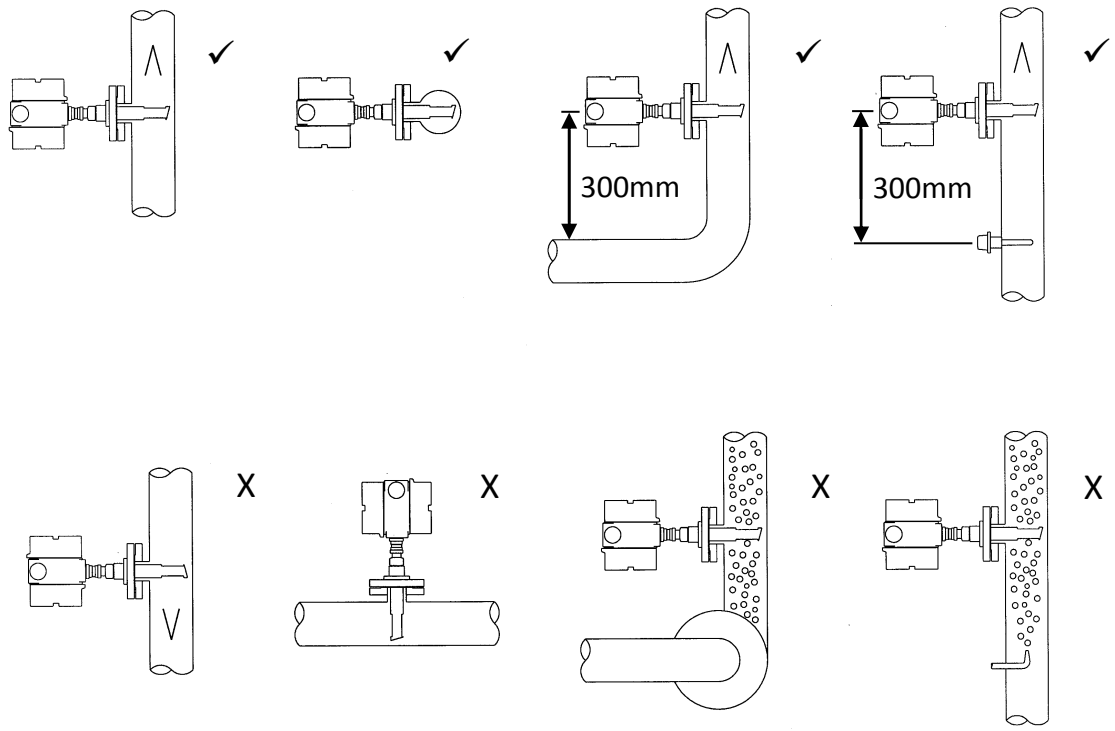
10. Do not open the enclosure when a potentially explosive atmosphere is present.

2 INSTALLATION

2.1 Sensor Installation

2.1.1 Selecting the Sensor Location

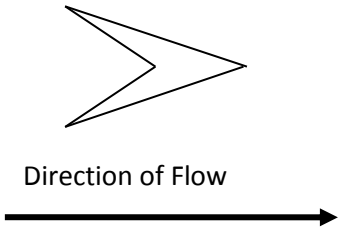
The correct location of the sensor is crucial for the operation of the instrument. Please study the following points prior to installation.



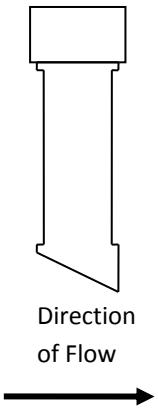
1. Liquid flowing vertically upwards is preferred to a horizontal pipe or vertical downward pipe as it is more likely to always remain full of liquid. **The sensor must be fully submerged otherwise there will be no echo from the reflector.**
2. Pipe bends upstream should be at least 300mm from the sensor as should any protrusions. In general a downstream location of a protrusion does not cause a problem.
3. The vicinity of gas injection equipment and/or cavitating pumps should be avoided as these can generate gas bubbles, which may lead to an unstable signal and affect the sound velocity. In extreme cases gas bubbles will block the signal entirely, and the concentration measurement will be lost.

2.1.2 Sensor Installation

Fit the sensor into the appropriate pipe fitting. The orientation of the sensor is indicated by a mark on the fitting.



The mark indicates the orientation of the sensing element as shown below.



2.2 System Installation

2.2.1 Cable Runs

To reduce the risk of interference, routes for running all cables should be kept clear of areas of high frequencies and voltages, such as high voltage mains cables, and sources of RF interference, such as motors and speed controllers

2.2.2 Power Supply

A regulated 24Vd.c. 250mA supply is required. ATEX applications will require the supply to be protected as detailed in section 1.2.

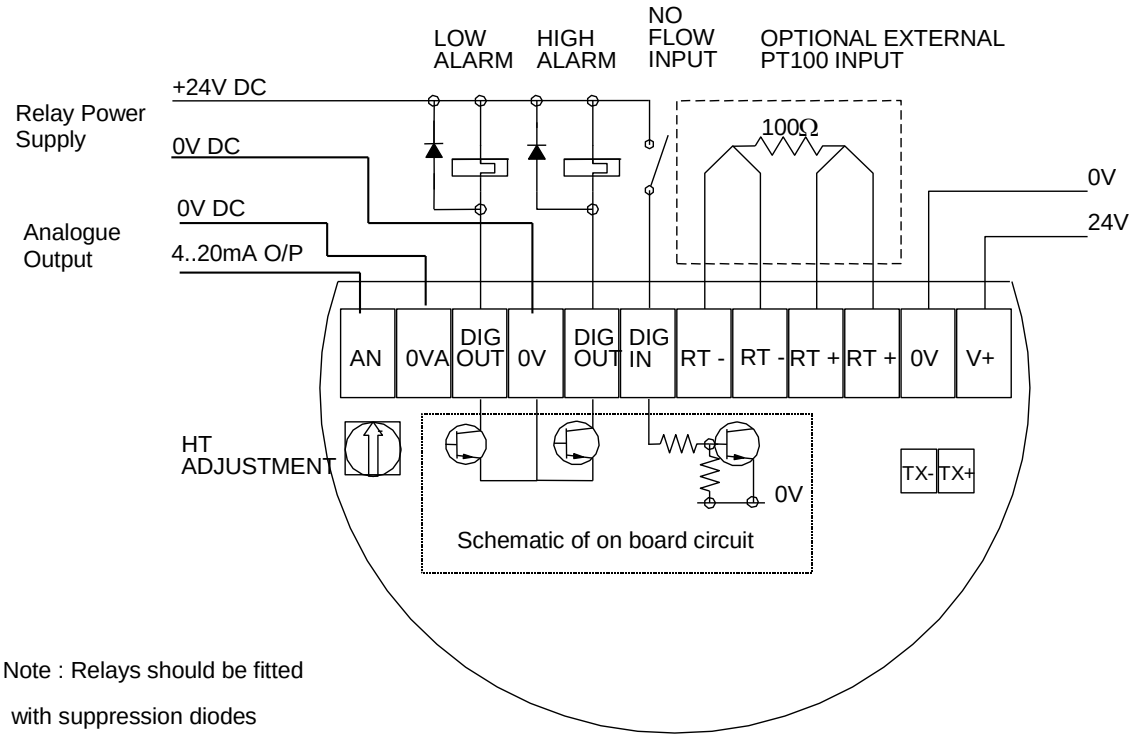
2.2.3 Cables

The following cable types are suitable for the installation of the DensiCheck Tx. This information is provided for guidance only.

For standard industrial (safe area) applications a suitable cable is 22 AWG stranded (7x30), 3 pair, twisted pairs individually foil shielded.

For ATEX applications a suitable cable is 0.5mm², 3 Pair BS5308 PT1 Type 2, collective screen, steel wire armoured, 16/0.2mm².

