Koehler
INSTRUMENT COMPANY, INC.

K86200
K86201
Digital Density Meters

Operation and Instruction Manual

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Petroleum Testing & Analysis Instrumentation • Custom Design & Manufacturing

CERTIFICATE OF CONFORMANCE

Automatic Density Meter
K8620X

This certificate verifies that part number K8620X, Automatic Density Meter, was manufactured in conformance with the applicable standards set forth in this certification.

Specifications:	**ASTM D1250**
	ASTM D4052
	ASTM D5002
	ASTM D5931
	DIN 51757

This unit is tested before it leaves the factory, to ensure total functionality and compliance to the above specifications and ASTM standards. Test and inspection records are on file for verification.

Jesse Kelly
Application Engineer
Koehler Instrument Company

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1. Introduction

Thank you for the confidence you have placed in Koehler Instrument Company, Inc. and for the purchase of the K86200 or K86201 Digital Density Meter for the measurement of density, specific gravity, and concentration for liquids and gases.

The K86200 and K86201 are the world's most advanced density meters with many exclusive features which include:

Exclusive VideoView™ with 10X Magnification and Scanning Video Camera
The common error made in density measurements using the U-tube oscillator method is undetected bubble(s) within the oscillator. A very small bubble, one which only is 10ppm the total volume of the oscillation, will cause a measurable error. The K86200 and K86201 Digital Density Meter has made it easy for the operator to completely eliminate this source of error. Using the patented VideoView™, even the smallest of bubbles are detected under the 10X magnification and the scanning video camera which permits a complete view of the entire U-tube.

cGMP/GLP Compliant
The K86200 / K86201 has three measurement modes:**single, multiple and Continuous**. Multiple measurement mode permits the user to make any desired number of measurements on a sample and then report the results of each measurement with complete statistics: average, standard deviation, min and max measurements. These results can be displayed, printed and saved locally or saved to any defined location on your network. Any network printer may be used to print out the results. The ability to do **multiple measurements** is necessary to fulfill the requirements of a cGMP/GLP facility.

Multi-Point Calibration/Adjustments Possible
The Digital Density Meters calibration flexibility resolves all the issues that hamper proper, accurate, and cGMP/GLP compliant calibration and adjustment. The K86200 / K86201 is not limited to only a two point calibration/adjustment but is able to be adjusted using 3 calibration points (standards). Further, the Digital Density Meter permits the use of any standards that best represent the density range of the end users. Accordingly, customers may define and customize a calibration/adjustment procedure at any desired temperature, which optimizes the density meter's performance.

Windows 7 Embedded Operating System Maximizes Flexibility and Features
With the K86200 / K86201, the display, the printout, and the saving of measurement results are completely flexible and may be tailored to meet the end user's requirements. Any printer may be used, either some local printer sitting next to the density meter or some networked printer in a completely different

building. The same is true for how and where the data is saved. And the Digital Density Meter's display is large, bright, and completely configurable. The Digital Density Meter is capable of all the same flexibility and features that would be available to you with the use of a PC running in Windows® 7 embedded. Embedded Windows means that your density meter is completely safe from all malware and viruses.

Peripherals and Networking
The Digital Density Meter has 5 USB ports, an Ethernet cable connection, 2 RS232 ports and will communicate immediately with any USB external keyboard, mouse, bar code scanner, printers and any other USB devices.

Traceable Density Standard
The Digital Density Meter is supplied with a traceable density standard which can be used for either calibration verification or for a 3 point calibration adjustment.

Easy Transfer of Data and Firmware Upgrades
The Digital Density Meter can either use a flash memory stick or exchange information directly from the Internet.

Virtually Unlimited Resources Available
With its 8 GB memory, the Digital Density Meter has virtually an unlimited number of special tables, formulas, methods, and also customized calibration checks and adjustments available for use.

Touch Screen User Interface
The Digital Density Meter's display is large (10.4" diagonal), bright, colorful, and completely configurable.

The Graphic User Interface is Very User Friendly
All functions required for measurements and daily operations are directly available to you on the main screen; no need to go into other menus or submenus. The Digital Density Meter is the most user friendly, intuitive density meter in the world.

2. Safety, General Considerations

No manual can address all the various hazards which may be possible in each laboratory's environment with the vast array of different chemicals presence. It is ultimately the user's responsibility to establish the appropriate health and safety regulations. The following are basic guidelines which apply to most all laboratory instrumentation.

Read the manual before using the K86200 or K86201. Contact Koehler Instrument Company directly with any questions or concerns. Do not install the Digital Density Meter until completely familiar with this instrument and its functions.

Always ensure that the power to the K86200 or K86201 is properly grounded.

Switch the Digital Density Meter unit off and unplug the power cable before doing any authorized maintenance to the density meter.

Only technicians trained by Koehler Instrument Company are permitted to perform any repairs, or service. Any and all parts used for this service and any software used must be specified by Koehler Instrument Company.

Follow all warnings and instruction in this manual.

Do not work in any hazardous area. Work in a fume hood when measuring any materials which are inflammable, toxic, or corrosive. The K86200 and K86201 **are not** explosion proof. Comply with all usual regulations when working with materials which could ignite or explode from a spark.

Use caution when using the liquid density standards. Be sure to read and understand the Material Safety Data Sheets which are supplied with these items.

Do not operate the Digital Density Meter if any malfunctions are suspected or detected. Please contact Koehler Instrument Company.

Be sure all operators of the K86200 / K86201 have been properly trained.

Use normal chemical common sense. For example, do not rinse **concentrated sulfuric acid** out of the Digital Density Meter's U-tube using water. The resulting exothermic reaction can damage both the instrument and any personnel in the area with splashing, spitting hot sulfuric acid. Always be cognizant of the nature of and the hazards of all the chemicals used in your laboratory.

Only use the accessories and auto-sampling devices supplied or approved by Koehler Instrument Company.

3. Understanding Density and Specific Gravity

3.1 Definitions

Density is the mass of a material divided by its volume. Some of the most commonly used units for density include: grams/cubic centimeter (g/cm^3), grams/milliliter (g/ml), kilograms/cubic meter (kg/m^3), and pounds /gallon (lbs/gal).
While a material's mass does not change as a function of temperature, its volume does. Therefore, a material's density is a function of temperature. It is necessary to always include temperature with any description of density.

Density is often shown in the literature as the Greek letter rho, ρ.

Specific Gravity, sometimes called Relative Density, is a dimensionless value that is the quotient of two density values. In its most basic form it may be expressed as:

$$SG_{t2}^{t1} = \frac{\text{Density of the material being measured at some temperature t1}}{\text{Density of some reference material (usually water) at some temperature t2}}$$

Temperature t1 does NOT have to be equal to temperature t2, that is; t1 ≠ t2

For example: $SG_{4^\circ C}^{20^\circ C}$, or $SG_{60^\circ F}^{20^\circ C}$ (See Chapter 6 page 31 for more details on t1 & t2)

Therefore, it is best to always indicate the temperature in both the numerator and denominator when describing Specific Gravity.

Unfortunately, this is not always done. It is common to hear or read descriptions of SG at only one temperature. That is, the SG at 20 ºC or SG at 60 ºF. If this is all the information given, one can only assume that the temperature in the numerator and denominator are the same. But assume this with some caution.

When temperature t1 equals temperature t2 the SG of water is always 1.00000, at all temperatures. Let's look at the example below to understand why this is so.

The Density of pure water at 20 ºC is 0.99820 g/cm^3 and the Density of pure water at 25 ºC is 0.99704 g/cm^3

If in the SG equation, t1 = t2, and if the reference material is water then,

At 20ºC:

$$SG^{t1}_{t2} = SG^{20^\circ C}_{20^\circ C} = \frac{0.99820 \quad g/cm^3}{0.99820 \quad g/cm^3} = 1.0000$$

and,
At 25ºC:

$$SG^{t1}_{t2} = SG^{25^\circ C}_{25^\circ C} = \frac{0.99704 \quad g/cm^3}{0.99704 \quad g/cm^3} = 1.0000$$

Note that the units of density cancel each other out; thereby leaving SG as a dimensionless unit of measure. Also, it should be apparent that whenever t1=t2 that the SG of water will be 1.0000 at all temperatures.

Apparent Density and Apparent Specific Gravity

In the discussion above, we only considered "true" density and "true" specific gravity, which are measurements related to mass of the material. Apparent Density and Apparent Specific Gravity are functions not of mass, but of weight.

That is, Apparent Density is the weight of a material divided by its volume. And, Apparent Specific Gravity is the Apparent Density of a material divided by the Apparent Density of some reference material (again, usually water).

As in the discussion above, temperature must always be defined.

Mass is a constant independent of an object's position. Weight, however, is a function of gravitational force. Subsequently, one's mass is identical on the earth and the moon, but one's weight is completely different.

The difference between True Density and Apparent Density can be shown easily by looking at the densities of air.

We know that air is made up of mostly Nitrogen and Oxygen. Therefore air has mass and we would expect air to have a density value.

The true density of dry air at 20 ºC at 1 atmosphere is 0.00120 g/cm^3

But you cannot weigh air on a balance; the Apparent Density of air is 0.00000 g/cm^3.

3.2 The Mechanical Oscillation Principle – A Brief Explanation

In the most simplistic of terms, the K86200 and K86201's glass U-tube (the sample cell) acts like a tuning fork. The tune fork always yields a reproducible harmonic oscillation; that is, always giving off the same exact tone or note similar to a piano key, it always strikes the same string the same way and yields the same note each time. The tuning fork and the piano string are examples of objects vibrating at their natural or harmonic frequency. Imagine, however, that

the tuning fork was hollow or was a capillary tube. It will again yield some reproducible frequency of oscillation or tone. But if we now fill that tube with water, the tone will become lower and the time required for a cycle of oscillation to happen is now longer. That is, the period (time) has now increased by adding mass to the inside of that hollow capillary tube. As it turns out, the period of oscillation is directly proportional to the increase in mass inside the vibrating oscillator.

The nature of the frequency or period depends upon the mass and subsequently the density of the materials filling the oscillator.

Through use of a piezo-electronic system, the hollow U-tube inside the K86200 / K86201 Automatic Density Meter is caused to vibrate at its natural resonance frequency, much like the tuning fork example above. At a constant temperature, this harmonic frequency is a constant and a reproducible value.

The U-tube is then filled with the sample which is also controlled to the same constant temperature. The frequency of the U-tube will shift; the shift in this frequency is indirectly proportional to the mass of the sample inside the U-tube. We now have a measurable frequency that indicates mass and we have a constant volume U-tube, acting somewhat like a pycnometer. With mass and volume, we now have all that is required for a very accurate and reproducible density measurement.

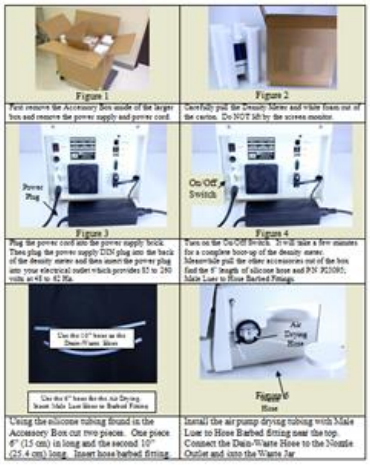
4. Unpacking your new K86200- K86201 Density Meter

4.1 Items Supplied

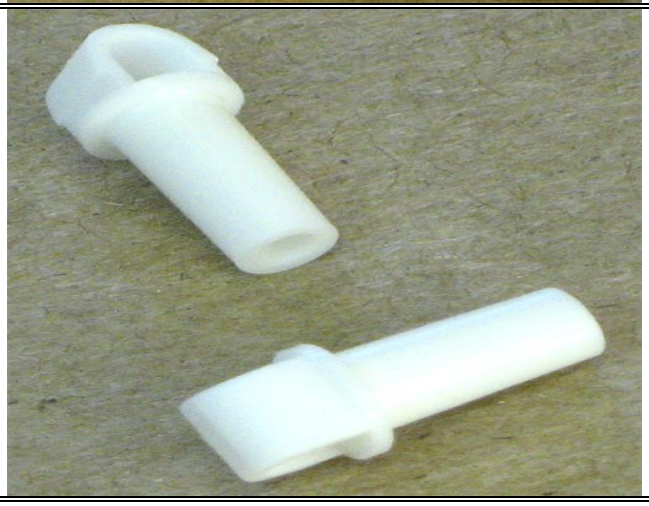
The K86200 or K86201 has been packed and inspected thoroughly prior to shipment. However, please inspect the box for damage prior to opening. Photograph if possible the condition of the box if any damage is evident and report this to the transportation company as well as your Koehler Instrument Company representative. Keep all packing material for inspection.

Standard Items supplied for each Digital Density Meter are as follows:

Item	Pcs.	Description & P/N
	1	K86200 or, K86201
The No Charge Kit supplied includes all the following items:		
	1	Power Supply 85 to 220vac; 48 to 62 Hz input DC, 12V 10A, 150W MAX output P/N K86225

	1	Power Cord 6’ 3 X 18AWG 2.5A/125VAC P/N K86226
	1	Plug Adapter IEC C14 Plug to IEC CS P/N K86238 May be required to permit the power supply to be compatible internationally
	1	Factory IQ/OQ Documentation
	1	Quick Start Guide P/N MD00132
	1	Users’ Manual – Hard Copy
	1	Lab Manager’s Password Unique password for each unit provides Manager’s level of security

	1	Waste Collection Jar, 500ml Polypropylene P/N K86231
	6	3 ml Luer Slip tip Syringes, With Elastomeric tipped plunger P/N K86220 Suitable for use with Acetone but will be attacked by Toluene, Heptane, Xylene, and similar solvents.
	6	3 ml Luer Slip Tip Syringes, All plastics P/N K86221 Suitable for use with most solvents.
	2	Female Luer to ¼”-28 thread ETFE P/N K86239

	2	Female Luer Lok to ¼”-28 thread ETFE P/N K86217
	2	Barbed to ¼”-28 thread, UNF ETFE P/N K86240
	1	6 feet of Silicone Tubing 1/8” ID x 3/16” OD P/N K86229
	2	Plug, Male Luer P/N K86218

	4	Hose Barbed to Male Luer 1/8" Polypropylene P/N K86214
	2	Fill Nozzle, PTFE P/N K86241
	1	Nozzle Repair Tool P/N K86223 For re-shaping the tip of the above Fill Nozzle should it become bent or damaged
	1	Screw Driver, Phillips head P/N K86224

The follow Density Fluid Kit is shown as a separate line item on the packing Slip

	1	Density Water Standard Kit P/N K86211-KIT Includes: UKAS Water Standard, Glass Syringe, Syringe Needle, Instructions, Certificates of Analysis and Materials Safety Data Sheet

Please check and make sure all the <u>above</u> items are received. Contact your Koehler Instrument Company representative if any of the above items are missing. Also, confirm all line items are received per your packing slip.

4.2 Other Optional and Spare Parts

Item	Pcs.	Description & P/N
	100	3 ml Luer Slip Tip Syringes, with elastomeric tipped plungers, sterile Sold in lots of 100 pcs. P/N K86220
	100	3 ml Luer Slip Tip Syringes, all plastic, non-sterile Sold in lots of 100pcs. P/N K86221
	1	Syringe Needles Sold in a bag of 50 pcs. P/N K86242
	1	Female Luer to ¼”-28 thread ETFE P/N K86239

	1	Female Luer Lok to ¼”-28 thread ETFE P/N K86217
	1	Barbed to ¼”-28 thread, UNF ETFE P/N K86240
	1	**Density Standards:** P/N K86211-1 5ml Isooctane P/N K86211-2 5ml Toluene P/N K86211-3 10ml Water P/N K86211-4 10ml DMP P/N K86211-5 10ml TCE Each includes a Certificate of Calibration or analysis and the Material’s Safety Data Sheet
	1	Density Water Standard Kit P/N K86211-KIT **Includes:** UKAS Water Standard, Glass Syringe, Syringe Needle, Instructions, Certificates of Analysis and Materials Safety Data Sheet

	1	USB Mouse (If delivered, may vary in its model) P/N K86222
	1	USB Bar Code Scanner (If delivered, may vary in its model) P/N K86206
	1	USB Keyboard (If delivered, may vary in its model) P/N K86213

	1	USB Laser Printer Kit P/N K86209 Consisting of: B/W Laser Printer, P/N P22078 USB Cable, P/N P23022
	1	USB Ink Jet Printer Kit P/N K86208 Consisting of: Inkjet Printer, P11787 USB Cable, P23022
	1	Serial Printer Kit Call Factory for latest information
	1	Fluke Hart Thermometer Kit P/N K86207 Consisting of: Handheld Temp. Probe Probe Calibration

	1	USB 4 Port Expansion Hub P/N K86230 Model may vary
	1	DRIERITE Gas Drying Unit P/N K86212 The DRIERITE granules give a visual indication of status. They are Blue when good and Pink when exhausted. The granules may be regenerated by removing them from the column and heated for 1 hour at 210ºC (425ºF)
	1	Automation/Manual Feed Kit P/N K86243 Consisting of: 2pcs. P/N K86244 – Fitting, Female Luer, ¼”– 28 male, Stainless Steel 2pcs. P/N K86245 – Quick Connect, Modified, Luer Lock, ¼”-28 female Threads are sealed using Teflon tape
	1	316 Stainless Steel Female Luer to ¼”-28 Used with Heated Interface Option P/N K86244

	1	Nickel Plated Brass Hose Barbed to Female ¼:-28 Used with Heated Interface Option P/N K86246

5. Setting up the Instrument

5.1 Basic Set Up

The K86200 / K86201's power supply may be plugged into any electrical outlet which provides 85 to 260 volts at 48 to 62 Hz. The power supply's output is 12volts, 150 watts. This power supply and the power cord are both found inside the cardboard accessory box. The On/Off switch to the K86200 / K86201 is also in the back near where the power cord plugs in. Once turned on, it will take a few moments for the software to boot-up. See the Back View of the instrument, Figure 5.1 below.

Figure 5.1 Back View of K86200 or K86201

The K86200 / K86201 is best to be at the ambient temperature prior to turning on. Normally a warm-up time of 15 to 20 minutes is best for accurate measurements.

HINT

After shipment, it is advisable to check the instrument's accuracy with air and water prior to making other measurements. If required, do a Two Point Air and Water Calibration Adjustment. Please see Chapter 9.3 on page 54 of this Manual for Complete Instructions.

The two filling nozzles which accept a Luer tipped syringe and/or other Luer fittings come preinstalled on the side of the K86200 / K86201. See the Side View, Figures 5.2 and 5.3.

The connection between the glass U-tube and the nozzles must be air tight. This connection was checked at the factory prior to shipment. However, it is

advisable to recheck these connections as follows: Close off the outlet hose barbed nozzles with your thumb. See Figure 5.4. Then with an empty syringe push air into the nozzle using a moderate amount of force. Hold the syringe's plunger in for a few seconds. Then release the plunger on the syringe. If this connection was air tight, the pressure inside the U-tube will push the plunger back to the original position. See figure 5.4 as shown on page 19.