2.2.3 Wiring Connection Details



Note : Relays should be fitted with suppression diodes

Terminal Marking	Description
AN	Analogue Output Positive
0VA	Analogue Output Negative
DIG OUT	Digital Low Alarm (Open Collector)
0V	0v Connection for Digital Signals
DIG OUT	Digital High Alarm (Open Collector)
DIG IN	Either No Flow or Product Selection Signal
RT-	External PT 100 Input Negative
RT-	External PT 100 Input Negative
RT+	External PT 100 Input Positive
RT+	External PT 100 Input Positive
0V	0v Supply
V+	24 Vdc Supply
TX+	RS485 Serial Communication Positive
TX-	RS485 Serial Communication Negative

3 INTERFACE PROGRAM

3.1 Introduction

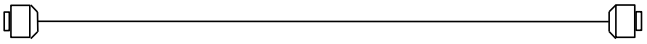
DensiCheck TX configuration parameters may be changed using a Windows based program DensiComms. The program will run on Windows 95 or subsequent operating systems.

Insert the DensiComms CD and run the **Setup** program, this will install the DensiComms program on to your hard drive. Unless instructed not to do so during the installation, the DensiComms program can be accessed via the Canongate Technology folder in your **Start**, Programs Menu.

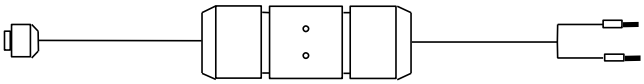
3.2 Connection Methods

The PC can be connected to the DensiCheck TX either by the nine way D type cable to the RS232 port or by a communications converter to the RS485 terminals.

RS232



RS485

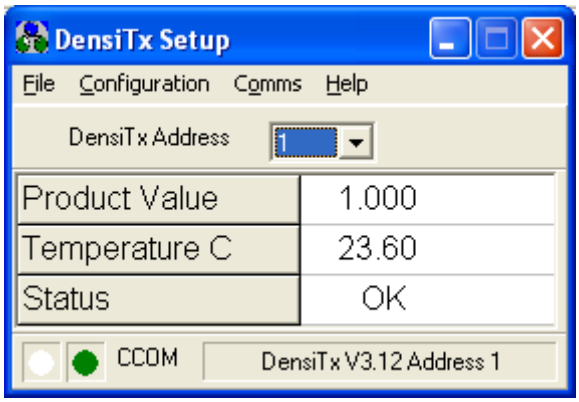


RS232 Connection
Remove the termination cover from the enclosure housing and plug the D type connector into the termination board. Connect the other D type to the serial port on the PC. If the PC is not fitted with a serial port USB to serial port converters are available.

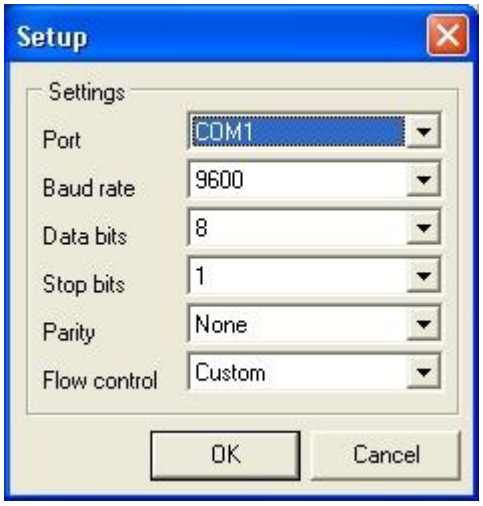
RS485 Connection
Connect the nine way D type to the serial port on your PC and the 25 way male connector to the RS485 converter. Connect the Yellow to TX+ and Blue to TX- on and 25 way female to the RS485 converter.

3.3 Communications Port Setup

When connected, run the DensiComms program. The program will start scanning for connected DensiCheck units.



The program will default to the last communications port used, if the program is being run for the first time it will select Comm1, if available. To select another communications port, select **Configuration > Comms** Port Setup, the screen following will be shown.

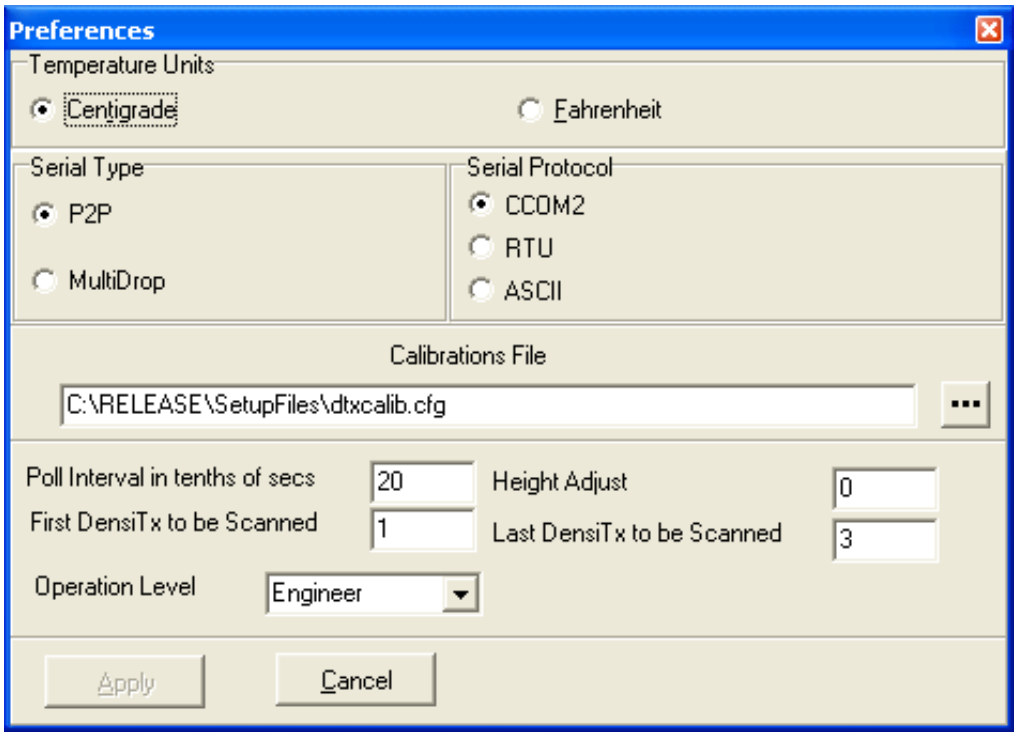


Select the required Port from the drop down list. Leave all other settings as shown.

Once the communications status displays OK the data for the first DensiCheck will be shown. When more than one DensiCheck TX is connected to the PC over the RS485 multidrop link, the other units may be viewed by changing the DensiCheck TX Address in the drop down box.

3.4 Preferences

From the task bar select **File > Preferences**, the screen allows the user to select their own preferences. The preferences will be stored in the PC register and will be used each time the program is started.



3.4.1 Temperature Units

Defines the units of temperature to be displayed in the setup program.

3.4.2 Poll Interval

Is the time in tenths of seconds between communications requests, the default is set to 20 (2 seconds).

3.4.3 First DensiCheck TX to be Scanned

Defines the first DensiCheck TX address to be scanned, when searching for connected units. The default is set to 1.

3.4.4 Last DensiCheck to Be Scanned

Defines the last DensiCheck TX address to be scanned, when searching for connected units. The default is set to 10.

3.4.5 Height Adjust

Will add an offset to the windows box height, this is required on some operating systems where the windows height is clipped.

3.4.6 Operator Level

The system has two operator levels, user and engineer. This manual only covers the User operation level. The engineer level is password protected.

3.4.7 Serial Type

This defines the serial protocol, which will be the default when the program is initiated.

3.4.8 Calibrations File

This defines a file containing pre-defined calibrations, which can be selected in the calibration factors screen.

3.5 Save and Load Data

From the task bar select **File > Save or Load.** The save and load functions allow the user to save and reload all data settings from a PC.

3.6 Print Options

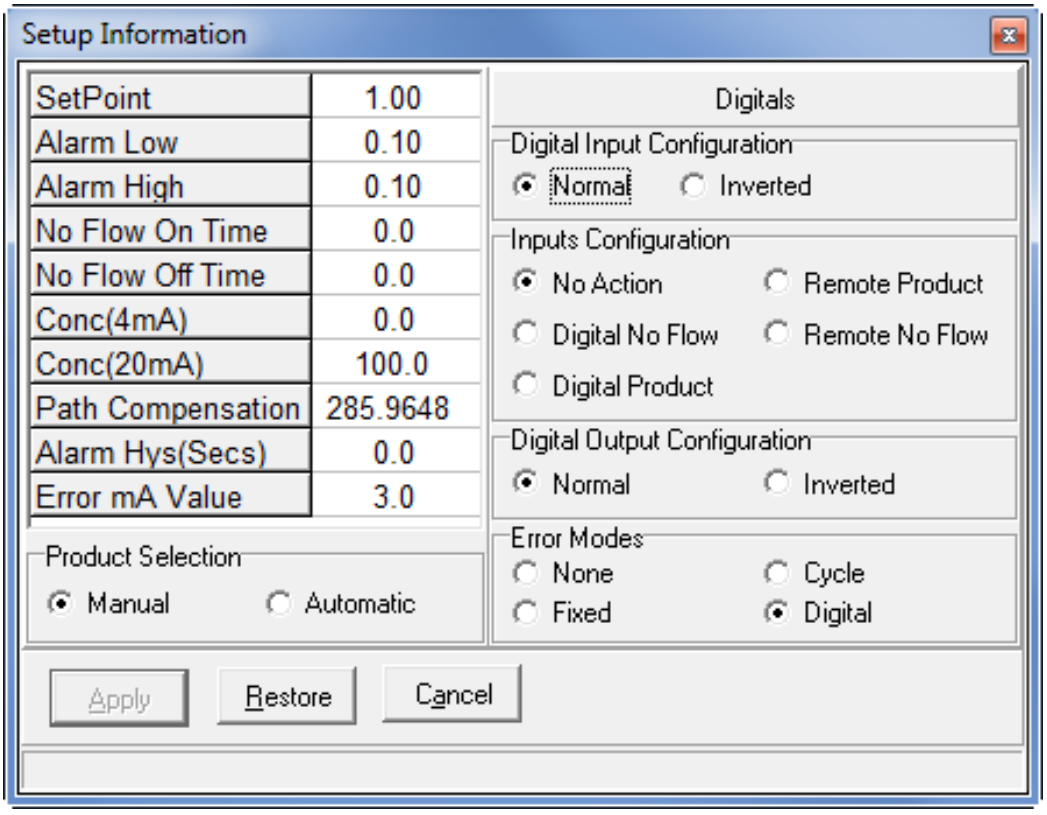
From the task bar select **File > Print Options.** The print option allows the user to print the current DensiCheck TX settings. The data can be viewed before printing by selecting the PreView option. When in the PreView screen data can be loaded and viewed from a previously stored data file.

4 INPUTS AND OUTPUTS CONFIGURATION

4.1 Introduction

The DensiCheck TX has two open collector digital outputs for high and low alarms, a 4..20mA active analogue output, a digital input, a RS485 and RS232 serial ports.

The configuration of the digital and analogue input/output is done in the **Configuration > Setup** Information Screen.



4.2 Digital Outputs

4.2.1 SetPoint

Defines the level around which the High and Low alarms will operate.

4.2.2 Alarm High

Is added to Setpoint to give the upper limit of concentration. If this is exceeded then the High digital output will be set (after Alarm Hys time).

4.2.3 Alarm Low

Is subtracted from Setpoint to give the lower limit of concentration. If this is exceeded the Low digital output will be set (after Alarm Hys time).

4.2.4 Outputs Configuration

Configures the outputs for fail-safe operation. If the invert option is selected, the output will be set active when not in an alarm state.

4.2.5 Alarm Hys(Secs)

The elapsed time before an alarm state can change in seconds.

4.3 Digital Input

4.3.1 Input Options

The digital input channel can be set to Disabled, No Flow Signal or a Product Selection.

No Action
The digital input line is not monitored.

Digital No Flow
The calculated concentration will be frozen until the digital input No Flow signal is removed. Product selection is disabled in this option.

Digital Product
The DensiCheck TX has two calibration sets. When this option is selected the system will change product on the activation of the digital input. No Flow is disabled in this option.

Remote Product
The DensiCheck TX has two calibration sets. When this option is selected the system will change by using messages sent via the serial communications link. Digital inputs are ignored in this state.

Remote No Flow
When this option is selected the system will switch between FLOW and NO FLOW by using messages sent via the serial communications link. Digital inputs are ignored in this state.

The orientation of the active state of an input, including the Remote states, is set by choosing either Normal or Inverted.

4.3.3 No Flow On Time

Is the time in seconds after applying a No Flow signal, before the DensiCheck TX will accept a No Flow condition.

4.3.4 No Flow Off Time

Is the time seconds after removing the No Flow signal, before the DensiCheck TX will accept a Flow condition.

4.4 Analogue Output

The DensiCheck TX has one active, non-isolated analogue output.

4.4.1 Conc (4mA)

Sets the concentration of the analogue output at 4 milliamps.

4.4.2 Conc (20mA)

Sets the concentration of the analogue output at 20 milliamps.

4.5 Error Modes

Defines the output states on loss of ultra sonic signal.

None - Does not effect any of the output states on error and holds the last valid value.

Cycle - Alternates the analogue output between the last good reading and a fixed value.

Fixed - Sets the analogue output to a fixed value.

Digital - Activates both of the digital outputs.

4.5.1 Error mA Value

Defines the analogue value on loss of ultrasonic signal, used when in either Fixed or Cycle Error modes.

4.6 Product Selection

The DensiCheck TX product selection can be controlled by an external input, as described earlier in this selection, or automatically by the DensiCheck TX. In the Calibrations Factor screen there are two variables (Range Low & High) that select the required range. When the measured value falls outside these ranges the instrument will switch to the other product set.

Once a new product has been selected it cannot switch back to the original set for 60 seconds.

5 CALIBRATION

5.1 Introduction

All user calibrations are done via the Calibration Factor Screen. The system has the option of two calibration sets (0 and 1). The calibration sets are selected by clicking on either the Calibration 0 or 1 tab. During normal operation the working calibration set must be selected by either the digital input or serial communications

The calculation of concentration from sonic velocity and temperature is done in two calibration stages. The first stage calculates the uncompensated concentration from the fifteen K constants. These constants are accessed in the Calibration Factors Screen and should not be changed unless instructed to do so by Canongate Technology.

The second stage calibration takes the uncompensated concentration and corrects it with two conditioning values, Skew and Offset, sometimes referred to M and C. The equation below shows how the Skew and Offset are applied to the uncompensated concentration to obtain the true concentration.

True Concentration = (Skew x Uncompensated Concentration) + Offset

The calibration is checked by taking a number of samples over the product range, analysing the results and creating a skew and offset correction using data regression. Data regression tools can be found in software packages such as Microsoft Excel or Lotus 123.

5.2 Collecting the Calibration Data

If the concentration changes during normal operation, the calibration checks should be done with at least 3 samples, to avoid sampling errors. Where possible the calibration should be check over the full product range required.

If the concentration changes rapidly during the normal operation, the number of samples should be increased. Where possible, the process should be slowed to ensure the sample taken is a true representation of the sample measure by the DensiCheck.

One sample may only be required if the concentration is normally stable, with changes only present during product change over, or in a fault condition. The error correction will only be applied to the offset.