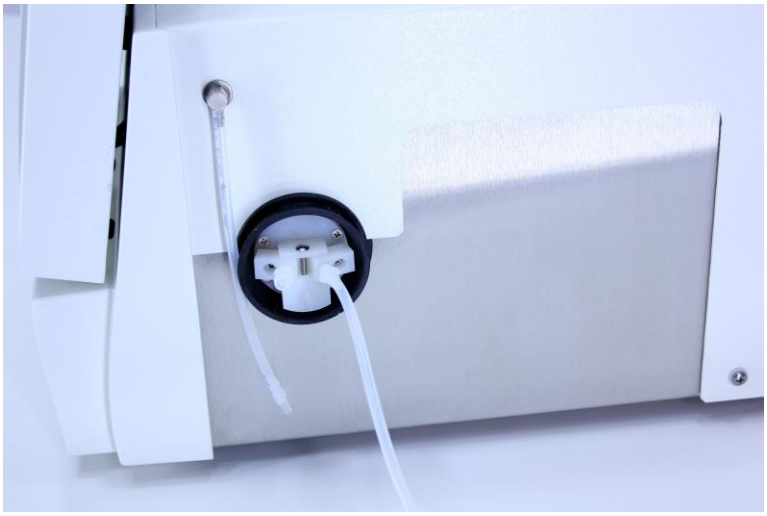


Figure 5.2 Side View of Drying Hose

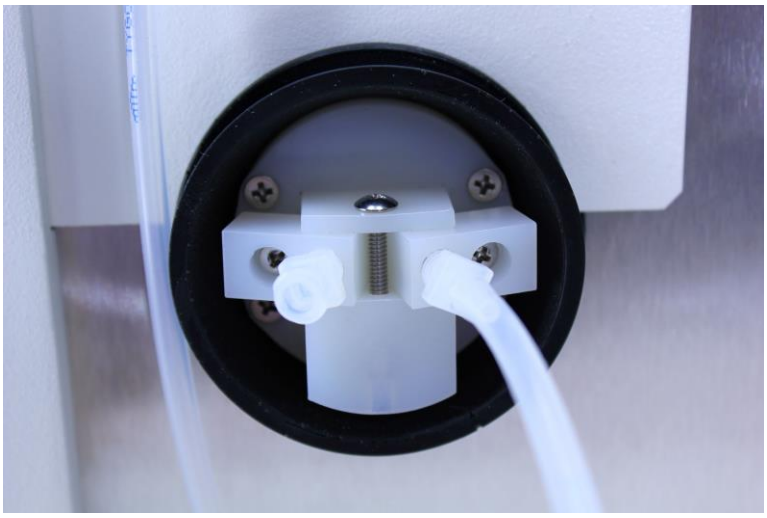


Figure 5.3 Side View of Filling Nozzles

Figure 5.4 Checking the Filling Nozzles for Air Tightness

5.2 Adding Peripherals; Bar Code Scanner, Keyboard, Printer

The 5 USB ports make possible the connection of optional peripherals. Bar Code Scanner, Keyboard, Printer, mouse and any other USB devices will all be plug-n-play and installed just as one would install the same in any PC. Use any of the five available UBS ports for any peripheral. Three USB ports are located in the back of the K86200 / K86201 and 2 UBS ports are on the front.

5.3 After Turning On – Menu Basics

Figure 5.5 Home - Accessing the Main Menu

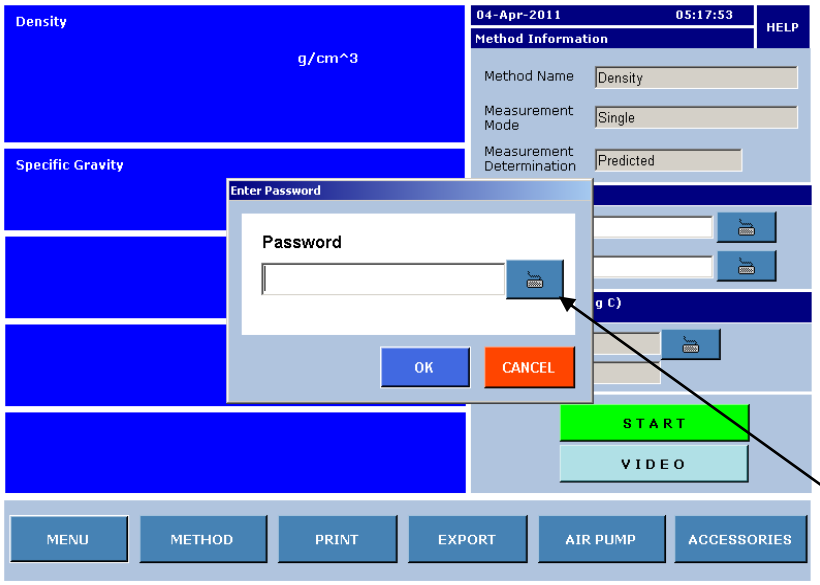


Figure 5.6. Accessing the Keyboard

Figure 5.7. Virtual keyboard

Typing in the password, if required, will gain you access to the Main Menu, which looks like the windows shown below in Figure 5.8. See Chapter 6 for additional details.

If you wish to turn off password protection, please see the Lab Manager's Confidential Envelope – Document.

Figure 5.8 - Main Menu

Within the submenu “System Information”, you will find Software, firmware versions, Serial number and 21 CFR module version* as shown in Fig 5.9

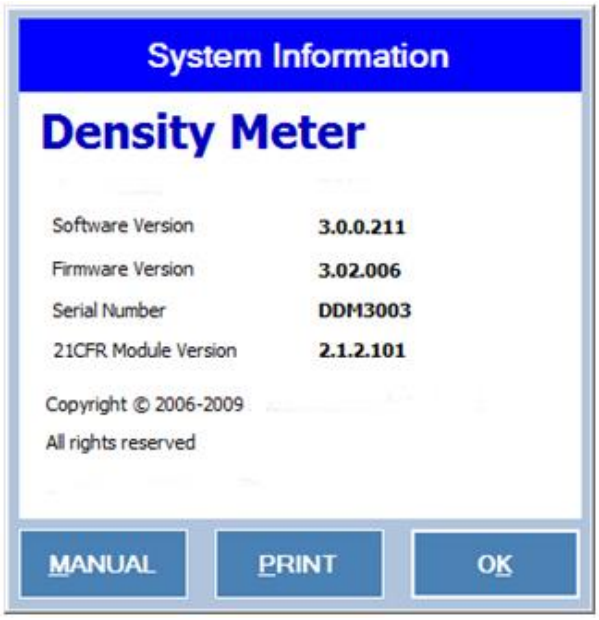


Figure 5.9 – System Information showing 21 CFR Part 11 installed

*** Note:** 21 CFR Part 11 module is an optional component and must be purchased separately. In this case, you may see “Not purchased” in 21CFR Module Version. Should you require it please contact Koehler Instrument Company or your local representative.

HINT

An Electronic copy of the User's Manual is available within this submenu

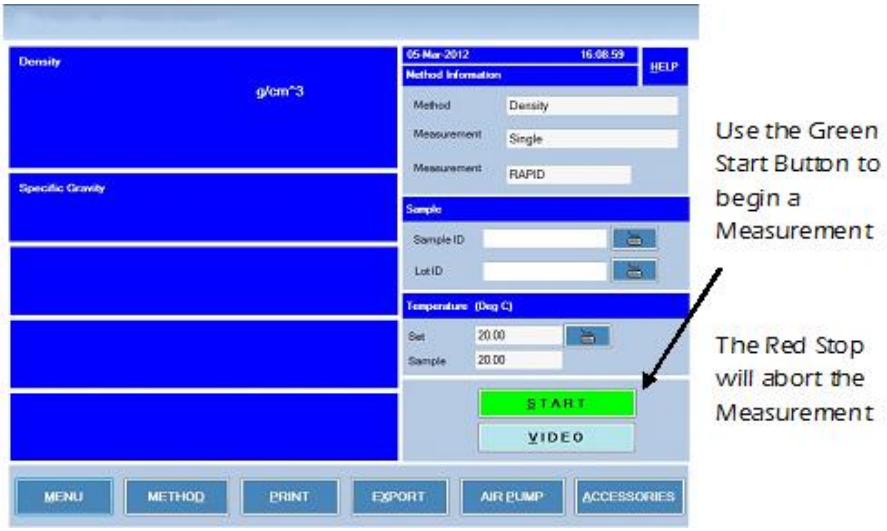


Figure 5.10. How to start a measurement

Figure 5.11.VideoView™ with scanning function

The patented VideoView™ feature may be opened by pushing the Blue Video Button. This permits a 10 times magnification of the glass U-tube, thus providing an excellent live view of the sample during filling. Bubbles are then easily seen under this magnification which has great resolution. Use the Scanning camera to view the entire U-tube.

VideoView™ is closed by either pushing the blue Video button once again or by using the “Close” button found on the lower right-hand corner of VideoView™.

6. Getting Started: Factory Methods & Their Customization

6.1 Selection of a Factory Method

The K86200 / K86201 has a list of 11 pre-loaded factory methods in the instrument's memory. This allows easy and immediate use for the most common applications.

Select the method which is closest to meeting your application. Method selection can be done from the Main Screen by touching the Method button.

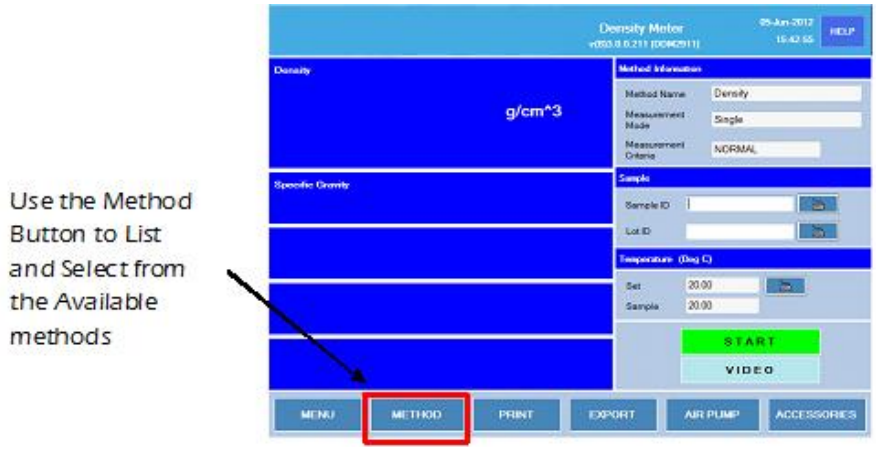


Figure 6.1.Home - Main Screen. How to load a factory method

Highlight the Method you wish to use and then touch the "Load" button.

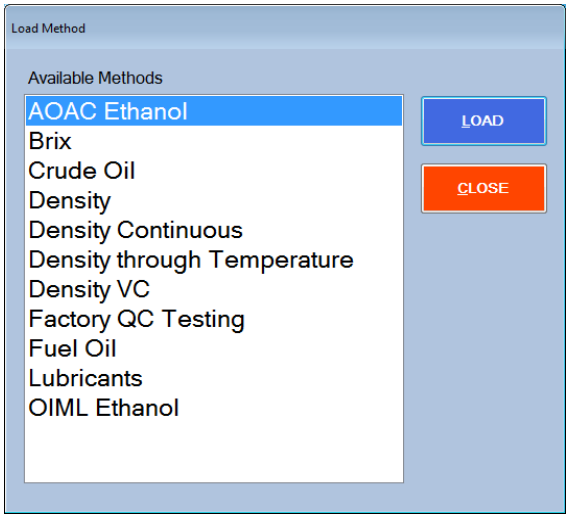


Figure 6.2 Load Method Screen

HINT

The defaults for all the Factory Methods Set Temperature is 20 ºC, the Measurement Determination is set to Normal, and the Measurement Mode is Single. An explanation of these settings and how to change them is fully covered in Chapter 6.2 “Customizing a Factory Method”.

It is possible to Edit and/or Rename the Eleven Factory Methods. Below are the default settings and descriptions as shipped:

AOAC Ethanol – Ethanol concentration is determined in accordance with the American Organization of Analytical Chemists (AOAC) Tables as percent by volume/volume and as Proof calculated at 60ºF but measured at 20ºC. The display is configured to show the following: AOAC Ethanol % by vol/vol, Proof, Density, and Specific Gravity at 20ºC.

Brix – Displays Brix, Density and Specific Gravity. Brix concentration is based upon NBS Table 113 and is the concentration of sucrose in percent by weight.

Crude Oil – This method calculates the API Gravity, the Specific Gravity, Density at 15ºC, 20ºC, and/or 60ºF for petroleum products, Group A (crude oil) in accordance with ASTM D1250 and DIN 51757. By factory default, the display is set to show the following 5 calculated results: API Gravity at 60ºF, API Gravity at 15ºC, API Gravity at 20ºC, Density and Specific Gravity at measured temperature.

Density– Displays both Density and Specific Gravity results which have No Correction for the influence of the sample’s viscosity.

Density Continuous – Displays Density and Specific Gravity Continuously.

Density through Temperature – This method displays Density and Specific Gravity beginning at some user defined “**Start**” temperature. After completion of this first measurement the temperature will automatically increase by some user defined “**Step**” or increment; make a second measurement and then continue onto a third measurement and continue to repeat until reaching the user defined “**End**” temperature. All measurement data is collected and stored in Results.

Density VC – Displays both Density and Specific Gravity results which have been Viscosity Corrected for the influence of the sample's viscosity.

Factory QC Testing – This is not a user Method but shows the data collected during QC testing at the Factory. See Chapter 13, page 112 for complete details on this Read Only File.

Fuel Oil – This method calculates the API Gravity, the Specific Gravity, Density at 15ºC, 20ºC, and/or 60ºF for petroleum products, Group B (fuel to heating oil) in accordance with ASTM D1250 and DIN 51757. By factory default, the display is set to show the following 5 calculated results: API Gravity at 60ºF, API Gravity at 15ºC, API Gravity at 20ºC, Density, and Specific Gravity at measured temperature.

Lubricants – This method calculates the API Gravity, the Specific Gravity, Density at 15ºC, 20ºC, and/or 60ºF for petroleum products, Group D (lubricants) in accordance with ASTM D1250 and DIN 51757. By factory default, the display is set to show the following 5 calculated results: API Gravity at 60ºF, API Gravity at 15ºC, API Gravity at 20ºC, Density, and Specific Gravity at measured temperature.

OIML Ethanol – Ethanol concentration in accordance with the International Organization of Legal Metrology (OIML) Tables as percent by volume/volume and also as percent weight/weight. The display is configured to show the following: OIML Ethanol % by vol/vol, OIML Ethanol % by wt./wt., Density at 20ºC,and Specific Gravity at 20ºC.

6.2 Customizing a Factory Method

6.2.1 Editing the Measurement Parameters

All of the Factory's eleven pre-installed factory methods may be modified to meet the requirements of the user. To do so, touch the "Menu" button on the K86200 / K86201's main screen.

Depending upon the instrument's current setting, entering the "Menu" may require a password. From the factory the password option is turned on with a factory password of "123". See Chapter 5, Figures 5.6 and 5.7.

After entering the password, if required, the "Main Menu" will appear.

Password may be turned off or edited using the Lab Manager's Password.

There are only 5 choices:

Calibration – For viewing history, doing verification, restoring, and performing an adjustment.

Method Management – From here you may edit, delete, add, rename, and modify existing Methods.

Operational Parameters – Communication Settings and all Instrument Configuration is done within this menu option.

System Information - You may View and/or Print the software and firmware versions, the instrument's serial number and Model number.

Back to Home – As the menu suggests, this option takes you backwards to Main Menu

For customizing a Method we therefore would;

Select/Touch the "Method Management" button.

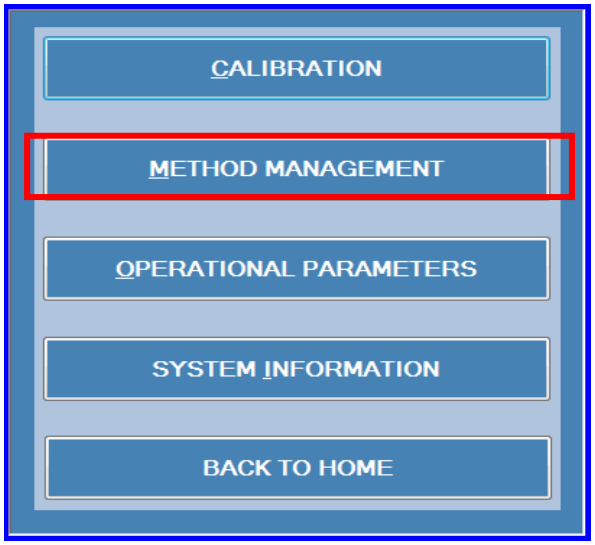


Figure 6.3 Main Menu

Now select/touch to highlight the Method you wish to edit and then select/touch "Edit". You may also add a new method – see Chapter 6.3.

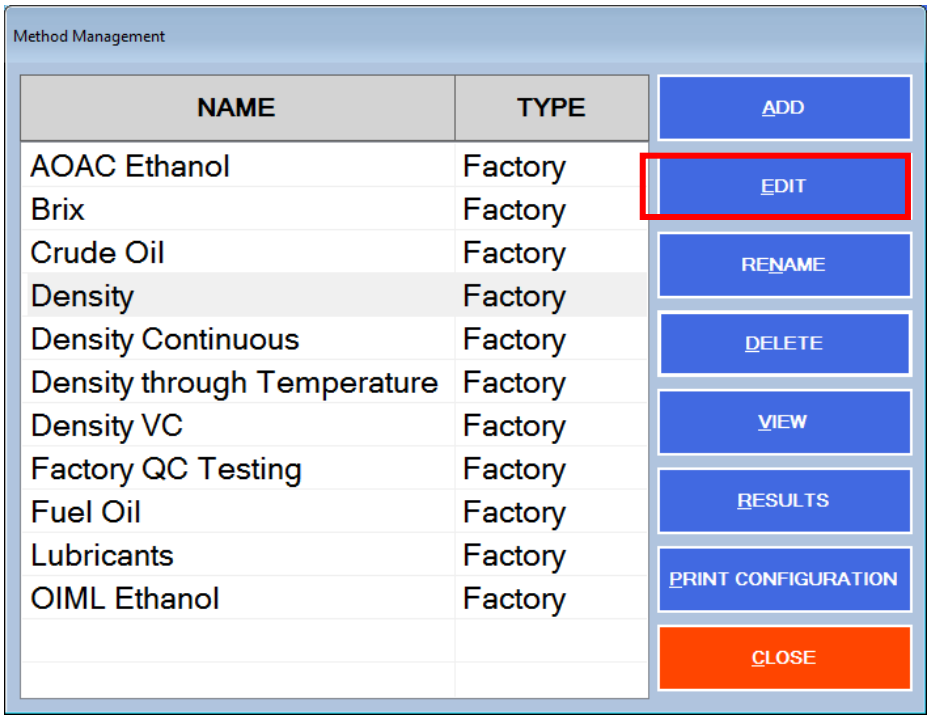


Figure 6.4 Method Management

After Selecting/Touching "Edit", the following Window will appear (except in the case of "Density through Temperature":

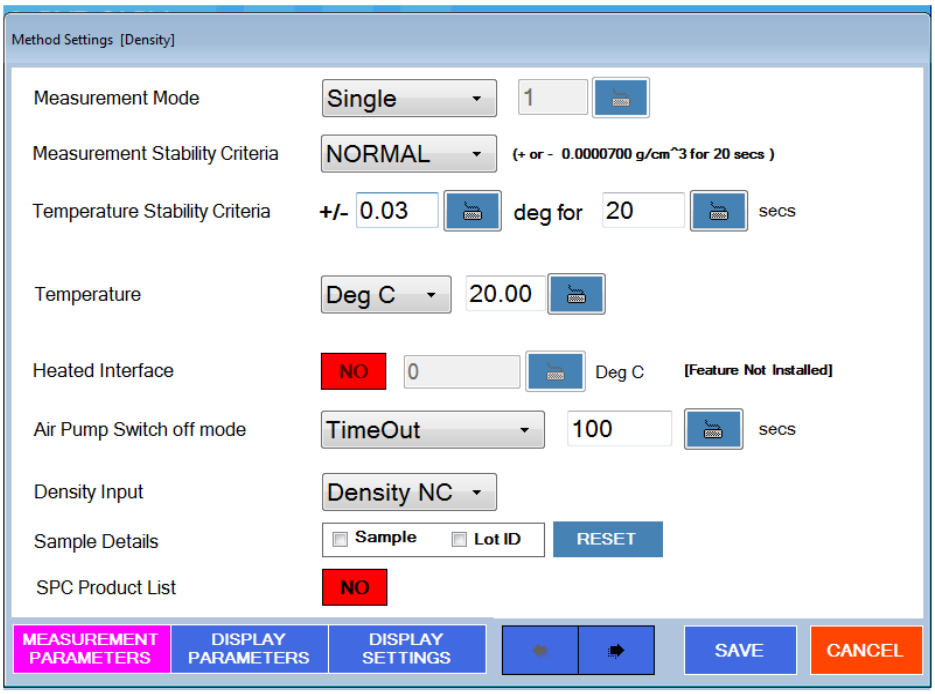


Figure 6.5 Method Settings – Measurement Parameters

An Explanation of all the options within this "Method Management - Measurement Parameters - Edit" window follows:

Measurement Mode – Within this dropdown menu selection there are 2 choices:

1) "*Single*" measure mode is where once all the specified measurement conditions or criteria are reached, a density measurement will be made and the display value(s) are now frozen on the display screen until the next measurement is started by selecting/touching the "Start" button. This measurement mode is the factory default.
2) "*Multiple*" measurements are where the user may specified any number of measurements (N=X) and that number of measurements will be made and full statistical information for these measurements will be displayed.