Calibration Stages

1. With stable flow take sample and note concentration.
2. If possible alter concentration. Wait for concentration to stabilise and take another sample.
3. Take a minimum of three readings before analysing.

5.3 Analysis of Calibration Data

Once the data has been collected and the samples analysed, the effect of the current skew and offset must be removed to get the uncompensated Concentration. This is done by first **subtracting** the current Offset and then **dividing** the result by the current skew.

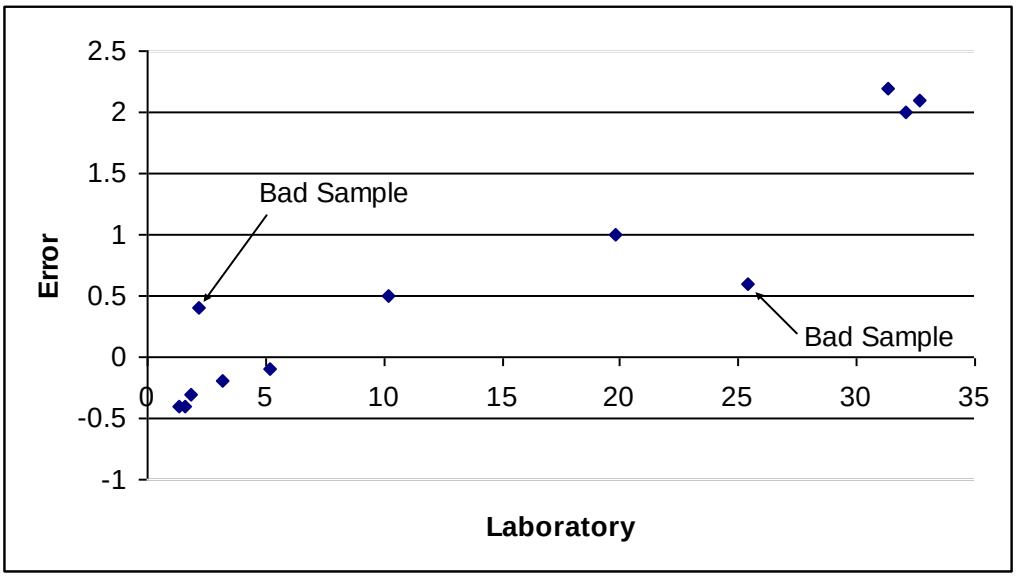
Example:
Where the current Offset is 0.6 and the Skew is 0.992.

Compensated DensiCheck	Current Offset Removed (0.6)	Current Skew Removed (0.992)	Uncompensated DensiCheck
35.1	34.5	34.8	34.8
34.4	33.8	34.1	34.1
33.8	33.2	33.5	33.5
26.4	25.8	26	26
21.2	20.6	20.8	20.8
11.2	10.6	10.7	10.7
5.7	5.1	5.1	5.1
3.6	3.0	3	3
3.2	2.6	2.6	2.6
2.1	1.5	1.5	1.5
1.8	1.2	1.2	1.2
1.5	0.9	0.9	0.9

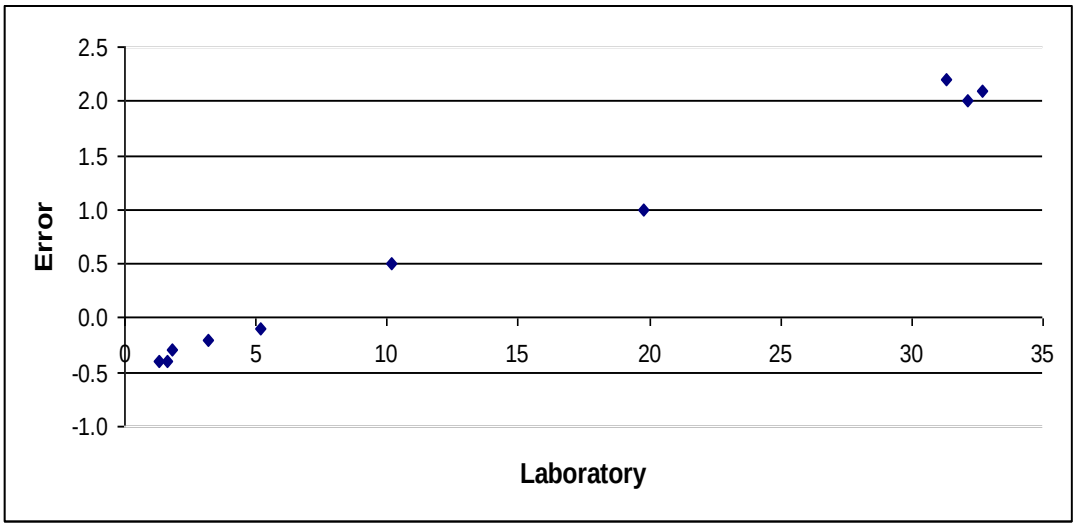
The results must be screened for poor data points (outliers and stragglers), which must be removed before data regression.

It is useful to plot a XY Scatter chart of Laboratory result against the Error.

Uncompensated Concentration DensiCheck TX	Laboratory	Error
34.8	32.7	2.1
34.1	32.1	2.0
33.5	31.3	2.2
26.0	25.4	0.6
20.8	19.8	1.0
10.7	10.2	0.5
5.1	5.2	-0.1
3.0	3.2	-0.2
2.6	2.2	0.4
1.5	1.8	-0.3
1.2	1.6	-0.4
0.9	1.3	-0.4



From the chart, errors in the sampling can be seen at Laboratory results 2.2 and 25.4. These must be removed before carrying out a data regression. The table and chart following show the error with these two samples removed.



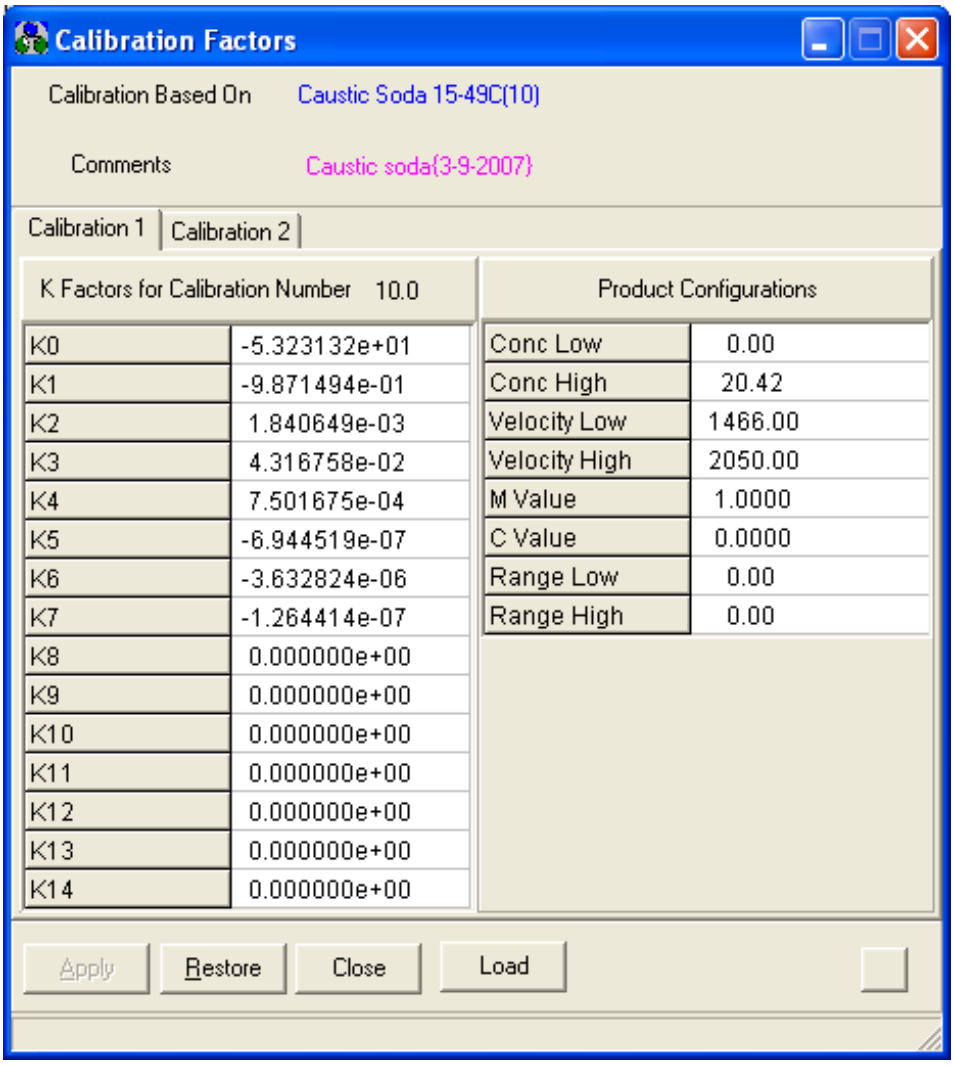
Carrying out a regression on the above data gives the following correction factors: Skew = 0.926 and Offset = 0.439, see appendix A for an example of an Excel regression and appendix B for a Lotus 123.

When these correction factors are applied to the DensiCheck TX results the following data and chart are obtained.

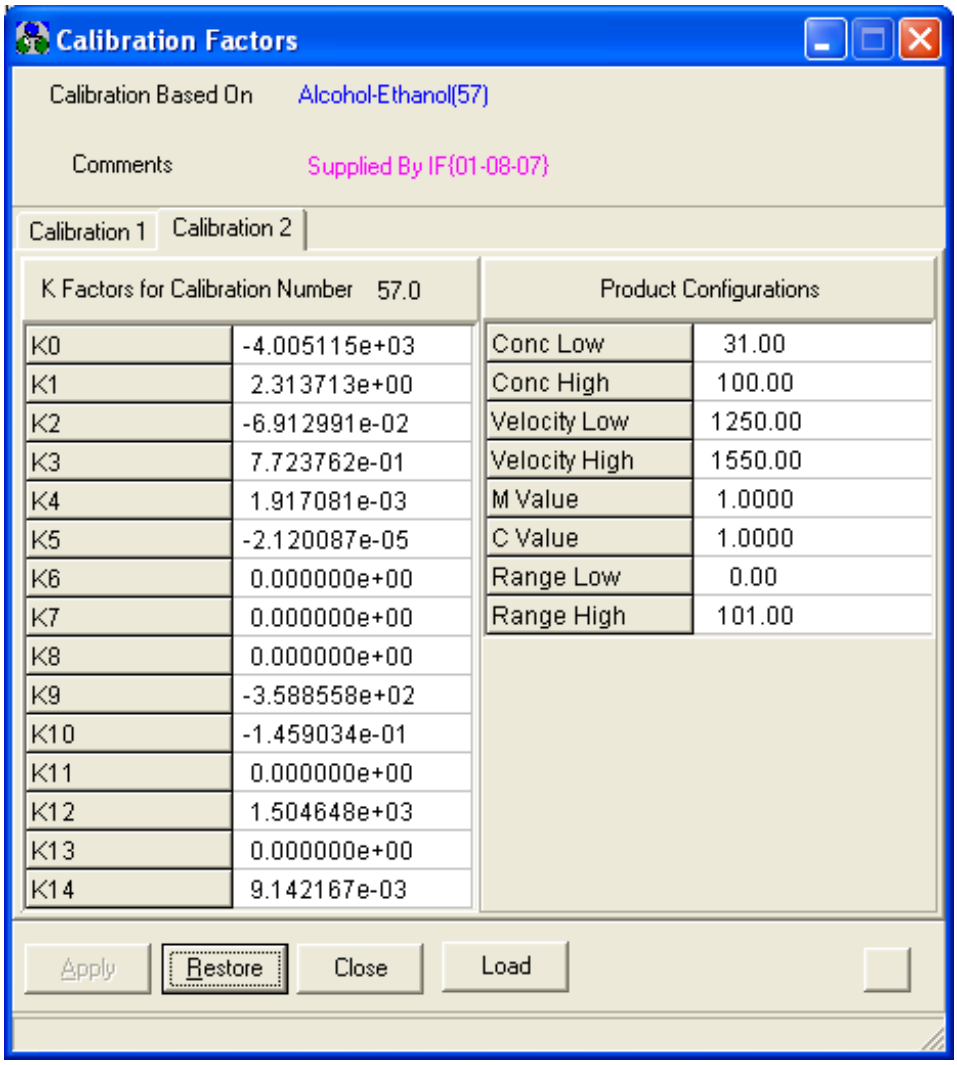
DensiCheck	Laboratory	Error	New Value	New Error
34.8	32.7	2.1	32.7	0.0
34.1	32.1	2.0	32.0	-0.1
33.5	31.3	2.2	31.5	0.2
20.8	19.8	1.0	19.7	-0.1
10.7	10.2	0.5	10.3	0.1
5.1	5.2	-0.1	5.2	0.0
3.0	3.2	-0.2	3.2	0.0
1.5	1.8	-0.3	1.8	0.0
1.2	1.6	-0.4	1.6	0.0
0.9	1.3	-0.4	1.3	0.0

The Skew (M value) and Offset (C value) data can now be entered into the Calibration Factor Screen.

Before entering the new values ensure the correct calibration set is selected.



Calibration Set Zero



Calibration Set One

6 FAULT FINDING

6.1 Introduction

The situations which can cause the DensiCheck TX to perform unsatisfactorily fall into the following the categories:

1. Plant process problems.
2. Product concentrations out with the predefined calibration range.
3. Electronic or sensor failure.

6.2 Plant Process Problems

The DensiCheck TX operation will be affected by the presence of gas bubbles and solids.

If gas is injected into the liquid the gas must be dissolved before reaching the sensing element.

Ensure the pump does not cavitate, if fitted down stream of a pump.

Ensure the line is always full, on gravity fed lines.

Check the line pressure is adequate to dissolve the injected CO2, where installed on a high pressure CO2 injection plant

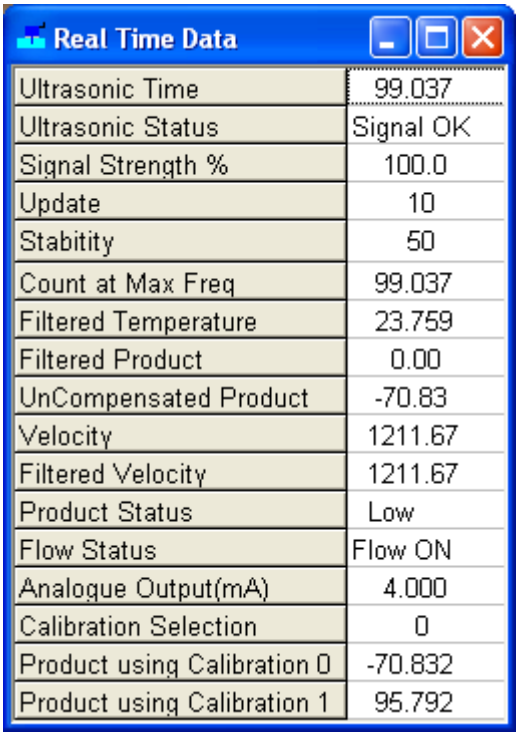
6.3 Concentrations outside Calibration Range.

The DensiCheck will be supplied with a calibration form stating the concentration and temperature ranges. Check that the process conditions are within these ranges.