Measurement Stability Criteria – There are three choices within this dropdown menu that determine when the measurement results are calculated:

1) "Full" will provide the user with the maximum accuracy which means that the measurement results will not be calculated until the measurement stability of the sample has met the criteria as defined to the right of this menu selection.
2) "Normal" is the optimum setting for the use of the density as per its accuracy specifications. Again, as above, defined to the right of this selection.
3) "Rapid" will provide a quicker measurement but with a slight loss of accuracy; accurate now only to the 4th decimal place.

Temperature Stability Criteria – It is possible to define how stable and for how long the temperature is needed to be prior to making a measurement. Default is ±0.03°C.

Temperature – This is the instrument's "Set" temperature; the temperature that which the sample is controlled to for the measurement. It may be set in either ºC or ºF. The factory default is ºC.

Air Pump Switch Off Mode – Here there are 3 choices for the air pump that is used for drying the u-tube after clean with the proper solvent(s):

1) **Auto** – The instrument continuously measures the density as the U-tube is drying. Once the dry is that of dry air the pump with automatically turn itself off. See Figure 6.6 in next page for how to set turn off conditions.
2) **Manual** – Pump is turned both On and Off manually.
3) **Time Out** - The pump will turn itself off after some pre-defined running time. This option ensures that the pump will not be turned on and forgotten and left running for excessively long periods of time. The factory default is Time Out after 100 seconds.

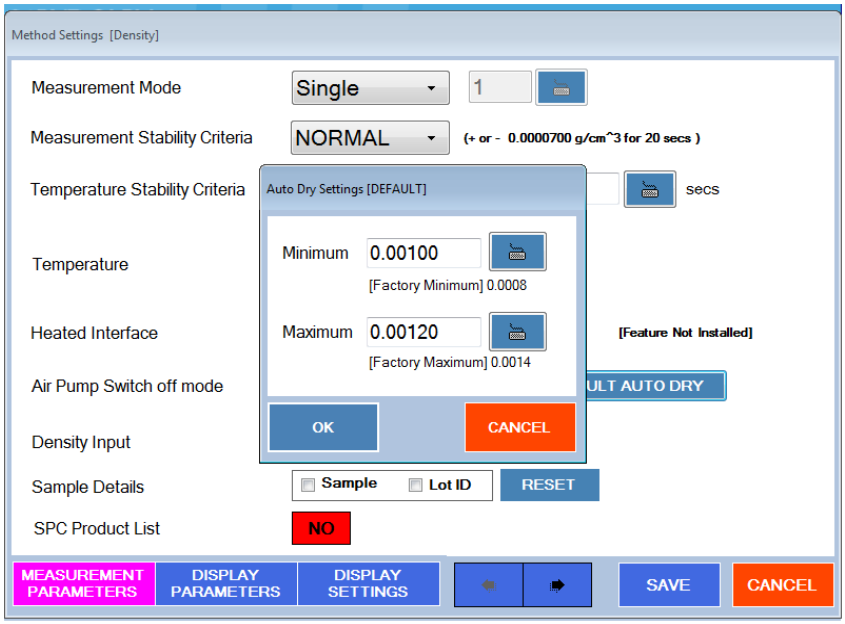


Figure 6.6 Auto Dry Feature

API Input – The density results are needed for subsequent calculations to determine the API Gravity for petroleum applications. This menu option permits the choice of either a density result which was corrected for the viscosity effect or non-viscosity corrected density to be used in this calculation. The factory default is "Density NC".

Sample Details – It is always possible to add Sample ID or Lot ID by means of an external keyboard, virtual keyboard in main screen or barcode reader. However, if the lab normally uses sample IDs it is possible to set the Digital Density Meter to remind you to enter Sample ID and/or Lot ID. If you do not wish to use Sample IDs or Lot IDs, unselect those fields as is set by default.

SPC Product List – Intended for use in Statistical Process Charting of different products. Feature not implemented in current software.

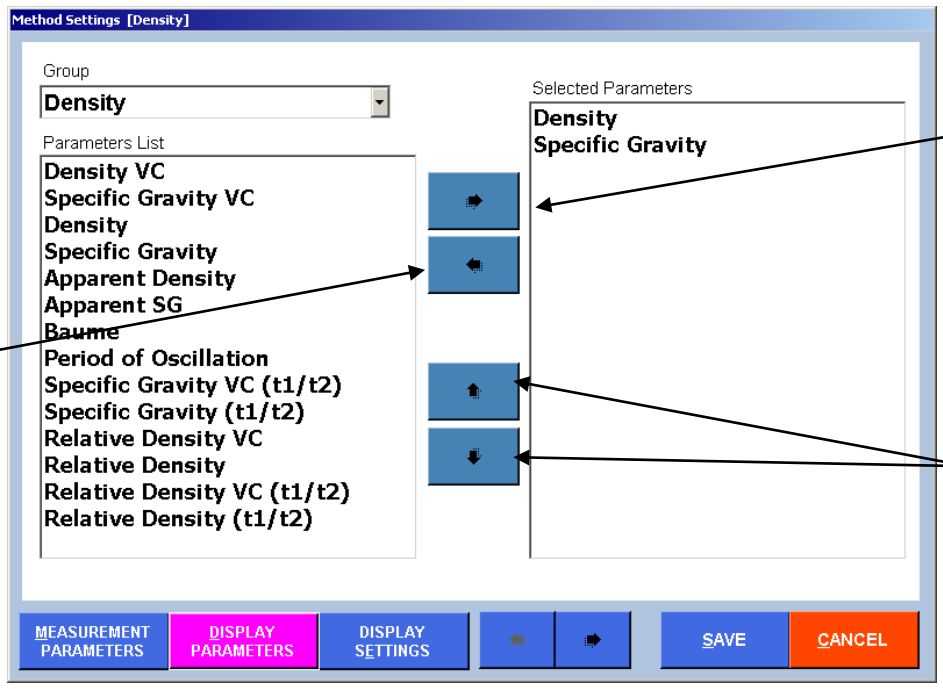
6.2.2 Editing the Display Parameters

After Editing the Measurement Parameters as explained above in Chapter 6.2.1; it is next possible to edit the display to best meet your requirements.

The left side of the main screen allows up to 5 different measurement results to be displayed. The top position on this display is larger and is used for the value of greatest importance to the user. The four lower positions are slightly smaller and are used for calculated results which are not as important to the user. The values displayed in all 5 of these positions are configurable by the user.

From the menu screen in Figure 6.5on page 27, Select/Touch the "Display Parameter" button.

The following window will open:



The ← Key will move an item from the Display Parameters over to the Parameter List

The → Key will move an item from the Parameter List over to the Display Parameters

The ↑↓ Keys will move the position of where a parameter is displayed.

Figure 6.7 Method Settings – Display Parameters

As there are many different parameters that are possible to display, these various parameters have been broken into different "Groups" or categories so that they are easier to locate and manage.

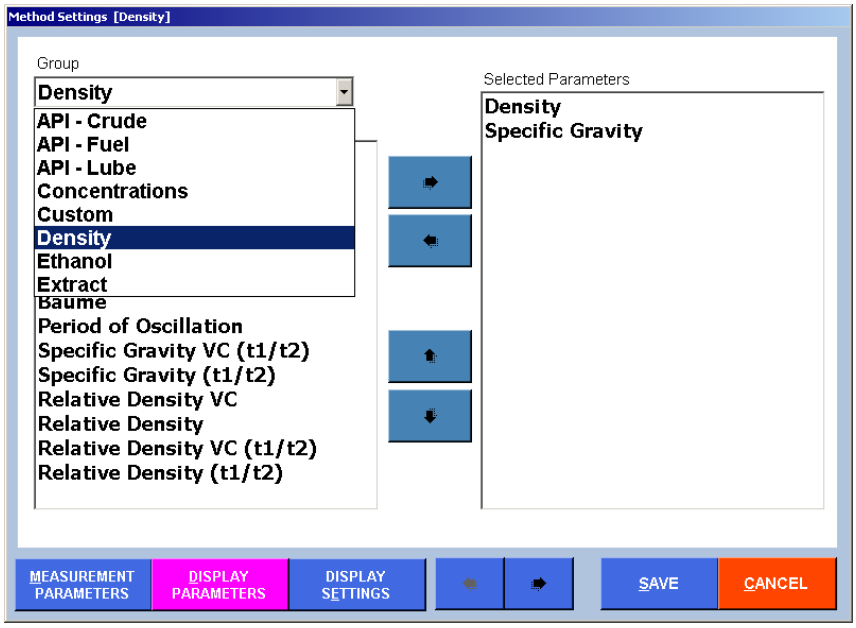


Figure 6.8 Groups for Display

The “Groups” are as follows:

Density –Within this Group List there are 14 difference choices: Density, Specific Gravity, Relative Density, Apparent Density, Apparent Specific Gravity, Baume, and Period of Oscillation. It is possible to select between either correct of viscosity or non-corrected as well as defining the temperature of water in the denominator for Specific Gravities and Relative Density calculations. Also, it is possible for both Specific Gravity and Relative Density to define t1 and t2 per SG^{t1}_{t2}. t1 is always the measurement temperature. t2 is set as per display settings within the Method Management’s Display Settings menu.

API Crude – API Gravity, API Density, and API Specific Gravity each are available at 3 different temperatures: 15ºC, 20ºC, and 60ºF. Nine separate choices.

API Fuel – API Gravity, API Density, and API Specific Gravity each are available at 3 different temperatures: 15ºC, 20ºC, and 60ºF. Nine separate choices.

API Lube – API Gravity, API Density, and API Specific Gravity each are available at 3 different temperatures: 15ºC, 20ºC, and 60ºF. Nine separate choices.

Concentrations – Density is an excellent and easy means for the determination of concentrations of many different chemicals and products. Twenty such density-concentration tables are preloaded in this “Group’s Parameter List”. Examples include: Hydrochloric Acid, Methanol, Sodium Hydroxide, Sulfuric Acid, and many more. It is possible to load additional concentration tables. See Figure 6.9 below.

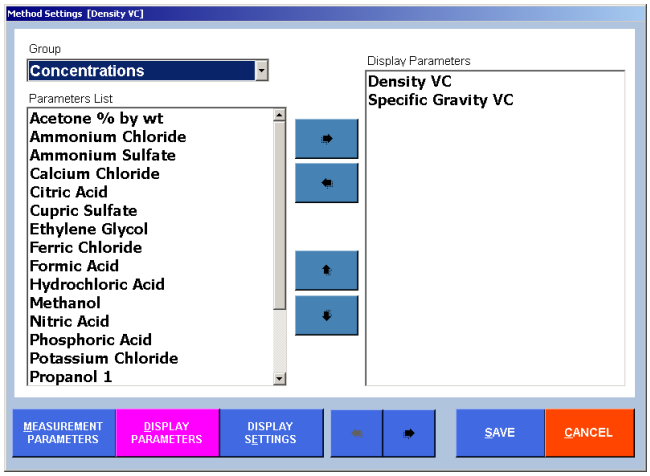


Figure 6.9 Concentrations Group

Ethanol – There are 14 different ethanol tables from which to choose. Units include %vol/vol, % wt/wt, and Proof using the AOAC, OIML, HM Customs, NBS, NTS, and the ABNT methods.

Extract - ˚Brix, Plato and Balling are available within the Group.

The first step in configuring your display is to find the various parameters within each "Group" you wish to display. As these parameters are shown in the "Parameter List", highlight the parameter of interest and then use the → button to move this parameter into the "Selected Parameters" list. Parameters may also be removed for the "Selected Parameters" list by using the ← button. You may select up to 5 different parameters that you wish to display.

Once you have selected and placed within the "Selected Parameters" listing other items you wish to display you may arrange the order in which they are displayed. The order in which the parameters are listed in this menu is the same order in which they will be displayed on the main screen. You may change their positions by highlighting the parameter you wish to move and then use the ↑ or ↓ buttons to move that parameter either up or down in this list.

6.3 Creating/Adding a New "Custom" Method

The K86200 / K86201 is supplied from the factory with 11 pre-loaded Factory Methods which will meet most users' requirements. However, the Digital Density Meter permits the addition of as many new methods as needed. The procedure used to add a new customized method is almost identical to the procedure used above in Chapter 6.2.1 and 6.2.2 to customize an existing method. However, instead of using the "Edit" button, you will use the "Add" button and once you "Save" the new method you just created, you will be asked to give this new method a name. This new method will now appear in the "Methods" list. These steps are outlined below:

1. Go to the main **Menu**
2. Select **Method Management**
3. Then select **ADD**
4. A new window opens; Method Settings [New Method]
5. Set the "**Measurement Parameters**" as desired; that is, Measurement Mode, Measurement Stability Criteria, Temperature, etc.
6. After setting all the **Measurement Parameters** now select at the bottom of the window, **Display Parameters**. A new window will open and you will see on the top left-hand side a drop down menu called "**Group**". All the different items which may be displayed by the density meter are within these Groups. The API Crude Group has a total of 9 different items from which you may select from for display. Another Group, Ethanol, has ten different items from which you may choice to display. Select the Group of

interest and highlight the first item within the Group that you wish to display.

7. Now, with the first display parameters of interest highlighted, press the → arrow to move this parameter over to the right hand column; "Selected Parameters". If there are more items within this Group that you wish to display just repeat the process by highlighting that parameter and again using the → arrow to move this parameter over also. Repeat as desired. Up to 5 different parameters may be displayed simultaneously.
8. You may also, if so desired, use the ↑ arrow or ↓ arrow to move the position of the parameter within the display.
9. Next go to "**Display Setting**s". Here you may select the proper number of decimal places to be displayed as well as the units (if applicable) and upper and lower limits. By default the **Print Parameters** and the **Export Parameters** will be the same as the Displayed Parameters.
10. Once you finish with content within this new method you have just created push **SAVE.**
11. After pushing **SAVE** you will be automatically prompted to give a **Name** to this new Method. You will now see the new Method listed as a Custom Method.

6.4 Adding a Custom Table into the Digital Density Meter

1) Select **Menu**, then **Operational Parameters**, then select **Instrument Settings** and then **Concentration**.

2) After the selection of **Concentration** you will see the following menu choices:

Figure 6.10. Concentration menu

Select **Custom Table Setup**. The following screen will open:

Figure 6.11. Custom table setup

Above is an example of an existing table; SG to g/liter sugar

3) Select **ADD** to input a new table. The following screen will open:

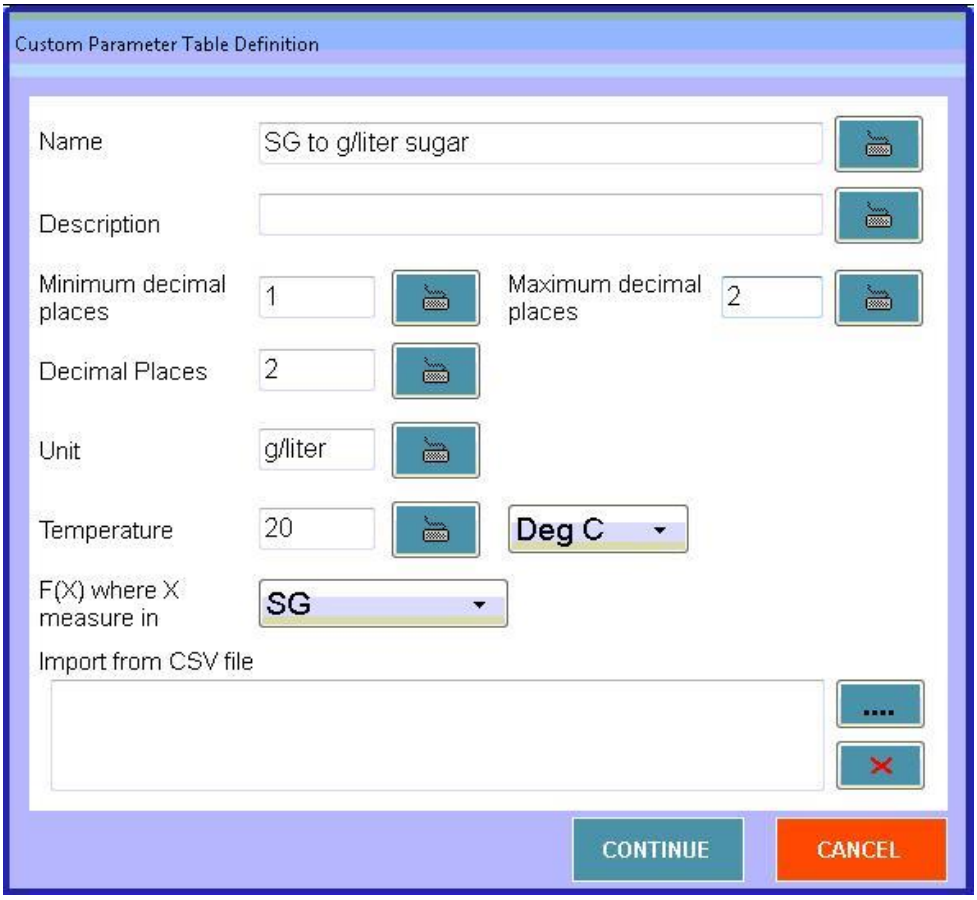


Figure 6.12. Custom Parameter Table Definition

4) Fill out the screen above with a Table name and description if desired. Then set the minimum decimals places possible to set as well as the maximum number of decimals place. You then set how many decimal places is the default. Select the unit and the temperature as well as the temperature units. Select the measured parameter which will be used for the calculation. It is possible also to import a table if you wish. If you do not already have such a table you may create the table as shown in Figure 6.13. When finished select Revoke and Save.

Your New Custom Table has now been created and is available for use within the “Custom” Group found in Method Management.