6.4 Electronic or Sensor Failure.

If no problem can be diagnosed in sections 6.2 or 6.3, remove the instrument from the line. Place the sensing element into a clear beaker filled with water at 20 degrees centigrade. Ensure the sensing element window is full and clear of bubbles. Connect your PC to the communications port as described in section 3 and run the DensiComms program.

Click on **Configuration > Real Time Data** to display the following screen.



The concentration may not display zero, this is dependent on the calibration set.

The following values are expected when testing with a water sample at 20˚C.

Variable	Test
Temperature	Check the temperature indication is correct
Status	Status should show OK
Ultrasonic Time	Should be between 60 to 145 microseconds
Ultrasonic Status	Status should show OK
Signal Strength	Should be greater than 95%
Stability	Should be greater than 40
Velocity	Velocity range should be between 1420 and 1470 m/s
Flow Status	Should show Flow On
Analogue Output	Check the mA output matches the displayed value
Calibration Selection	Selected product
Product using Calibration 0	Raw product value using calibration 0
Product using Calibration 1	Raw product value using calibration 1

Table 1

6.5 Recommended Spares

The DensiCheck TX has no user serviceable parts and must be returned to the manufacturer for repair.

6.6 Status Messages

STATUS	APPLIED TO	REASON
OK	U/S	OK: SUCCESSFUL READING
NO SIGNAL	U/S	NO RETURN SIGNAL FROM TRANSDUCER
RINGING	U/S	THE PIPE IS EMPTY

7 LOGGING AND CHARTING

7.1 Logging

The logging function will store the selected data in the Logging Parameters Screen into a text file, with a comma separating the data fields. The file name is automatically created and stored in the selected directory. The file name is created from the system Type, Date, Month, Hour and Minute with the file extension Dtx.

System Type	-	Dx
Date	-	Numeric 1 to 24
Month	-	Alpha Numeric A to L (January to December)
Hour	-	Alpha Numeric A to X (00:00 to 23:00)
Minute	-	Numeric 1 to 60
File Extension	-	Dtx

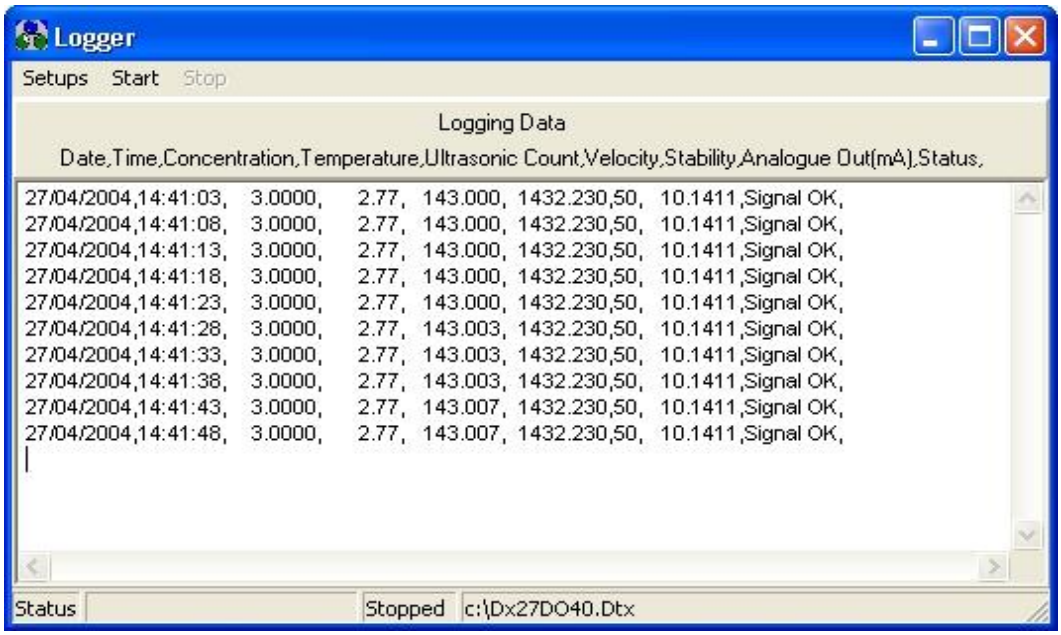
Example:
A file created on 23/4 at 13:23 would be saved as Dx23DM23.dtx

7.1.1 Logging Screen

Click on the Setup option on the Menu Bar to select the parameters to be logged and directory to which they are to be saved to.

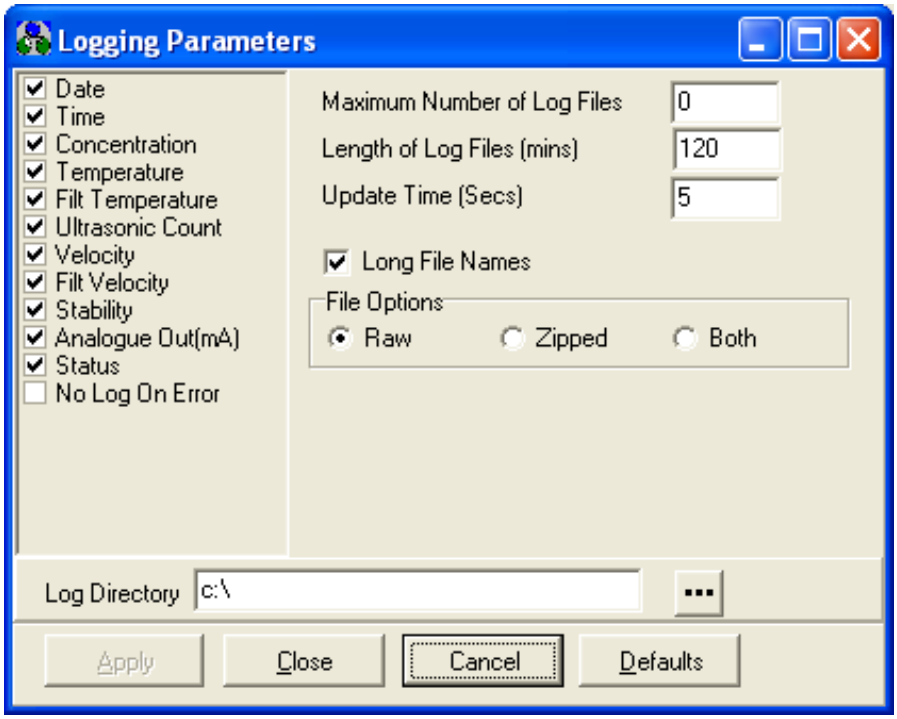
Begin logging by click on the Start option, the file name will appear on the bottom of the form.

Stop the logging by clicking on the Stop option.



7.1.2 Parameter Setups

This screen allows the user to select the parameters to be logged, file length, number of files to be logged, update time and storage directory.



Maximum Number of Log Files
Defines the number of new files to be started. When left at zero no limit will be placed on the number of files to be logged.

Length of Log Files
Defines the length of the file in minutes before creating a new file.

Update Time
Defines the file update time in seconds.

Log Directory
Allocates the directory in which the files will be stored.

Long File Names
File names will contain the date as text. If not selected file names are restricted to standard DOS style names.

File Options
Resulting logged files can be stored as Raw or Zipped. If the Both option is chosen two log files are created i.e. a raw and a zipped. These options can be used depending on the available disk space on the logging system.