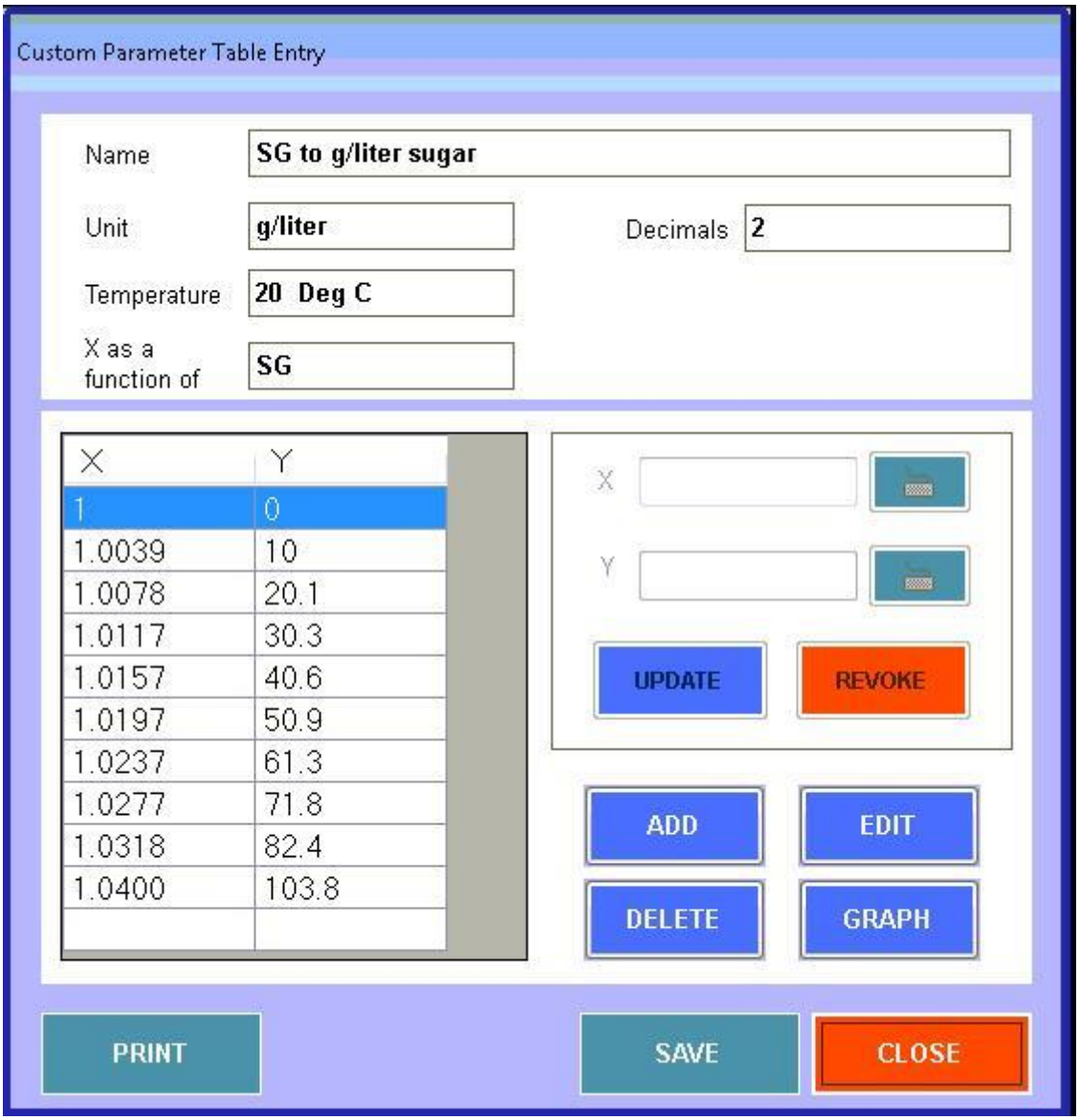


Figure 6.13. Custom Parameter Table Entry

7. Measurements – Manual Injections Using a Syringe

This Chapter only deals with the measurements made in a manual mode using a syringe. Automation is considered separately in Chapter 12.

7.1 Method and Measurement Conditions

Select the desired Method to be used for the measurement using the "**Method**" button on the bottom of the display screen. After pushing this button the list of possible Methods will be shown in Figure 6.2 on page 24.

The measurement conditions, such as, temperature, items displayed, results printed and/or saved, etc. are all defined and set within each Method. See Chapter 6 for complete details for changing and customizing all the various Method settings.

After this selection, the K86200 / K86201 will configure itself to all the proper settings as defined by that Method.

7.2 Manual Measurement Using a Syringe

Check to be sure that the glass sample U-tube and the filling nozzles are empty, clean and dry. You may use the VideoView™ for visual confirmation, but it is also useful to look at the density value measured for this empty U-tube. If the U-tube is completely empty, clean, and dry the measurement value should be that of air. The measured value for clean, dry air is normally 0.0012 g/cm³ at 20.00 ºC and 25.00 ºC. Slight variations of one or two counts in the forth decimal place are possible due to changes in barometric pressure and/or relative humidity. However, if the air density is seen to be greater than 0.0013 g/cm³, (or whatever value prior experience has shown), please clean and dry the U-tube prior to continuing with this measurement. See Chapter 8 for complete details for proper cleaning and drying of the sample U-tube.

The wetted materials during a sample measurement are the borosilicate glass U-tube, and the filling nozzles assemble (Teflon-PTFE and Halar-ECTFE), the polypropylene hose barbed adapter, and the connecting Silicone tubing which leads to the waste container. Please be sure that the sample materials being measured and the solvents used in cleaning and drying of the U-tube after a measurement are compatible with these materials.

Sample ID and/or Sample Lot numbers may be optionally entered at this time. Use the “Sample ID” and/or the “Lot ID” buttons on the main screen. Once pushed, a keyboard will appear as below.

Figure 7.1 Touch Panel Keyboard

Carefully fill a syringe with the sample to be measured. Inject the sample carefully into the front filling nozzle. The back nozzle uses a drain line that leads the used sample and rinse solutions into a waste container.

While filling the sample with the syringe, it is very important to use the VideoView™ feature to ensure that no bubbles are present in the sample. Bubbles, even very small ones can cause measurable errors. Push the Video Button and watch as you are filling the glass U-tube. If you see a bubble go into the glass cell, continue push in more sample until you see that same bubble leave the cell. Leave the syringe in place to avoid leakage or siphoning of the sample back out of the U-tube.

The K86200 / K86201 has 3 different modes for making a measurement. Two of these modes, **Single** measurement and **Multiple** measurement are available within most all Methods. The third mode, **Continuous** measurement has a method all its own.

After the sample has been successfully injected into the U-tube without any bubbles, push the “Start” button to start the measurement process.

After the measurement has been made and the results obtained, clean and dry the U-tube with suitable solvents. Often this cleaning requires two different solvent rinses. The first rinse is a solvent in which the sample itself is soluble. Push this rinse 1 solvent through the K86200 / K86201’s U-tube using either a syringe or a rinse solvent bottle. Rinse #2 is often used as a solvent which will

push out and replace any residue of rinse #1 and also dries completely and quickly. Acetone is often used as rinse #2 for this purpose. Use the built-in air pump for drying out this solvent. In the “Method Management”, “Measurement Parameters” menu it is possible to set the air pump to turn itself off automatically in a predetermined amount of time. Normally, 1 to 2 minutes of drying time is adequate for the drying of acetone. If an alcohol is used as the drying solvent rinse #2, then it may be necessary to increase the drying time to 2 to 3 minutes.
After the K86200 / K86201 is clean and dry it is now possible and recommended to make a measurement on air to see if this cleaning and drying was done properly. If the Measurement Mode is set to either Single of Multiple, the air density measurement can be started after the cleaning and drying process by pushing the Start button. If the density meter is in the Continuous Mode, this air density will happen automatically. When the U-tube is completely clean and dry, the empty U-tube, filled only with air will return to 0.0012 g/cm³ if set at 20 ºC (or whatever the air density was prior to the sample measurement).

7.3 Generalized Standard Operating Procedure (SOP) for Manual Syringe Injection

The following is a generalized or generic SOP. It will not be suitable for all applications but is included here as a help in developing your own SOP for your particular one.

1) Begin with a clean, dry U-tube. Note the air’s density. Normally this should be 0.0012 g/cm^3 at ambient conditions; ±0.0001 g/cm^3.
2) Carefully fill a Luer tip syringe (most often 2 to 5 ml in size) with a representative sample. Try to fill the syringe without any bubbles. If bubbles are present hold the syringe with the Luer tip upright and allow the bubble(s) to float to the top and then push them out using the plunger.
3) Open VideoView™ and watch the sample enter the u-tube. Watch for bubbles entering the system.
4) After you make sure that sample has been completely injected and without any bubbles; hit the green Start button. Leave the syringe in place; do not remove at this time from the nozzle inlet.
5) The green Start will become a Red Stop button which can be used to abort the measurement if necessary.
6) The K86200 / K86201 will bring the sample to the required measurement temperature. This may take 30 seconds to 1 minute for complete thermal equilibration.
7) Once the measurement is complete the displayed values will be shown as below:

Figure 7.2. Main Screen showing results

8) The measurement results may be printed, exported, and/or saved locally. See Chapter 10 for more details of these various options.
9) With the syringe still in place, pull back off the plunger thereby pulling much of the sample back into the syringe and out of the U-tube. Discard the disposable syringe. If you are using a glass reusable syringe it will require complete cleaning and drying prior to reuse.
10) Rinse Solvent #1 is now used. Select the solvent which is best for dissolving the sample. This rinse may be pushed through the U-tube by use of another syringe or by using a wash bottle.
11) Follow Rinse #1 with Rinse #2; a solvent which will dry quickly and completely, this could be acetone or alcohol for example.
12) After cleaning with the two rinse solvents connect the drying hose in the inlet nozzle and turn on the air pump. By default this air pump will run for 100 seconds.
13) After the drying is complete, push Start again to measure the air's density. If the U-tube is clean and dry the air density will return to the same value as noted in step #1 above.

7.4 Measurement Result Management

There is great flexibility and many options available to the user for the management, printing, saving and exporting of measurement results.

7.4.1 Printing

Mostly any printer may be used to printout the results. The printer may be connected directly to the K86200 / K86201 via a USB cable or any Networked printer.

Sample results may be printed out as required with the use of the "**Print**" Button or if the Method is so configured; printing will be automatic after each measurement is made.

Windows 7 Embedded supports over two hundred different commonly used printers. This includes printers manufactured by Hewlett Packard, Epson and Lexmark. These printers are all plug-n-play. The software will, within a minute or two, recognize the printer which will then appear within your Devices and Printers in the Windows Control Panel. See Appendix D for a list of printers supported by Windows 7.

You may access the Windows Control Panel as follows:
Press **Menu > Operational Parameters > Instrument Configuration > DDM Control > Windows Control Panel**
If you double click on "Devices and Printers" the following screen will appear:

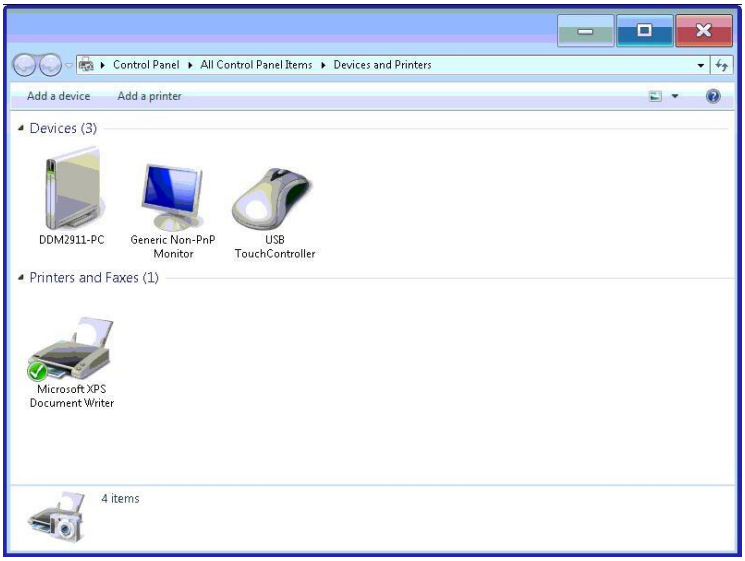


Figure 7.3. Printers and Faxes in Windows Control Panel

However, if required, other drivers may be installed just as would be done with any PC. Much more detailed information is provided in Chapter 10 for loading printer drivers.

The selection of what measured parameters are within Method Management. That is, go to: **Menu > Method Management** (See Figure 6.4 on page 27)

Then highlight the Method where you wish to define what measured parameters are printed. Then select "**Edit**". The menu will now open as shown in Figure 6.5.

If you now select the ⟶ button you will see the parameters which have been set by default to print in Print Parameters Tab. However, it is possible to select or deselect what measured parameters will be printed. By default, the same parameters which are on the main screen's display are set to be printed.

The same holds true for Exported measured parameters.

Besides selecting which printer you wish to use it is also possible to set when the results will be printed and if you desire to add your companies' logo onto the printout. See Figures 7.4 and 7.5.

Go to: **Menu > Operational Parameters > Communication Settings**. The following submenu will open:

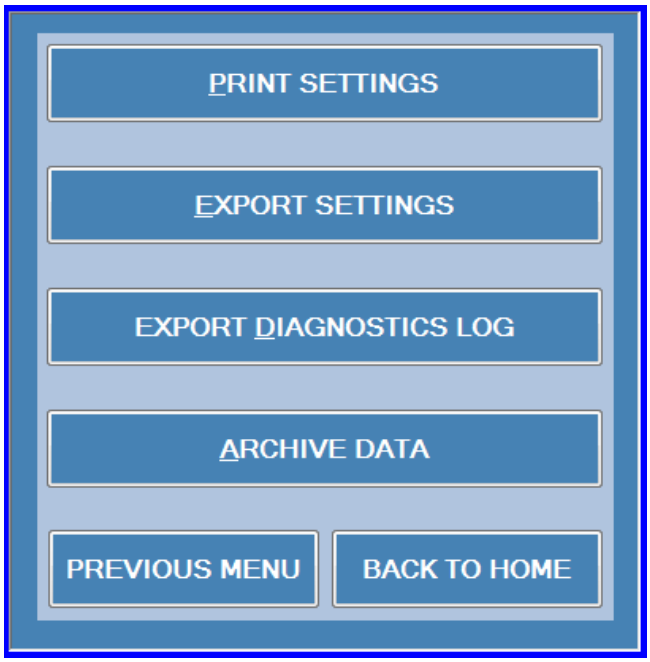


Figure 7.4. Communication Settings Menu

This submenu allows your access into both Print Settings and Export Settings as discussed in the next section 7.4.2.

Select "Print Settings" and the following menu opens as shown in Figure 7.5…..

Figure 7.5. Print settings

7.4.2 Exporting

The selection of what measured parameters are exported is done exactly the same as the selection of printed parameters as explained above in section 7.4.1.

To further define the items exported you must use the “Export Settings” submenu as in figure 7.4 above.

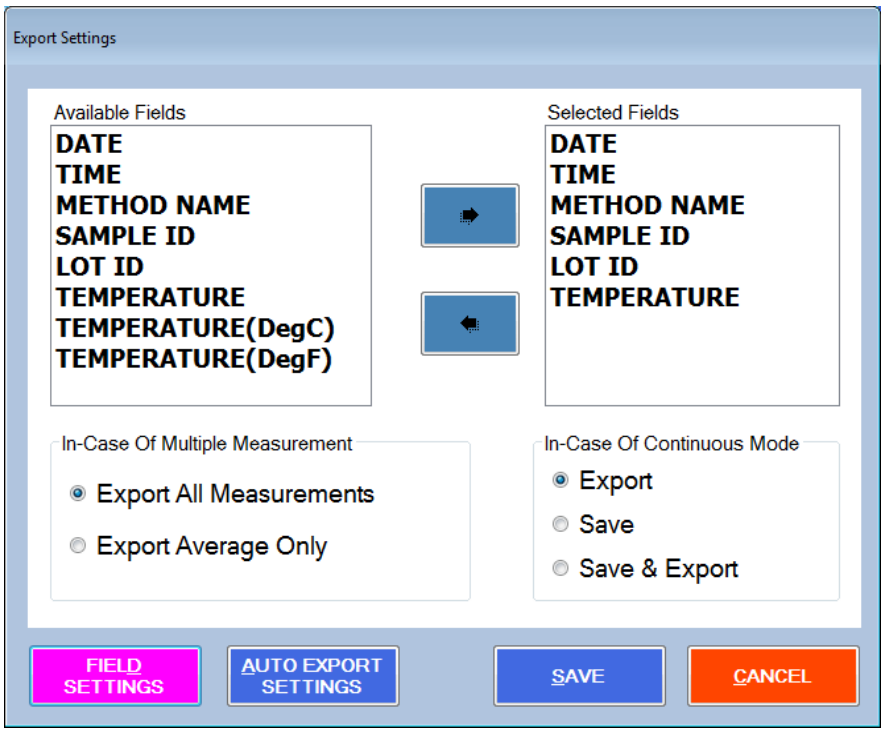


Figure 7.6. Export Settings

From the screen shown in Figure 7.6 it is possible to define where to export the data and what file name should be used. To do so, select the Blue Button, “AUTO EXPORT SETTINGS”. When you do so, the following menu screen will appear:

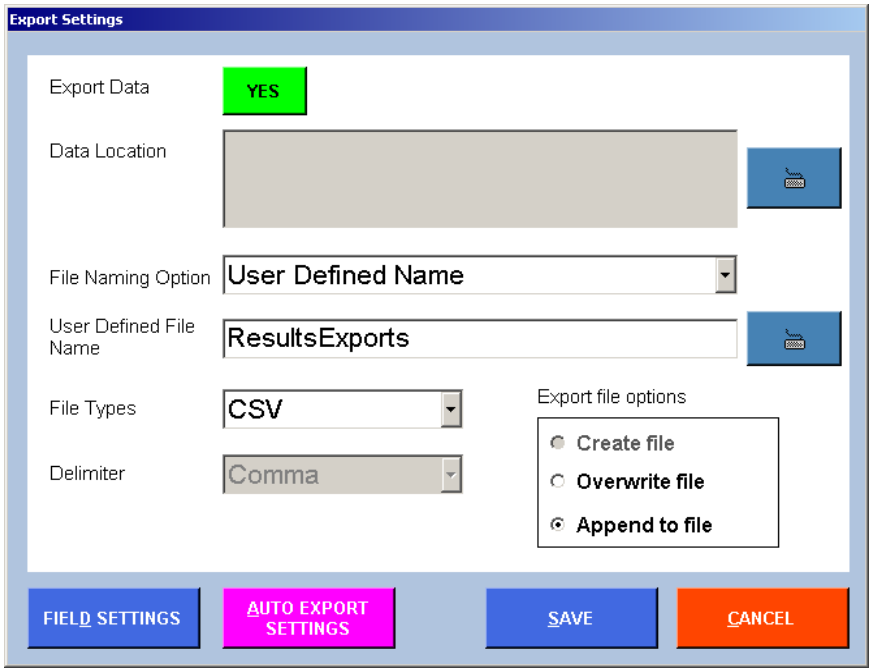


Figure 7.7. Auto export settings

Select “Data Location” in Figure 7.7 and the menu as in Figure 7.8 will open…..

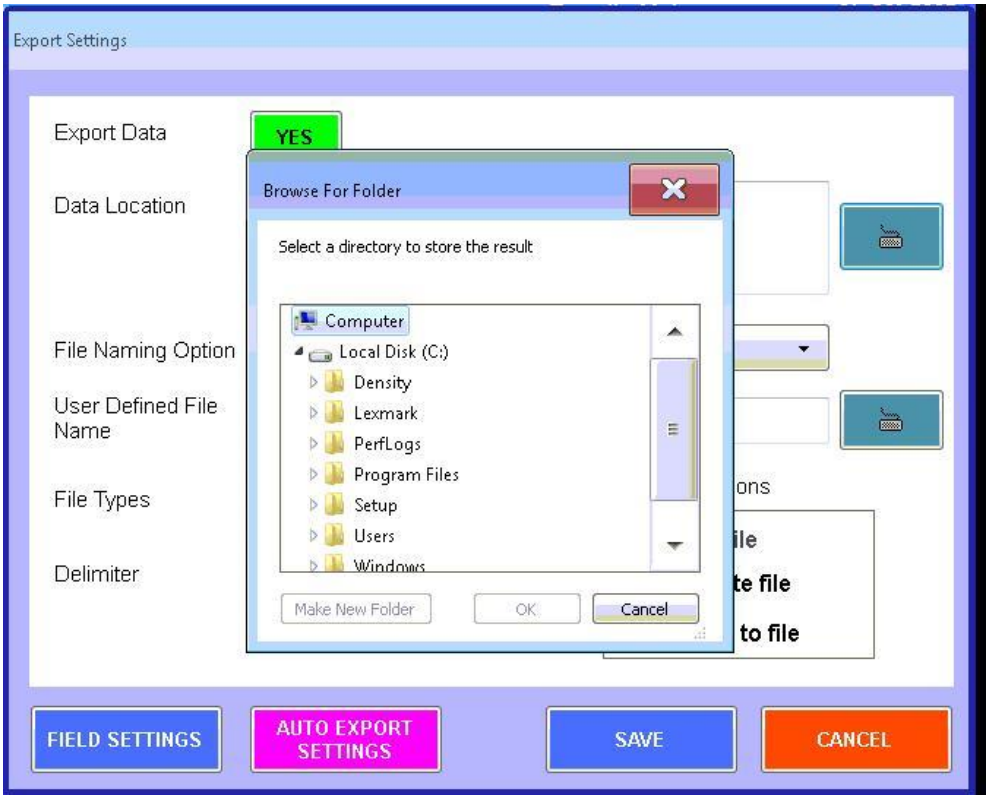


Figure 7.8. Exporting data to a desired location

Data may be saved/exported to any desired location, this is, a second PC, a server, etc. Just define the path. Notice in Figure 7.8 that a "Removable Disk (D:)" if shown. If a flash Drive (thumb drive) is inserted into one of the USB ports the K86200 / K86201 will recognize this USB device and offer it as an option for export location.

7.4.3 Saving Results

Measurement Results are automatically saved locally.

To review these saved results select:
Menu > Method Management. Then, Highlight the Method and press Results
By default the result for today's date are immediately available; however, any date range may be selected.

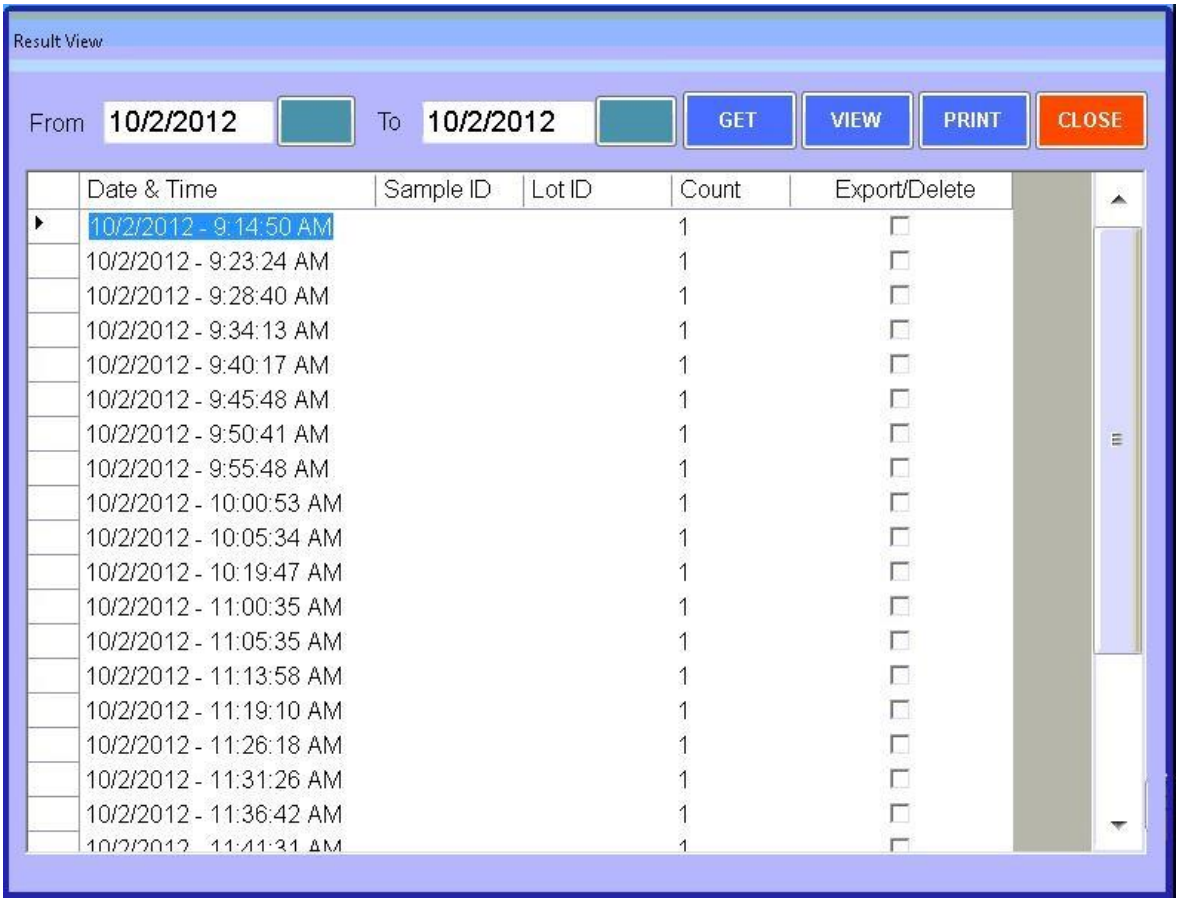


Figure 7.9. Previous stored results

7.5 Making Manual Measurements on Difficult Samples

7.5.1 Waxes -Using the Heated Interface for Viscous and Solid Samples

The normal procedure when using the digital density meter is to inject the sample into the U-tube with a syringe. However, with highly viscous samples and those samples which are solid at room temperature (waxes, chocolates, crude oils) this may not be the best method. Such samples can solidify in the syringe and/or that of the exit tube and will "pop off" due to the pressures required to push the sample out once measurement is completed.

The key to making measurements on these types of samples is to reverse the normal filling procedure by pulling back on the syringe's plunger and pulling the sample through rather than pushing the sample through. Keeping the sample hot during this procedure using a hot plate is also beneficial.

The Heated Interface has just recently been redesigned. The photos shown in Figures 7.12 to 7.15 are of the older original design. Never-the-less, the procedure as to how to make the measurements are the same.

The newly designed Heated Interface, if supplied with your new DDM density meter, will look like the following:

Figure 7.10 Heated Interface

The following pictures illustrate the procedure with the older style system:

Figure 7.11 Items to be used for viscous and solid samples
(For the new system, the two plastic hose barbed male Luer adaptors are not used)

You may want to use a large 5 to 10 ml syringe and a short piece of cheap tubing which may become plugged with sample and you can throw away. The plastic hose barbed male Luer adapter could be replaced by the same but made of stainless steel to conduct the heat from the Heated Interface and thereby avoid becoming plugged.

Figure 7.12Sample is Hot. Notice the syringe; it is to be used to pull the sample into the density meter rather than being pushed

Figure 7.13Another view of the same as in Figure 7.12

Figure 7.14Here the syringe's plunger has been drawn back and the molten sample pulled up into the tubing and into the U-tube. The molten sample will harden inside the cheap tubing which is thrown away.

Figure 7.15Now rinse as normal with a suitable solvent.

7.5.2 Suspensions

Some times when non dissolved particles are dispersed in a liquid; the resulting suspensions may cause difficulties in getting accurate and repeatable measurements. And worse, sometimes these measurements are not possible at all.

Suspensions have a general tendency to settle to the bottom of the container in which they reside. The speed or the rate of this settling effect is what determines how difficult this type of measurement may be. If you are to stir a suspension in a glass beaker and that suspension settles to the bottom of the beaker within 1 or 2 minutes, this sample will be problematic. However, if the suspended particles remain floating for several minutes, there is a much greater opportunity to make accurate and repeatable density measurements.

Three suggested methods to improve a suspension's measurability:

1) It is often easy to just pre-thermostat the sample in a temperature controlled water bath. If making the measurement at 20˚C, bringing the sample to 20˚C prior to introducing the sample into the density meter will speed up the measurement time. Thereby giving the sample less time to settle within the glass U-tube.

2) It is also possible to use the force of gravity to our benefit. As the U-tube is oscillating the centrifugal force created by this oscillation causes the particles to flow to the end of the glass tube and be collected in the U. However, this centrifugal force can be negated by raising one end of the density meter slightly off the lab bench as shown in Figure 7.16. In this way, gravity is forcing the particles downward towards the syringe as the centrifugal force is pushing in the other direction. This provides extra time for the measurement to be completed.

3) Another suggestion is to make the measurement as fast as possible; before the suspension has time to migrate and/or settle. To do so, place the Measurement Stability criteria to RAPID.

Figure 7.16. Alternative when working with suspensions

8. Cleaning and Drying the Sample U-tube

8.1. Routine Cleaning in-between samples

In general, it is best to rinse, clean, and dry the U-tube after each and every measurement. This process is best done with two different rinsing solvents. The first rinse is selected as the best solvent for the sample material. If the sample is an aqueous solution, then water is often the best choice as rinse #1. Then this rinse #1, water could next be cleaned out best with the rinse #2 which could be some solvent, like acetone, which dries quickly. The rinsing with solvents may be done using either a syringe or using solvent rinse bottles.

The chemistry of the sample determines the selection of the rinse solvent. A general rule of thumb is polar dissolves polar and non-polar dissolves non-polar. The end user must be responsible for appropriate selection of these rinse solvents. Special hazards of your samples may be only known to user. For example, you would not wish to rinse out concentrated sulfuric acid using water due to the resulting violent exothermic reaction that could cause splattering of sulfuric acid and possible exploding and **damage to the glass U-tube**. Always have an understanding of the chemistry of the samples being measured.

The general steps to proper cleaning and drying are as follows:

1. Using a well selected rinse solvent #1, push out the sample to the waste container and wash the U-tube using this solvent. Either a Luer tip syringe or a solvent rinse bottle may be used but the advantage to a syringe is it is possible to push and pull the solvent back and forth using it. Pulling back and forth on the plunger of the syringe with the solvent does a very good job at “scrubbing” of the U-tube and uses less solvent than the same cleaning done with a solvent wash bottle. It may be necessary to repeat this rinsing with a second syringe full of rinse solvent #1.
2. If Rinse Solvent #1 is not a solvent which dries quickly or dries without residues, then rinse it out with solvent that does dry quickly and without residues. Often reagent grade acetone or an alcohol is used in this step. If both solvents are available, acetone is preferred as it dries quicker than all alcohols.
3. The K86200 / K86201 has a built-in drying air pump. Use this pump to push out Rinse Solvent #2 and to completely dry the U-tube. It has available the option of a timer which will automatically turn it off after a set predetermined amount of time. See Chapter 6.2.1 under the heading, “Air Pump Switch Mode”. Normally 2-3 minutes of drying time is sufficient.
4. Once the U-tube is completely dry, it is possible to confirm complete cleaning and drying by making a measurement of air. If the U-tube is completely clean and dry, the measurement results should be that of clean dry air. For complete data on what the density should be for clean, dry air see Appendix D. In most cases, at 20º C and at one atmosphere, the density of air should be 0.0012 g/cm^3. If the air measurement results are more than one or two counts high in the 4th decimal place, there is

good reason to believe that the cleaning and/or drying process was not adequate. It would be suggested to clean and dry the U-tube again.

TIPS:

- If the Rinse Solvent #1 is a solvent which both dissolves the sample and also dries quickly, this is the only solvent required.
- In additional to the use of a Luer tip syringe for his cleaning as described above, the same cleaning may be accomplished by use of a peristaltic pump or gravity fed system.
- Be sure there is no chemical reaction between the sample and Rinse Solvent #1
- Be sure there is no chemical reaction between Rinse Solvent #1 and Rinse #2
- Do not use Alcohols as a rinse solvent for samples which contain sugars or proteins.
- In general, it is best to rinse, clean, and dry the U-tube after each and every measurement. The exception to this rule would be when the next sample is almost identical to the last sample. In this special case, the next sample acts to wash out the previous sample. This sample replacement mode of operating works well when filling the U-tube using a peristaltic pump or using the gravity fill method with a funnel. In these cases, there are copious amounts of sample available to wash out the previous sample thereby ensuring that little or no cross contamination between samples occur.

8.2 Cleaning and Drying Prior to an Adjustment and/or Calibration

All subsequent measurements are only as good as the last calibration adjustment done to the density meter. Therefore it is absolutely essential that every effort is made to ensure the best calibration-adjustment as possible. This begins with the best possible cleaning and drying of the U-tube.

A good practice in cleaning and drying prior to a calibration/adjustment is to double or even triple the amount of time and solvents used in normal daily operation. In other words, normal cleaning may consists of using about 10 ml of Rinse Solvent #1 followed by 10ml of Rinse Solvent #2 followed by 100 seconds of drying time. For the cleaning prior to a calibration/adjustment double or triple all of those values; use 20 to 30 ml of each solvent and set the drying time to 200 to 300 seconds or more.

8.3 Special Problem Cleaning Methods

If care is taken to clean the K86200 / K86201's U-tube after each sample measurements and if the proper rinse solvents are used, there should never be any problems with cleaning the U-tube. However, problems can happen if 1) a sample is forgotten about and left remaining inside the U-tube for a long period of time or 2) a sample is put in the U-tube and the proper solvent is not used or 3) the sample may be cleaned after a measurement but is not cleaned completely and over time a gradual build up of residue occurs.

Never stick pipe cleaners or paper clips or any other sharpened object down inside of the U-tube in an effort to clean the ID of the glass tube. These items will break the glass and require expensive factory repair.

Instead, use one of the following 4 methods for problem cleaning:

Room Temperature Soaking

Often, just allowing the Rinse Solvent #1 soak inside of the U-tube for 5 to 10 minutes will clean the U-tube. You may also try using a mild soap detergent. And, there are many commercially available cleaning solutions made for cleaning laboratory glassware. Most require diluting with water. And most work very well at room temperature. Never leave the cleaning solution inside the U-tube for periods of time longer than required. In addition to soaking, many times scrubbing with the cleaning solution is helpful pull back and forth on the plunger of the syringe which contains the cleaning solution for a scrubbing effect.

Melting the Residue

It is often possible to just increase the temperature of the K86200 / K86201 and melt whatever residue is inside of the U-tube. This works best for difficult to clean samples which are very viscous or for samples like wax that have solidified inside the U-tube.

Hot Cleaning: Scrub and/or Soak

Warm or hot mild soapy water cleans much faster and better than cold soapy water. You could use a syringe and inject this hot soapy water into the U-tube pull back and forth on the plunger of the syringe to “scrub” the residue away. Also you may increase the temperature of the K86200 / K86201 and let the soapy solution soak inside the U-tube for some period of time.

However, never use any hot or warm solutions which could cause damage to the glass U-tube. Warm or hot caustics can etch and subsequently damage the glass. The same is true for some of the commercially available cleaning solutions. Read the directions on the label and use good common sense.

The best general practice to follow when trying to solve a cleaning problem is to always use the least aggressive method(s) first. In other words try cleaning at room temperature before cleaning at an elevated temperature. Also, use the lowest possible concentration (most dilute) of cleaning solution before trying a slightly more concentrated solution.
When in doubt about cleaning, please contact your Koehler Instrument Company representative.

If none of the chemical methods above clean well; try the following:

Mechanical Method of Cleaning:
If the above chemical cleaning does not work you can use a mechanical method.

Please don't use pipe cleaners or put anything inside the U-tube as it may result in a broken glass U-tube and very expensive factory repair. Besides, even if a pipe cleaner can clean away stubborn dirt on the straight legs of the U-tube there is no way to clean the bend of the U-tube

Use NaCl, that is, normal table salt found in the lunch room.

First grab a 3ml to 5ml luer syringe. Pull the plunger all the way out. Cap the luer tip off with your finger or some other capping device to keep the salt from not pouring back out. Fill the syringe about half way with this solid salt. Then with the luer tip still capped, add a few drops of water. Shake. Maybe add another drop or two of water. Shake again. What you are trying to make is a salt paste; you don't want the salt to all dissolve into solution. Now put the plunger back into the syringe.

Next be patience. You are going to start pumping the plunger of the syringe back and forth into the nozzle inlet of the density meter. This is going to take several minutes to get the salt slurry into the glass U-tube. But it will go in; it just takes a little time; keep pumping back and forth. As the salt slurry gets into the U-tube it is abrasive enough to clean the glass tube but it will not harm the glass. After working this for several minutes take a good look at the U-tube. Does it look 100% better? If so just rinse the salt out with water.

9. Calibration; Checking and Adjusting

9.1 Definitions

Calibration Check or Calibration Verification: It is the resulting procedure when a density measurement is compared to a known density standard. The K86200 / K86201 is supplied from the factory with one density standard. Either this or some other standard is possible to use. Whenever a measurement is made and then this resulting value is compared to a known or published value, this process is considered a Calibration Check or Verification. This procedure does not change the density reading, it is only a confirmation of the performance of the density meter. At least one density standard is required for a Calibration Check.

Calibration Adjustment: This is a procedure that is done which affects the resulting readings of the density meter. That is, if a Calibration Check proves that the density meter's results are incorrect, an Adjustment will bring the density meter back into specifications so that it will measure within the required or specified accuracy. Calibration adjustments may be done with two or three density standards (normally air, water, and a third standard with a density representative of the user's samples). A two point calibration adjustment using air and water is best for most applications.

9.2 Calibration Checks – Verification

The frequency of the Calibration Checks is done as required by the Quality Management or as outlined in your SOP. Some users may select to do informal calibration checks with pure distilled water (non-traceable) as often as several times a day. Then it could be selected to formalize and record the results as frequently as once a week to maybe infrequently as once a year using a traceable known density standard.

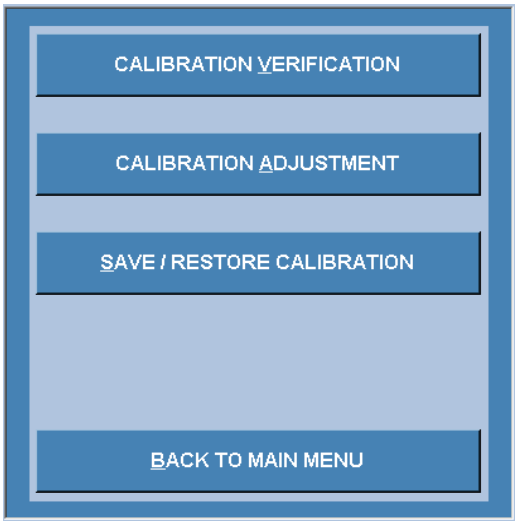


Figure 9.1. Calibration menu

When entering the Calibration Verification Menu, you may be asked to supply a password. The Factory default password is 519. Password protection may be turned off or edited. See the Lab Manager's Password.

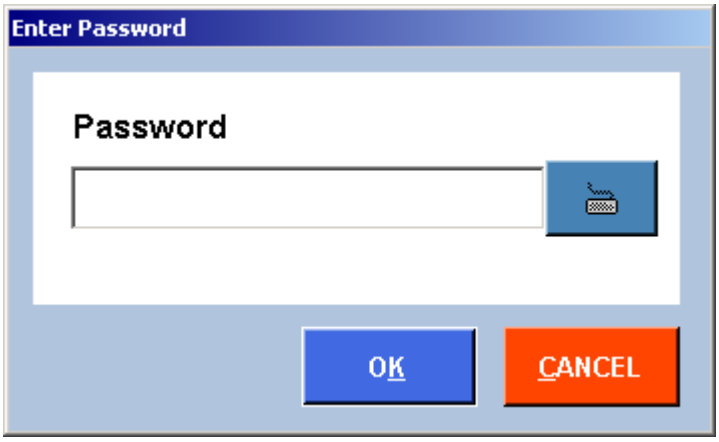


Figure 9.2 Calibration Verification Password

Once the proper password has been entered and "OK" is selected/touched the following screen will open.