7.2 Charting

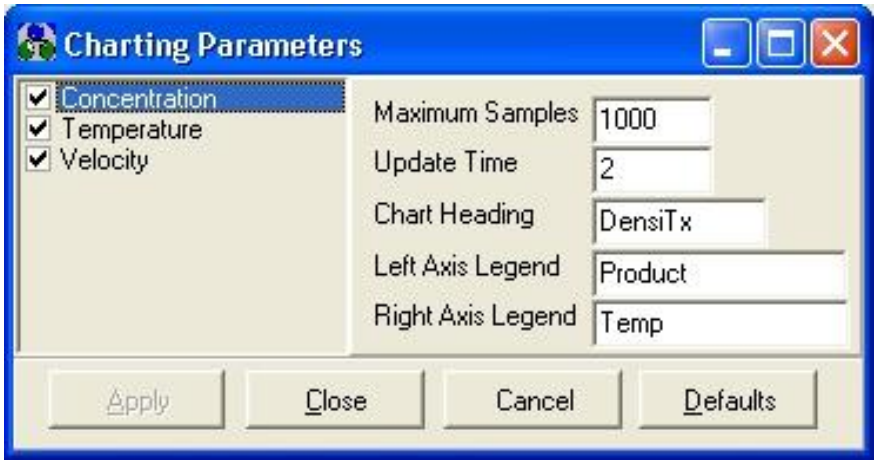
This function displays a coloured chart of Concentration, Temperature and Velocity. The chart axes and pen colours are configured via the Setup option on the Menu Bar.

Click on the Start button to begin the log, this will clear off any existing data held on the screen. Data in the chart function is not save. When the chart has reached the maximum sample size, the charting will stop.

Click on the Stop option to stop the charting.

7.2.1 Chart Setup

The Chart parameters screen allows the user to configure the displayed chart



Maximum Samples
Defines the maximum numbers of samples to be charted.

Update Time
Defines the sample update time in seconds.

Chart Heading
Applies a title to the chart.

Left Axis Legend
Defines the text legend on the charts left-hand axis.

Right Axis Legend
Defines the text legend on the charts right-hand axis.

7.2.2 Chart Configuration

Double click on Concentration, Temperature or Velocity labels to show the Chart Configuration Screen.

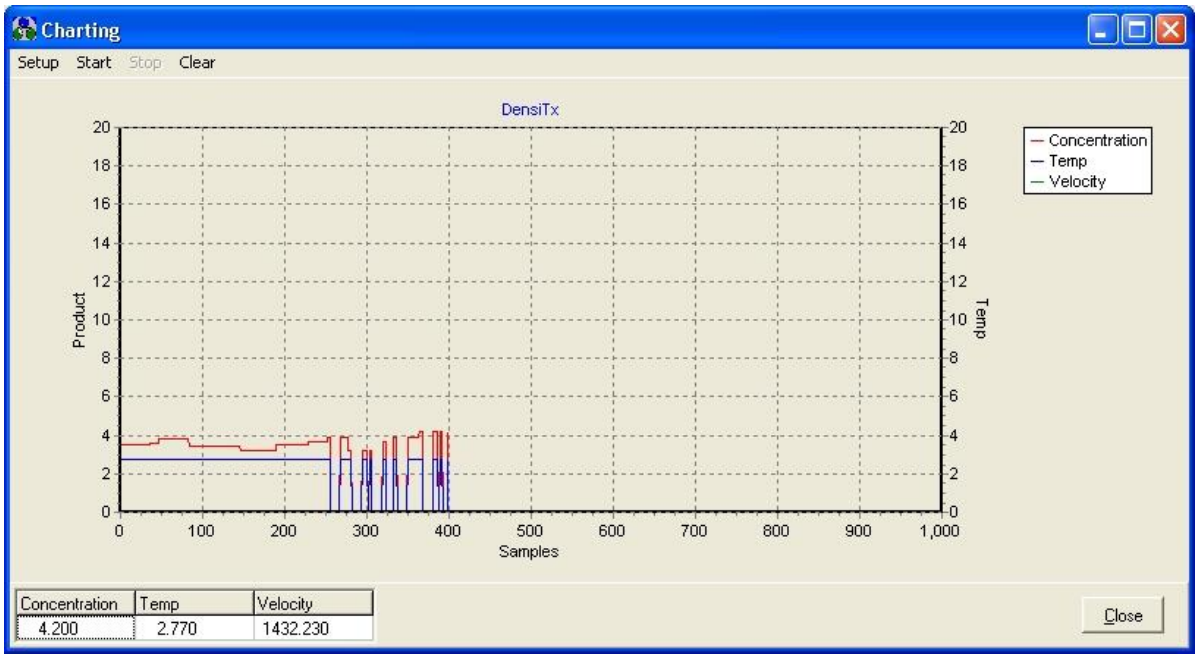


Chart
Selects the Chart Configurations for Concentration, Temperature or Velocity.

Scale
Multiplies the measured value by the scale factor.

Offset
Adds an offset to the measured value.

Colour
Selects the pen colour.

Axis Direction
Defines the axis to which the value is scaled.

Axis Minimum
Defines the minimum value on the selected axis.

Axis Maximum
Defines the maximum value on the selected axis.

8 TECHNICAL SPECIFICATIONS

8.1 Overall Unit Performance

ACCURACY:	Typically +/- 0.1% concentration (product dependant)
REPEATABILITY:	+/- 0.1m/s, +/- 0.02°C
RESPONSE TIME:	Isothermal response time 2 seconds, response time in all other conditions depends on software configuration and temperature gradient.
TEMPERATURE RANGE TRANSDUCERS:	up to 110°C continuous up to 150°C for 5 minutes intermittently

8.2 Processor Unit

RATING:	IP66
SUPPLY:	24Vdc, 250mA
ELECTRONIC AMBIENT TEMPERATURE RANGE:	10 to 70°C
NUMBER OF CALIBRATIONS:	Two
ANALOGUE OUTPUT:	One 4..20mA active non-isolated analogue output for concentration maximum resistance 500Ω
DIGITAL OUTPUT:	Two open collector for high and low alarms. Maximum current 500mA, maximum voltage 50Vdc
INPUTS:	One digital input for flow indication

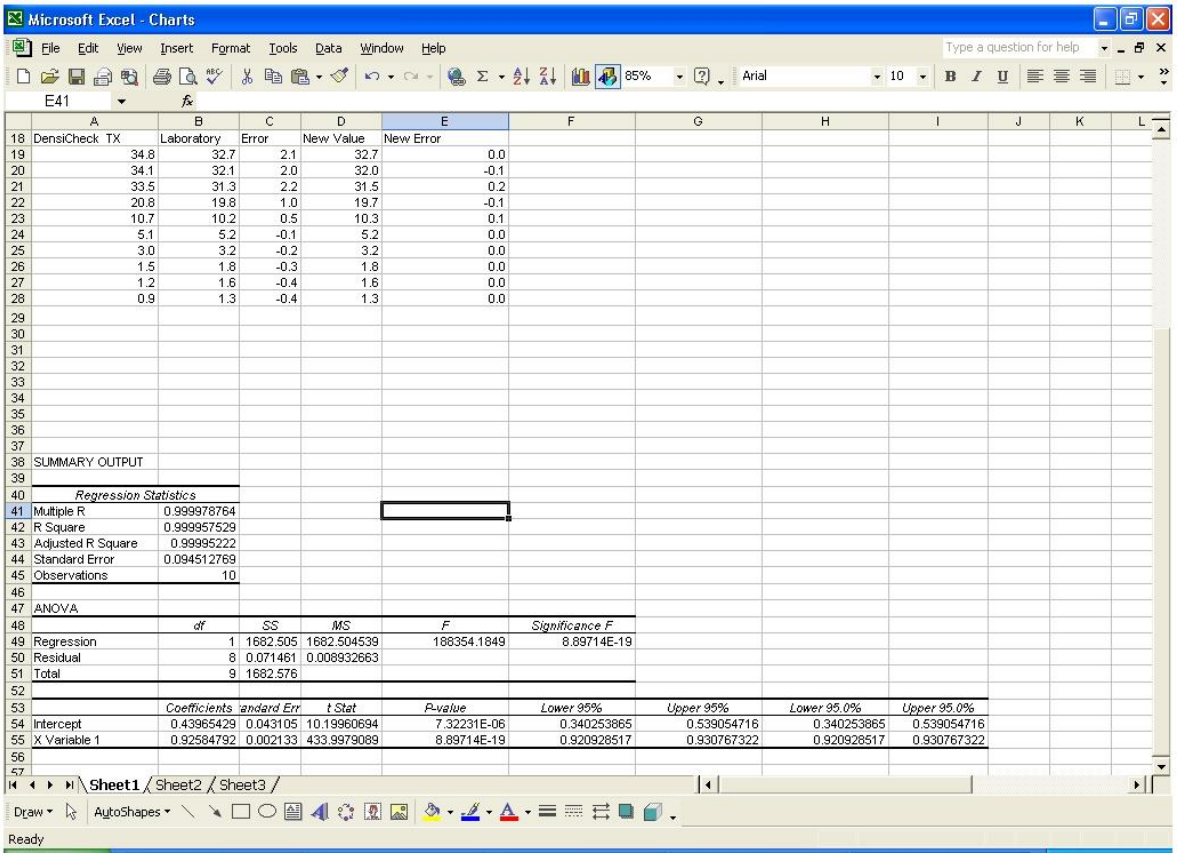
APPENDIX A

Excel Regression

This example is taken from Windows XP version of Excel, other versions of Excel may vary.