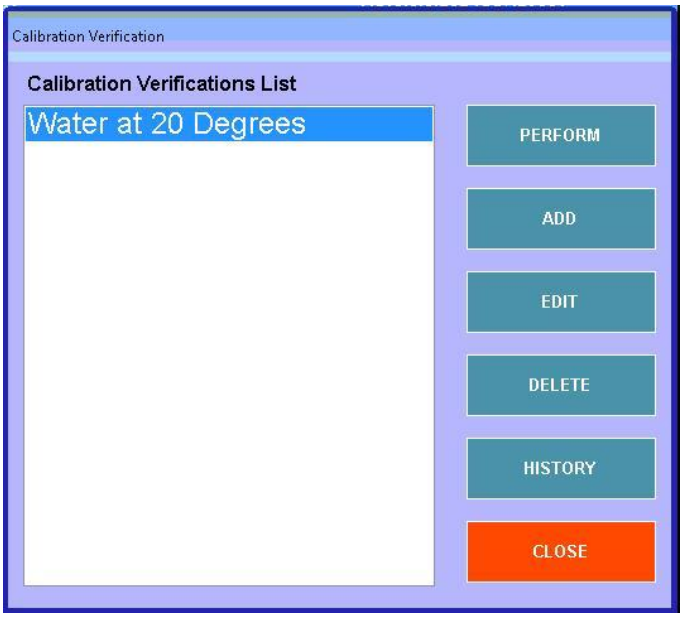


Figure 9.3 Calibration Verification Menu

HINT

Only one Calibration Verification method is pre-loaded by the Factory. By selecting "Add", other standards and temperatures are possible. This list of Calibration Verifications may grow as large as required.

After selecting the desired Calibration Verification Method, the measurement is done as is any other measurement. These results are automatically saved within the K86200 / K86201's internal memory as well as in any external path defined by that method. These results cannot be either deleted or changed.

Be sure to follow the Cleaning and Drying Instructions as outlined in Chapter 8.2 prior to any Calibration.

The digital density meters have a feature whereby a single calibration adjustment done at 20°C will permit accurate measurements at all temperatures. It is possible to do a calibration adjustment at other temperatures, but by doing so the feature of making accurate measurement at other temperatures will no longer be effective.

9.3 Two Point Calibration Adjustment

If the K86200 / K86201 has shown that it is making measurements correctly and within the limits of uncertainty of measure (combined uncertainties of both the digital density meter and the density standards itself) a Calibration Adjustment cannot make the instrument more accurate. In other words, you cannot fix something which is not broken. Therefore it is best to perform an Adjustment only when necessary to correct the K86200 / K86201's measurement results when they are not correct as shown by a Calibration Verification. If the K86200 / K86201 has failed a Calibration Verification it is recommended that the U-tube be again cleaned and dried carefully as outlined in Chapter 8 and the Calibration Verification is done a second time. If then it fails this verification it is safe to perform the Calibration Adjustment.

Be sure to follow the Cleaning and Drying Instructions as outline in Chapter 8.2

Select the Air/Water Calibration Adjustment, hit on "Perform"and follow the command prompts.

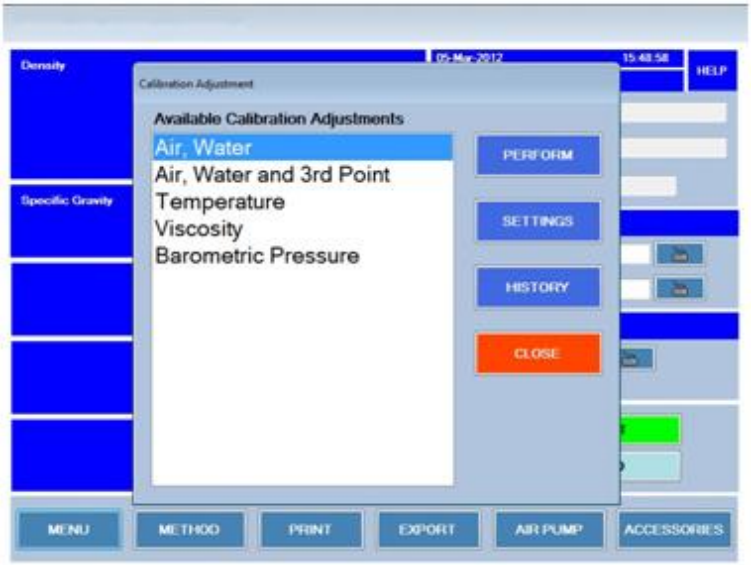


Figure 9.4 Calibration Adjustment Menu

If necessary, you may change the Calibration adjustment settings before performing a procedure by pressing “SETTINGS”on Figure 9.4. You will see instantly a new window as show in Figure 9.5

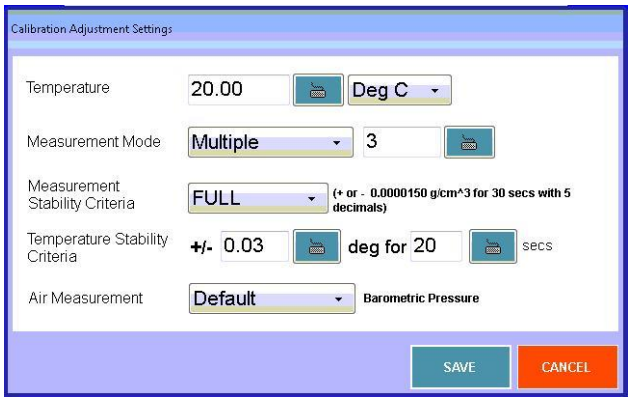


Figure 9.5. Calibration adjustment settings

From this menu it is possible to define how you wish to do the two point air and water calibration adjustment.

Koehler Instrument Company recommends using 20°C as the calibration adjustment temperature as by doing so it is then possible to make accurate measurements at any other temperature.

While it is possible to do a calibration adjustment at temperatures other than 20°C, the DDM density meter will no longer be accurate at all other temperature; it will only be accurate at the other calibrated temperatures.

For the air measurement, you may select a Default Barometric Pressure value or use the Internal Barometer to correct the air’s density.

During the air calibration, when prompted, enter the average of typical barometric pressure for the area in which the K86200 / K86201 is located. For sea level that value is 1013 mbar. For locations which are 1,000 ft above sea level that value is about 976 mbar, 2,000 ft above sea level it is about 942 mbar, and at 4,000 ft above sea level it is about 875 mbar.

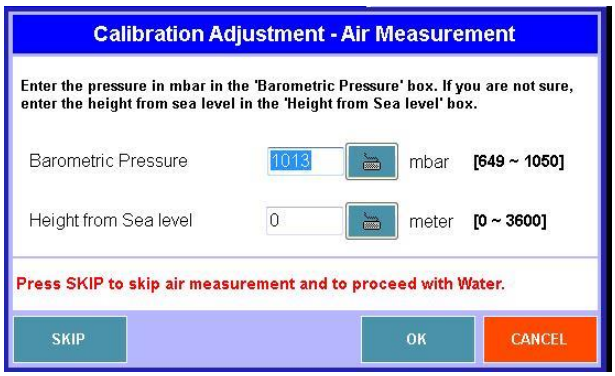


Figure 9.6.Calibration adjustment. Air measurement

At this point you may either skip the air calibration or complete it. Once is done, you will have the option to water calibrate the instrument as shown in Figure 9.7

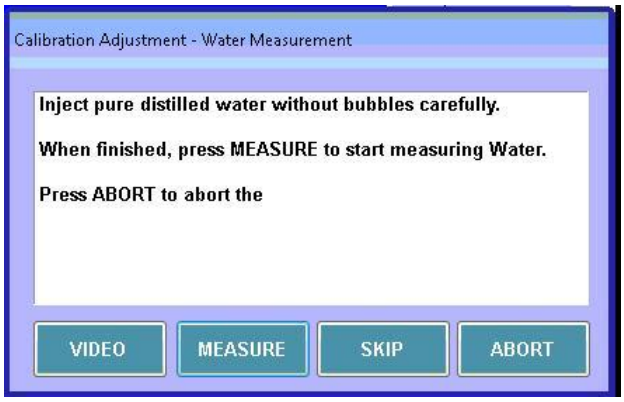


Figure 9.7.Calibration adjustment. Water measurement

9.4 Three Point Calibration Adjustment

Koehler Instrument Company recommends the use of a 3 point Calibration for the best possible accuracy within the density range of those 3 calibration points. The use of Air, Water and a third density standard which has a density similar to the highest density product or sample to be measured is the best choice. Therefore if your samples have densities around 1.1 g/cm³ it is advisable that the third standard (calibration point) also have a density near 1.1 to 1.2 g/cm³

Be sure to follow the Cleaning and Drying Instructions as outlined in Chapter 8.2

The third point in this Calibration Adjustment needs to be defined by the operator. Select “Settings” to enter the standard’s name and its certified density value in g/cm³.

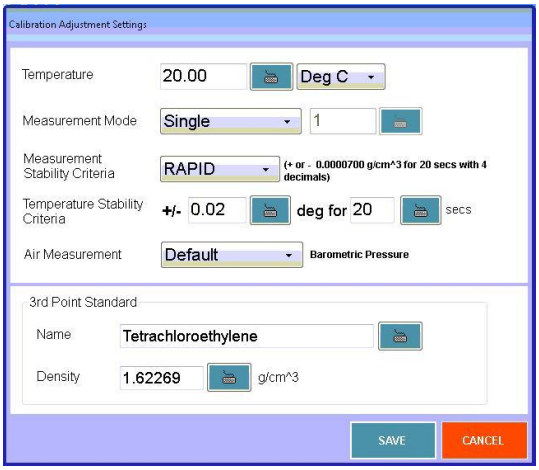


Figure 9.8. Calibration adjustment settings for a three point calibration adjustment

Once “PERFORM” is selected you will see a new window as show in Figure 9.9

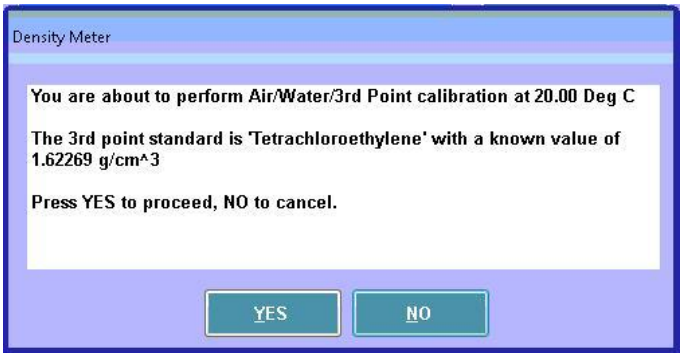


Figure 9.9. Three point calibration

HINT When converting a density standard’s units from Kg/m³ to g/cm³ it will only require the movement of the decimal three places to the left (e.g.1191 Kg/m³ = 1.191 g/cm³).

As above, follow the commands prompts from the K86200 / K86201 during the Calibration Adjustment procedure.

9.5 Using Liquid Density Standards

A liquid density standard in glass ampoule is supplied with the K86200 / K86201 density meter. This liquid may have various hazards associated with it. Be sure to read and understand the Material Safety Data Sheet.

These standards may be used for either doing a Calibration Verification or used during a 3 point Calibration Adjustment. Nevertheless, the same general procedures and recommendations apply whenever handling these standards. This is a short list of additional cares you should have:

- A sterile glass syringe is best. Do not use the supplied BD syringes which have the black elastomer end on the tip on the plunger. These may be attacked by the standard.
- Never dip the syringe into the liquid standard as the ink on the outside of the syringe barrel will be dissolved and change the density of the standard.
- Be cautious of syringes which may have a lubricant on the plunger that may also dissolve in the standards and change the density.
- Once an ampoule is opened, it may not be stored or used for more than a few hours. If necessary, cover the ampoule’s opening with clean tape. But the ampoule cannot be sealed and reused the next day. Once opened, they will be stable for only for a relative short period of time.
- Always be absolutely sure that the standard that is being injected into the K86200 / K86201 is done so using a clean syringe and only after the U-tube has been cleaned very well and dried for extra time.

- Never pour the liquid standard out of the ampoule into another container. Once done, the standard is no longer traceable and runs a very high risk of being contaminated.

The general procedure is to carefully crack off the ampoule's top along the white painted line for the UKAS standard and slightly below the gold line on the NIST standards. For both, this is where the neck of the glass is at its narrowest.

Insert the supplied needle onto the tip of a clean syringe as recommended in the bullet points above. Insert this assembly into the glass ampoule, again carefully. It is very easy to either knock over the liquid standard as the bottom of the ampoule is rather small and it is also easy to miss the small opening in the ampoule's top and stick your hand holding the ampoule with the needle instead.

While holding the ampoule with one hand, draw back on the plunger of the syringe with the other and GENTLY suck the liquid standards up into the syringe. Fill the syringe with about 1.5 to 2 ml of liquid. Carefully remove the needle from the Luer tip of the syringe. While holding the syringe vertically with the opening at the top, gently push out any air in the syringe.

Insert the syringe into the filling nozzle of the K86200 / K86201 density meter and gently inject the liquid. Use VideoView™ while filling to be sure there are no bubbles in the U-tube.

You may, with another clean syringe draw another sample from the ampoule. For this purpose it is often desirable to have left the needle in the ampoule so that it does not get contaminated. If it will be some time before you draw a second sample from the same ampoule you may wish to discard the needle, tape the opening of the ampoule and use a clean needle once you are ready for the next sample.

9.6 Temperature Calibration Verification & Adjustment

9.6.1 Temperature Verification

The temperature inside the U-tube is verified using a Fluke Hart Handheld thermometer with temperature probe and probe calibration or its equivalent.

Fluke Hart thermometer's certificate of calibration must be valid. Serial numbers are recorded for thermometer and probe on the Measurement Data Sheet. Remove one of the filling nozzles and carefully place the thermometer probe inside the internal diameter of the U-tube and very slowly and with very little force as **the glass is very fragile**. See Figure 9.10. Set the K86200 / K86201 temperature and permit sufficient time for the U-tube and the thermometer probe to come to complete thermal stability. This may require up to 10 minutes. Then compare the digital density meter's sample temperature as displayed to the temperature reading on that of a certified thermometer. The results of the two temperature readings must be within the combined accuracies of the K86200 / K86201 and that of the thermometer. That is, the digital density meter's

temperature's accuracy is ±0.03ºC and the thermometer's probe has an accuracy of ±0.04ºC. The combined maximum error or difference between the two readings is therefore 0.07ºC.

Figure 9.10 Temperature verification with a certified Fluke Hart Thermometer

9.6.2 Temperature Calibration Adjustment

Always follow the instructions above for the Temperature Verification prior to deciding to perform a calibration adjustment. If the instrument is within specification for temperature, doing an adjustment of temperature will not make the instrument any more accurate.

If the K86200 / K86201 requires a Temperature Calibration Adjustment enter the menu as shown and select Temperature. Then select Perform. The digital density meter requires adjustments at 3 temperatures. By default these temperature are 20ºC, 40ºC, and 60ºC. Allow 20 minutes or more between temperature changes and confirm that the temperature is stable for both the K86200 / K86201 and the Fluke Hart Thermometer.

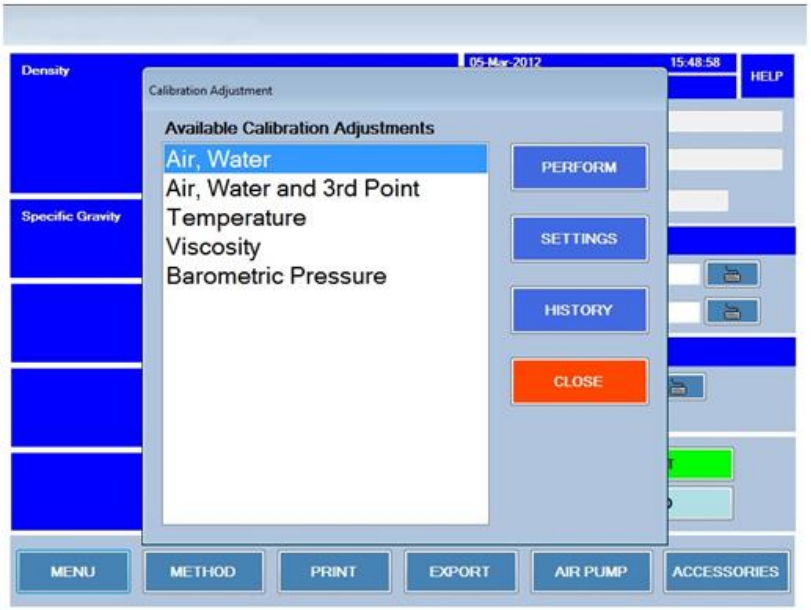


Figure 9.11 Calibration Adjustment Perform Screen

The density meter should be calibrated at 3 different temperatures. Select those temperatures or temperature range which best suits the end use. If the instrument is to be used at only a single temperature; then do the temperature calibration ±5 degrees around that temperature (for temperature 1 and 3). Temperature 2 should than be that temperature at which measurements are made. See Figure 9.12.

Figure 9.12. Temperature Calibration Settings

Follow the instruction displayed on the screen for Figure 9.13

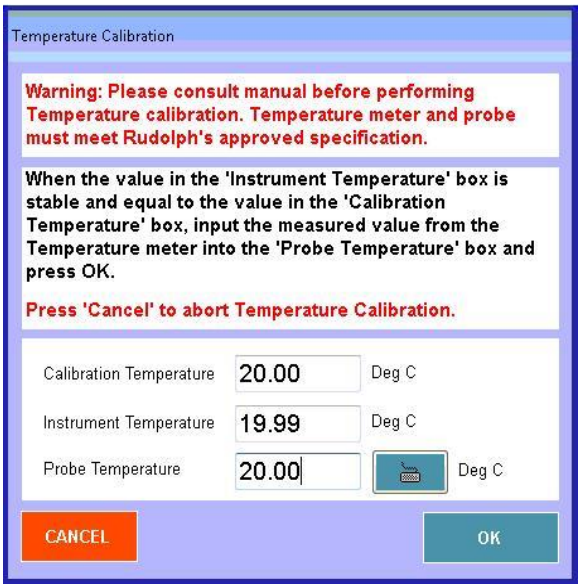


Figure 9.13. Temperature calibration


HINT

It is advisable to re-check the measurement accuracy after re-assemble of the nozzle which was removed for the temperature verification and/or temperature adjustment. It is very possible that the tension between the nozzle and the opening to the glass U-tube may be slightly different and will not oscillate exactly as before. Therefore, an air and water calibration check (verification) is always best. Perform a calibration adjustment, if required.

9.7 Viscosity Calibration Adjustment

The viscosity calibration adjustment was done at the factory and normally is not required to redo again by the end user. However, this calibration is easy to do. All that is required is a viscosity standard which has a known density.

It is best to use a viscosity standard which has a kinematic viscosity of between 150 to 200 mm^2/s (centistokes) at room temperature. The actual viscosity value is not needed for this calibration, it is only necessary to know the density of this standard.

From: **Menu > Calibration > Calibration Adjustment** ; highlight Viscosity and then select “Settings”. A Window will open as shown in Figure 9.14 on next page.

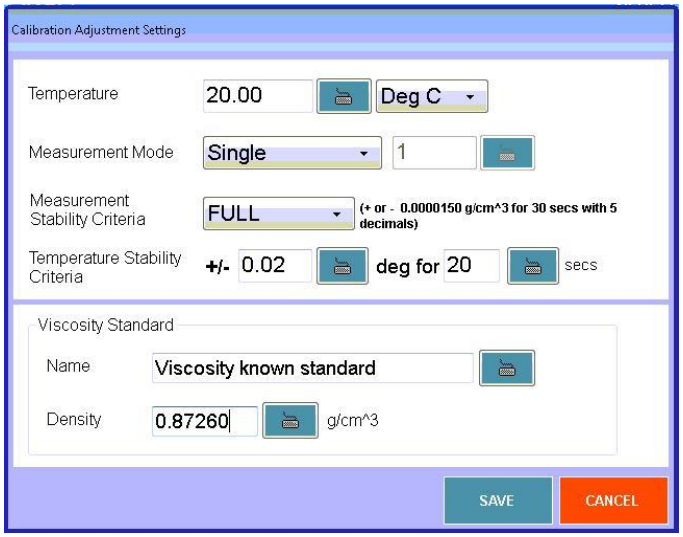


Figure 9.14. Viscosity Adjustment Settings

Type in the correct density in g/cm^3 for this standard being used and then hit on "SAVE". Select "PERFORM". Then follow the prompts on the display.

10. Printers and Network Connections

10.1 The Basic Steps required for most of the following operations

It will be necessary to access the Windows 7 Control Panel and be able to turn off disk protection in many of the following procedures. Therefore, this procedure will be outlined only once and will be referred to in the remainder of this document as the "Basic Steps".

Basic Steps:

1. Click the **Menu** button, enter the password and click OK. The factory default password; if it has not been deactivated or changed by Lab's Manager; is **123**.

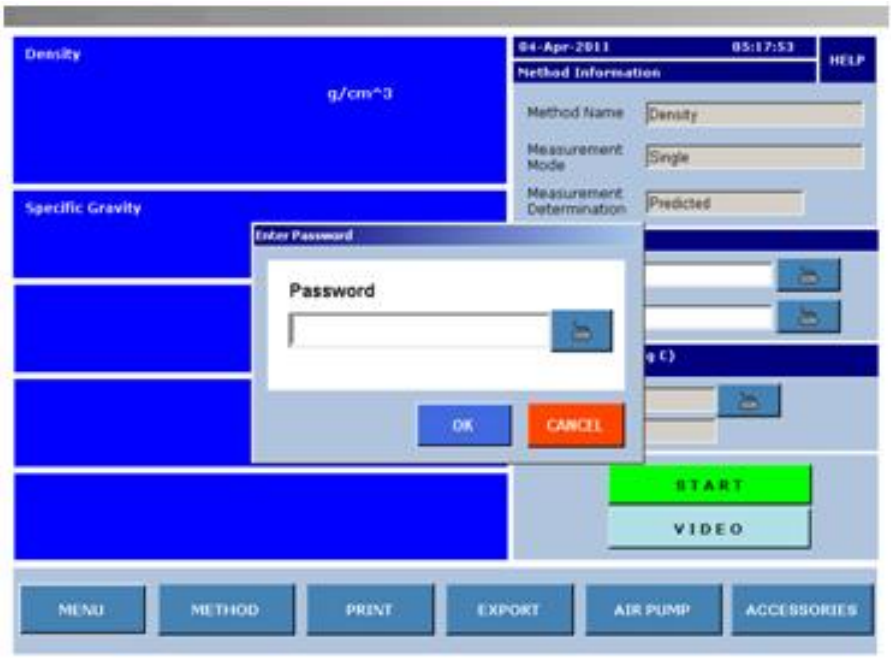


Figure 10.1 – Enter Menu Password – if required

2. Select **Operational Parameters** from the menu.

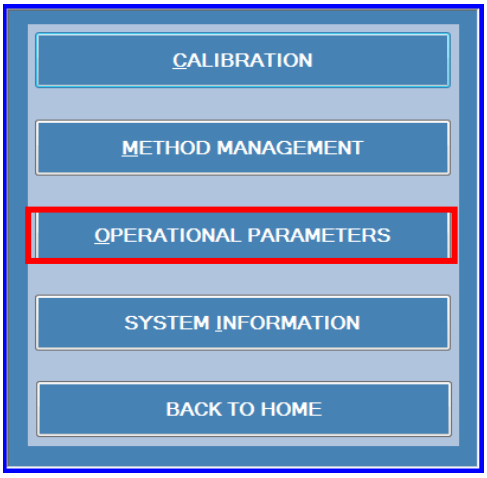


Figure 10.2 – Select Operational Parameters from Main menu

3. Select **Instrument Configuration** from the Operational Parameters menu.

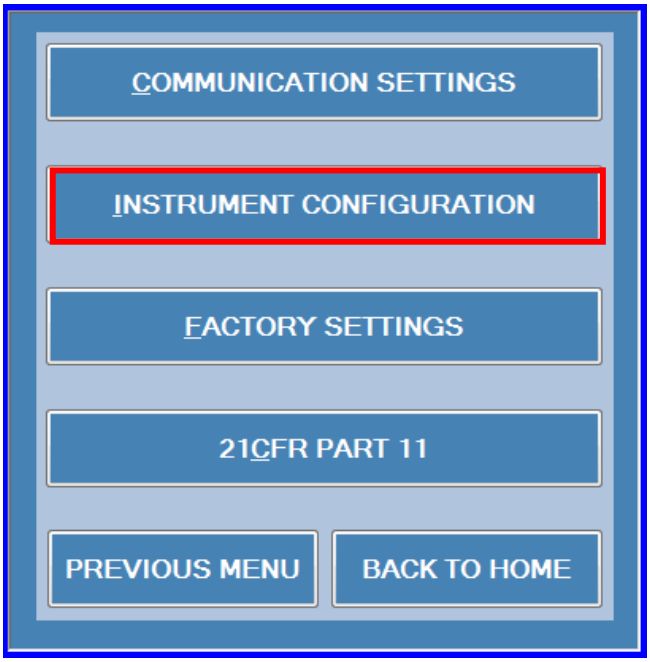


Figure 10.3 – Select Instrument Configuration

4. Select **DDM Control** from the Instrument Configuration menu.

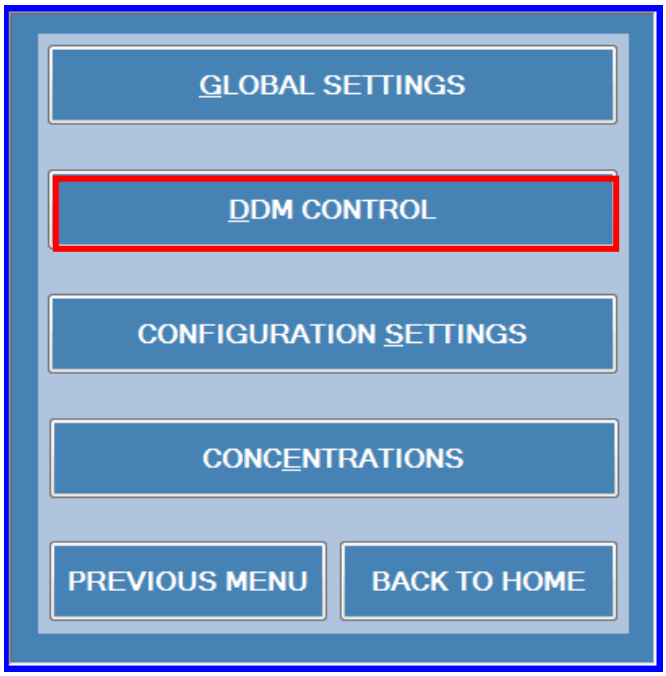


Figure 10.4 – Select DDM Control

5. Select **Turn Disk Protection Off** from the K86200 / K86201 DDM Control menu.

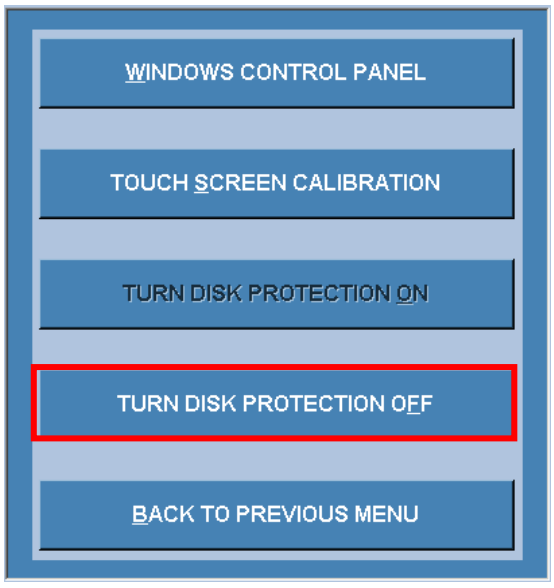


Figure 10.5 – Select Turn Disk Protection Off

6. You will see the warning message shown in Figure 10.6 below. Click the Yes button.

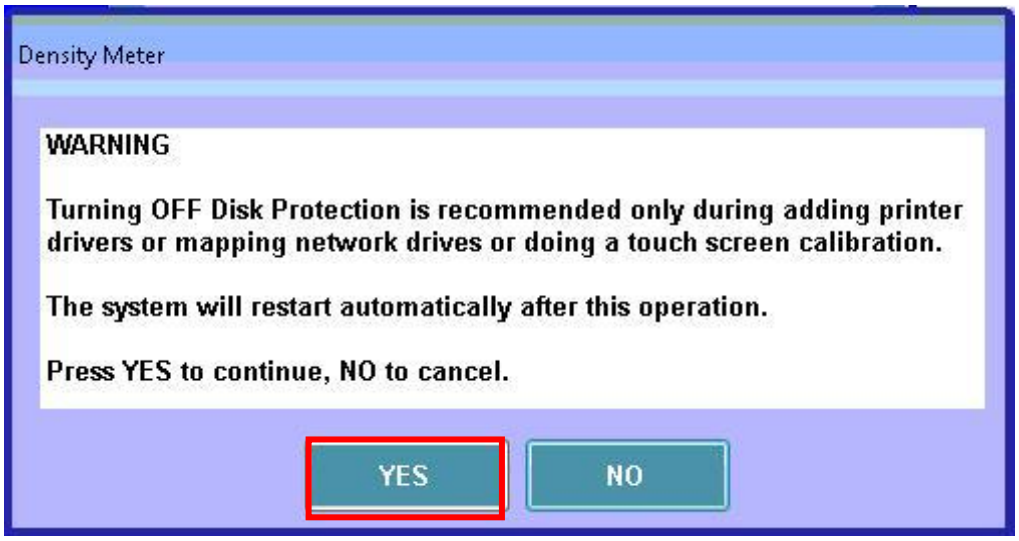


Figure 10.6 – Turn Off Disk Protection Warning Message

7. When system reboots you will see another warning message that Disk protection is off (see Figure 10.7). Click the **Menu** button and enter the password (refer to Figure 10.1). The factory default password is 123, if was not modified by the Lab's Manager.

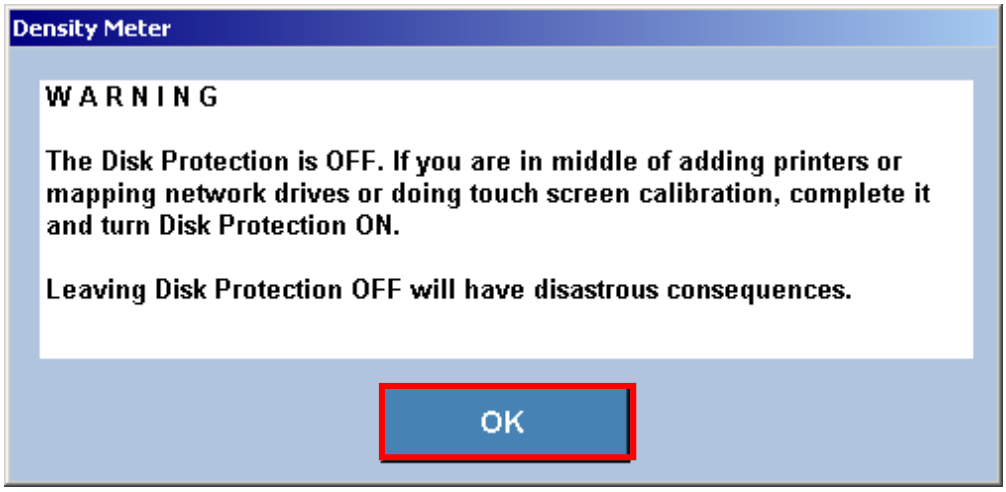


Figure 10.7 – Disk Protection Off Boot Message

8. Click **Operational Parameters** and select **Instrument Configuration** from the menu.

9. Select **Control Panel** from the Instrument Configuration menu (see Figure 10.4).
10. Select **Control Panel** from the K86200 / K86201 Control Panel menu (see Figure 10.5).
11. You are now in the Windows 7 Embedded Control Panel as below.
12.

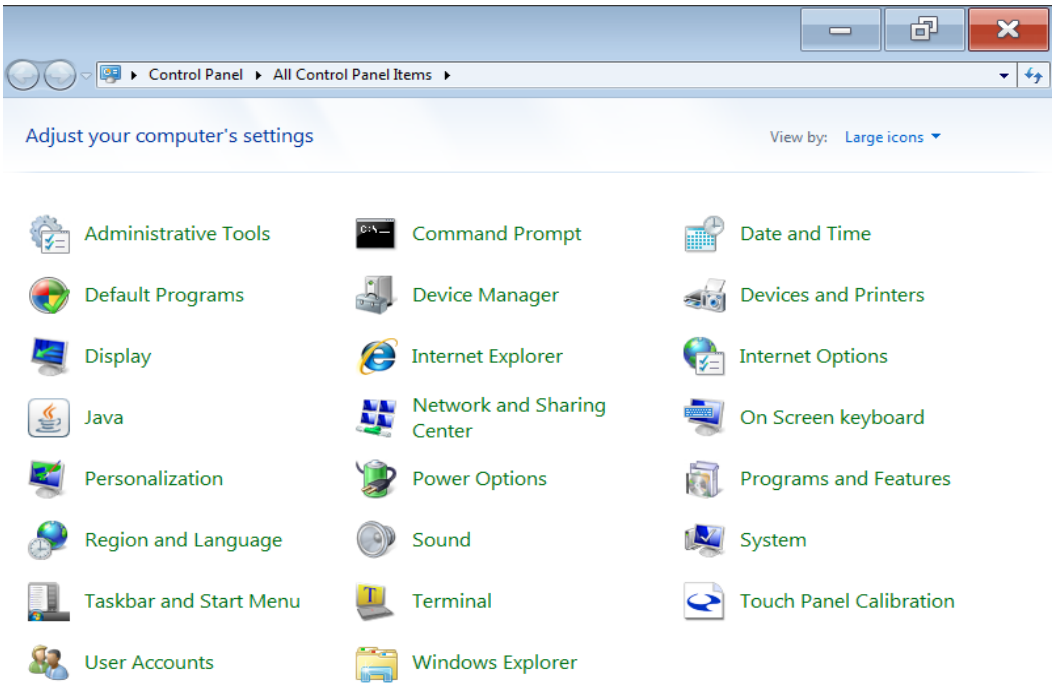


Figure 10.8 - Windows 7 Control Panels

10.2 Plug-n-Play Local Printers

The K86200 / K86201 allows the connection of any of the 200 plus USB printers whose drivers are preloaded in Windows 7 Embedded. Follow the instructions below to install a plug and play compliant USB printer on the digital density meter. See Appendix D on page 122 for the complete list of printers.

HINT Most printers released in the last 5 years or longer are plug and play compliant.

Connect the USB cable from the printer to the digital density meter. Be sure both instruments are turned ON. It may take a minutes but the Windows 7 Embedded software will recognize the printer.

You now need to set this as your default printer. To do this ensure that disk protection is off as outlined above in “Basic Steps”.

Once in the Control Panel select Devices and Printers. Right click if using a mouse on the select printer and check “Set as Default Printer”.

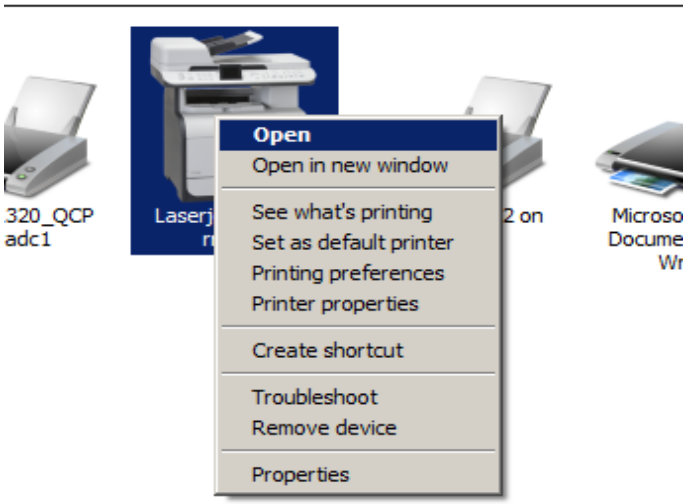


Figure 10.9 – Selecting a default printer

10.3 For a Local Printer which is not Plug-n-Play

For some case it will be necessary to load a printer’s driver.

You should load a driver on the K86200 / K86201 when absolutely required. Some printers ship with printer management software, additional editing software and additional fonts. You do not need these or want these to use resources on your K86200 / K86201. Most printer manufacturers have just the printer drives available for download on their web sites.

1) Load the printer’s driver onto a USB thumb drive.
2) Follow the Basic Steps as outlined above.
3) Plug the USB storage device containing the printer drivers (such as a USB flash drive) into one of the digital density meter’s USB ports.

4) Connect the USB cable from Printer to K86200 / K86201. When the Found New Hardware wizard starts, select **No, not this time** and click **Next**. (See Figure 10.10)

Figure 10.10 – New Hardware Wizard Start

4) Select **Install from a list or specific location (Advanced)** and click **Next**.