The data regression function in Excel, is accessed via the Menu Bar **Tools > Data Analysis**. From the analysis tools list select **Regression**. When the regression window is shown, click on the Input Y Range text box and select the laboratory column, click on the Input X Range text box and select the DensiCheck column. Click on the Output Range Radio Button, click on the text box to the right, click on an available space on you spread sheet. When finished click on the OK button, Excel will now perform the data regression and display the results on your spreadsheet.

The new offset value is displayed as the intercept and the skew as X Variable 1.



	A	B	C	D	E	F	G	H	I	J	K	L
18	DensiCheck TX	Laboratory	Error	New Value	New Error							
19	34.8	32.7	2.1	32.7	0.0							
20	34.1	32.1	2.0	32.0	-0.1							
21	33.5	31.3	2.2	31.5	0.2							
22	20.8	19.8	1.0	19.7	-0.1							
23	10.7	10.2	0.5	10.3	0.1							
24	5.1	5.2	-0.1	5.2	0.0							
25	3.0	3.2	-0.2	3.2	0.0							
26	1.5	1.8	-0.3	1.8	0.0							
27	1.2	1.6	-0.4	1.6	0.0							
28	0.9	1.3	-0.4	1.3	0.0							
29												
30												
31												
32												
33												
34												
35												
36												
37												
38	SUMMARY OUTPUT											
39												
40	*Regression Statistics*											
41	Multiple R	0.999978764										
42	R Square	0.999957529										
43	Adjusted R Square	0.99995222										
44	Standard Error	0.094512769										
45	Observations	10										
46												
47	ANOVA											
48		*df*	*SS*	*MS*	*F*	*Significance F*						
49	Regression	1	1682.505	1682.504539	188354.1849	8.89714E-19						
50	Residual	8	0.071461	0.008932663								
51	Total	9	1682.576									
52												
53		*Coefficients*	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*			
54	Intercept	0.43965429	0.043105	10.19960694	7.32231E-06	0.340253865	0.539054716	0.340253865	0.539054716			
55	X Variable 1	0.92584792	0.002133	433.9979089	8.89714E-19	0.920928517	0.930767322	0.920928517	0.930767322			
56												
57												

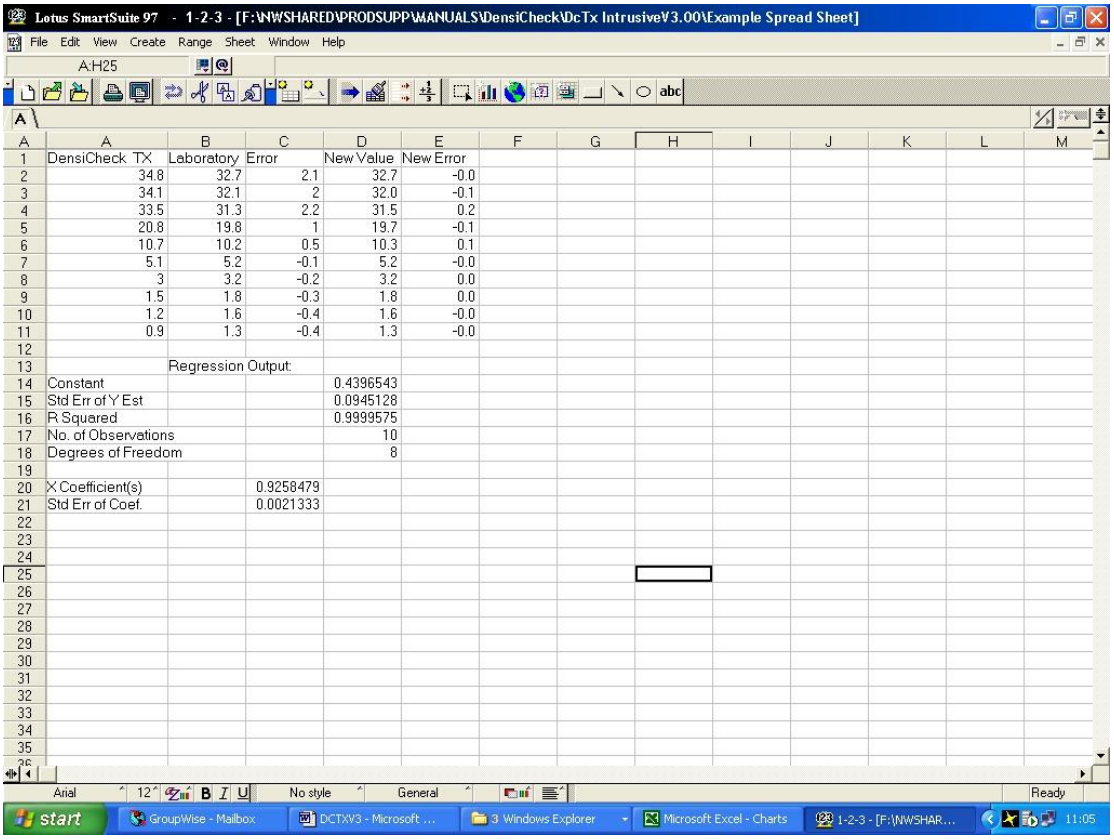
APPENDIX B

Lotus 123 Data Regression

This example is taken from Lotus 97 version of 123, other versions of 123 may vary.

The data regression function in Lotus 123, is accessed via the Menu Bar **Range > Analyze > Regression**. When the regression window is shown, click on the Y Range text box and select the laboratory column, click on the X Range text box and select the DensiCheck column. Click on the Output Range Text box, click on an available space on you spread sheet. When finished click on the OK button, Lotus 123 will now perform the data regression and display the results on your spreadsheet.

The new offset value is displayed as the Constant and the skew as X Coefficient(s).



	A	B	C	D	E
1	DensiCheck TX	Laboratory	Error	New Value	New Error
2	34.8	32.7	2.1	32.7	-0.0
3	34.1	32.1	2	32.0	-0.1
4	33.5	31.3	2.2	31.5	0.2
5	20.8	19.8	1	19.7	-0.1
6	10.7	10.2	0.5	10.3	0.1
7	5.1	5.2	-0.1	5.2	-0.0
8	3	3.2	-0.2	3.2	0.0
9	1.5	1.8	-0.3	1.8	0.0
10	1.2	1.6	-0.4	1.6	-0.0
11	0.9	1.3	-0.4	1.3	-0.0
12					
13		Regression Output:			
14	Constant			0.4396543	
15	Std Err of Y Est			0.0945128	
16	R Squared			0.9999575	
17	No. of Observations			10	
18	Degrees of Freedom			8	
19					
20	X Coefficient(s)		0.9258479		
21	Std Err of Coef.		0.0021333		