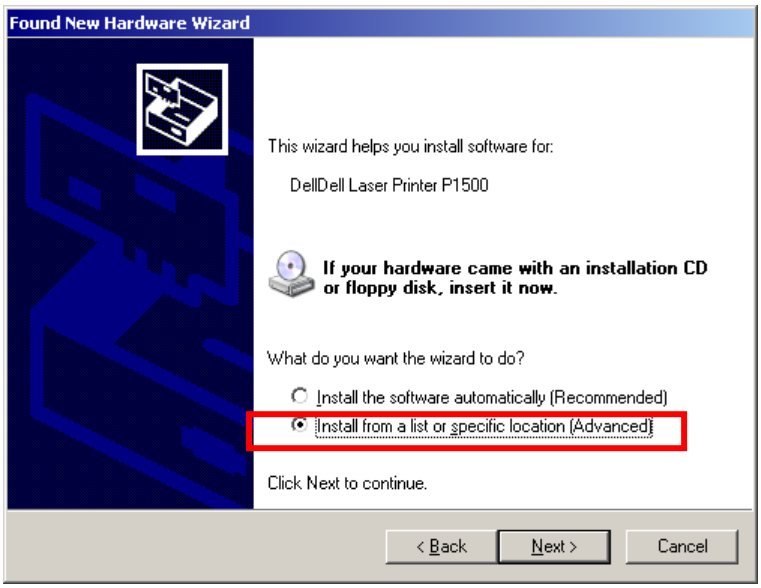


Figure 10.11 – New Hardware Wizard Install from list or specific location

5) Select **Search for the best driver in these locations**. Only select the **Include this location in the search**: check box and click **Browse** to navigate to the folder on the USB storage device where the printer drivers are stored. Click **Next**. (See Figure 10.12)

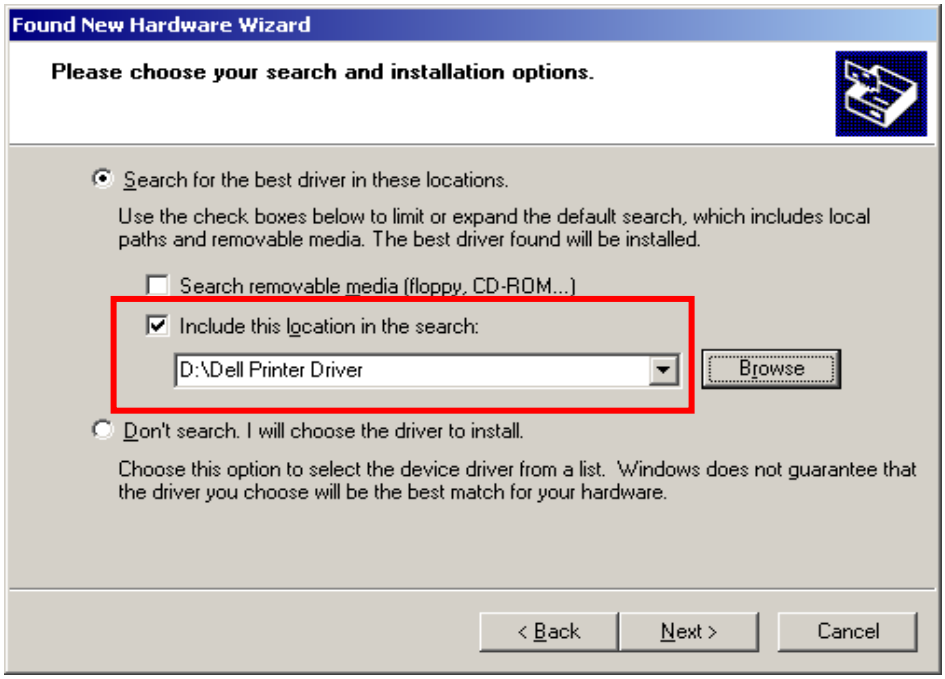


Figure 10.12 – New Hardware Wizard Driver Location

6) If presented with a list of printers, select your printer from the list, then select **Next**

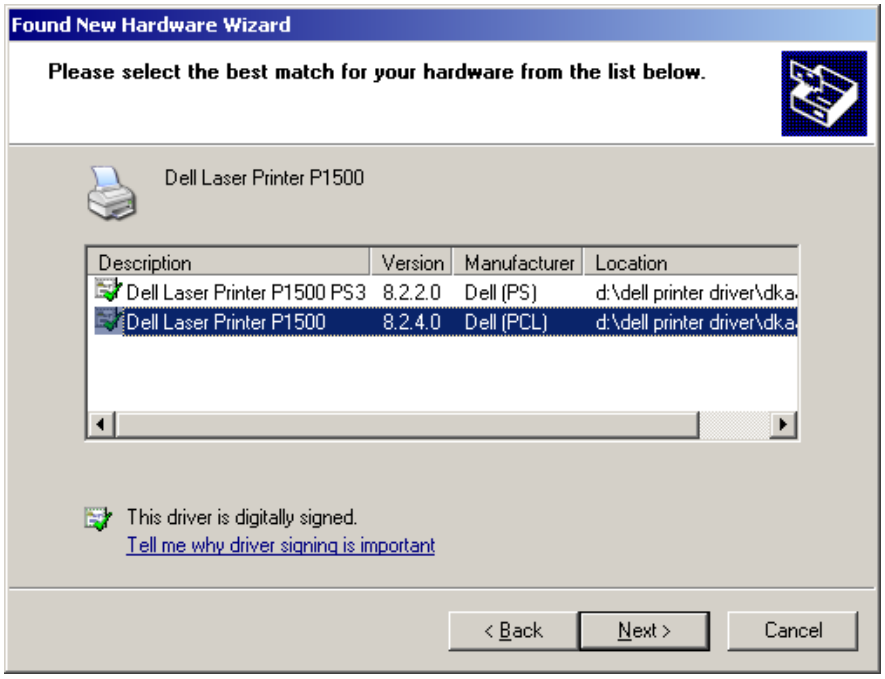


Figure 10.13 – New Hardware Wizard Printer List

7) Select Finish.

8) Double click the Devices and Printers Icon as shown in Figure 10.14 below.

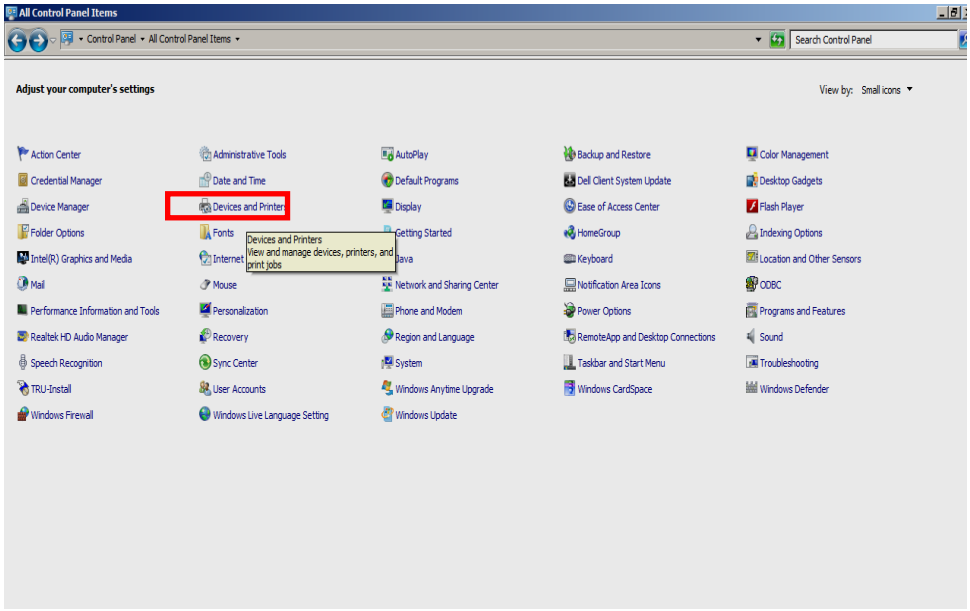


Figure 10.14 – Control Panel Select Devices and Printers icon.

9) Right click on the printer you just installed and select Set as Default from the menu.

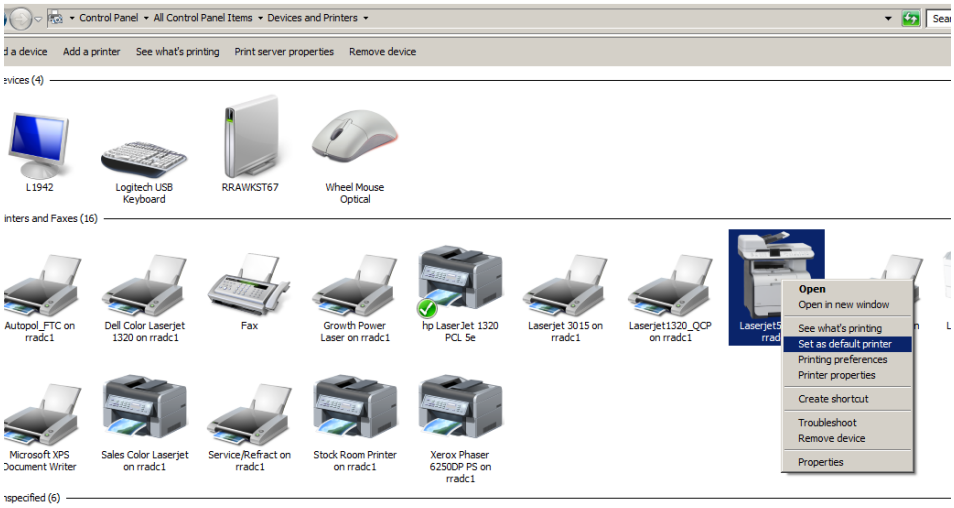


Figure 10.15 – Set Installed Printer as Default Printer

10) Close the Devices and Printers window by clicking the X in the top right hand corner of the windows. This will return you to the digital density meter's Control Panel menu. Select **Turn Disk Protection On**. The system will display a message that the K86200 / K86201 will restart. Click **Yes** to continue.

After the system restarts, the K86200 / K86201 is ready to print to your printer.

10.4 Serial Printers

Usually most serial printers are not plug and play. The instructions below show how to install the drivers required to use such a printer.

1) Follow the Basic Steps listed earlier to gain access to the Control Panel.
2) Once in the Control Panel select **Devices and Printers**.
3) Select **Add A Printer** at the top of the window as shown in the image below. (see figure 10.16)

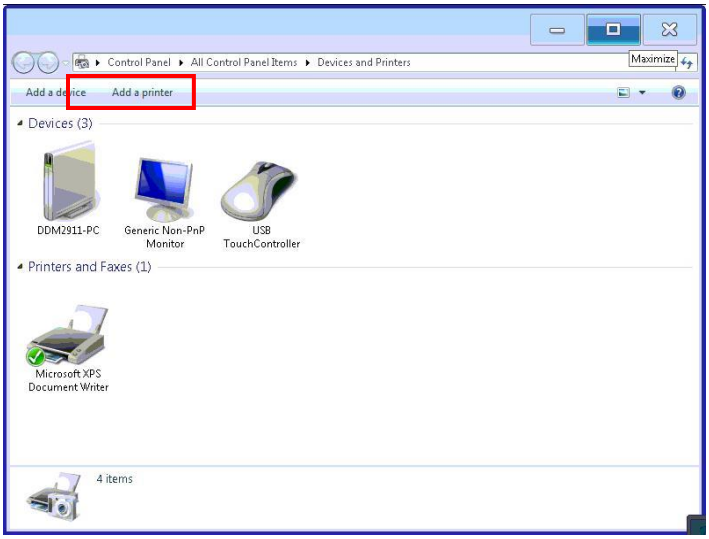


Figure 10.16 – Select Add a printer.

4) The Add Printer dialogue will start as shown below in Figure 10.17.

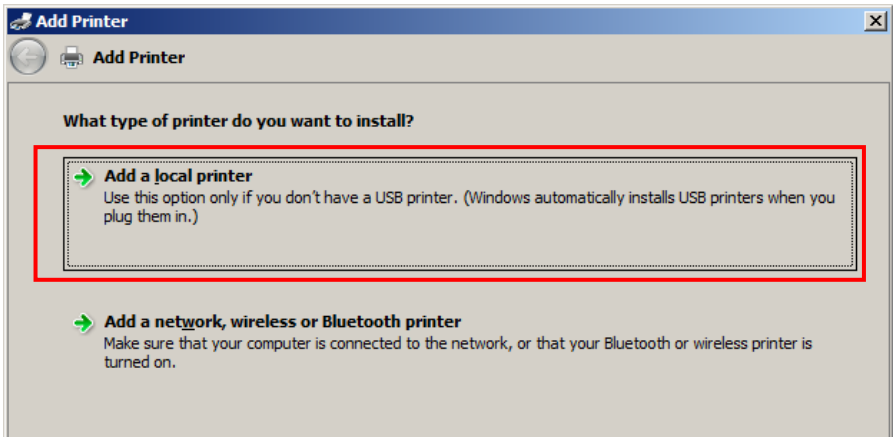


Figure 10.17 – Add Printer dialogue.

5) Select "**Add a local printer**". (Figure 10.17)
6) Click **Next** and select the port the printer is attached to on the back of the K86200 / K86201. For the serial port on the back of the K86200 / K86201 select **COM2**. (figure 10.18).

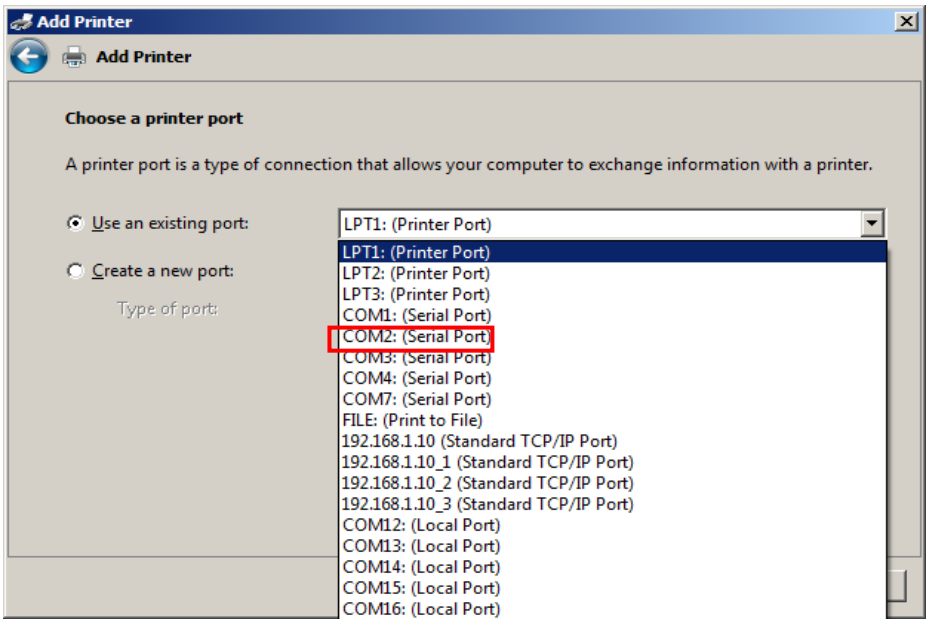


Figure 10.18 – Select port where printer is attached to on the K86200 / K86201

7) Once the correct port is selected hit **Next**.
8) On the Add Printer dialogue box shown below (Figure 10.19) select the "**Have Disk**" option and point it to where you saved the printer drivers on your USB drive.

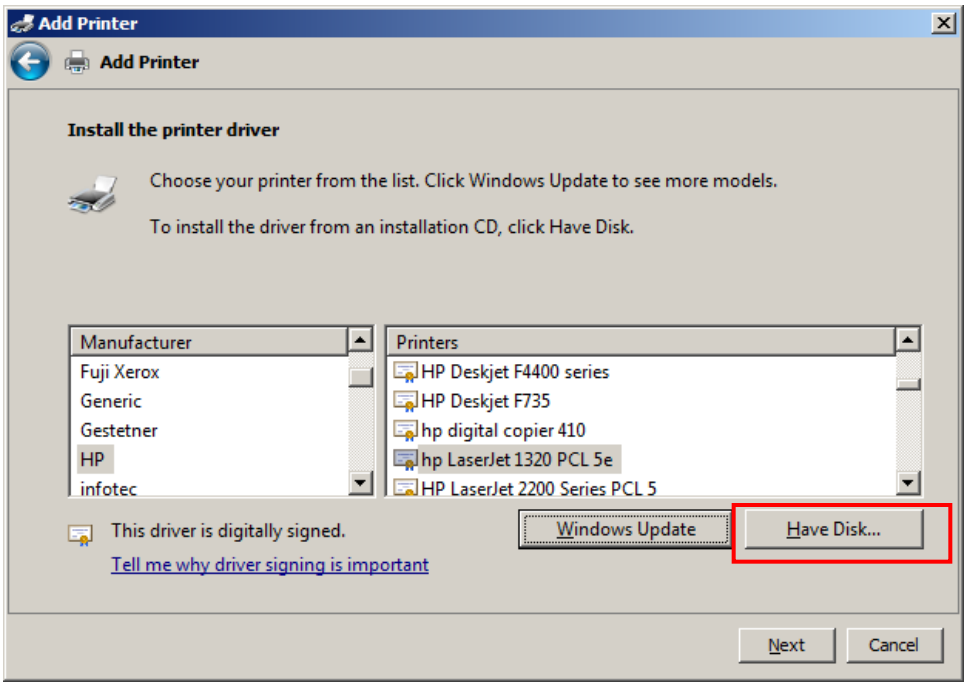


Figure 10.19 – Select Have Disk

9) Navigate to the USB storage device or network location where the drivers for the printer to be installed are located as shown in Figure 10.20.

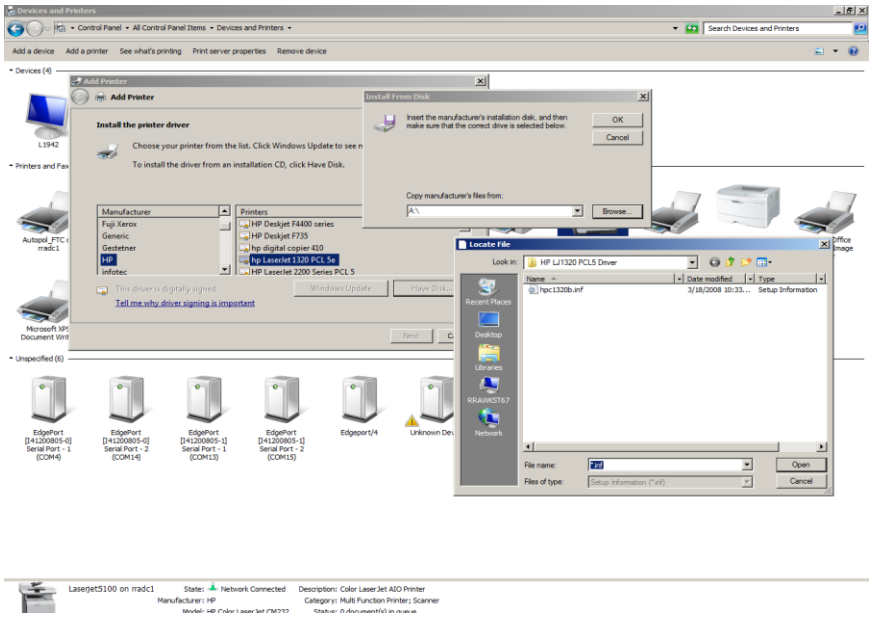


Figure 10.20 – Selecting Printer Drivers Location

10) Select your printer from the list and click **Next**.

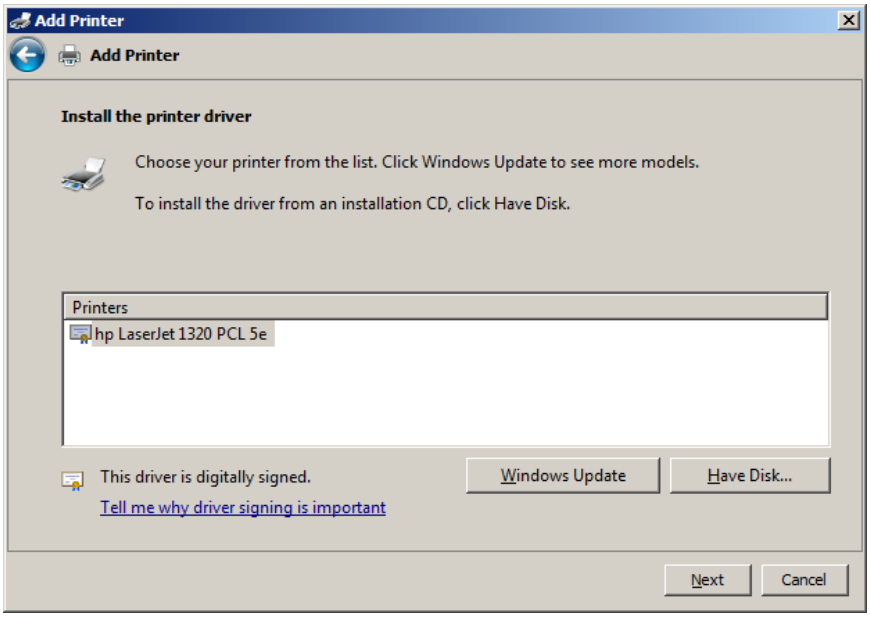


Figure 10.21 – Select Printer from the List.

11) Enter the name you would like to call the printer. See figure 10.22 below.

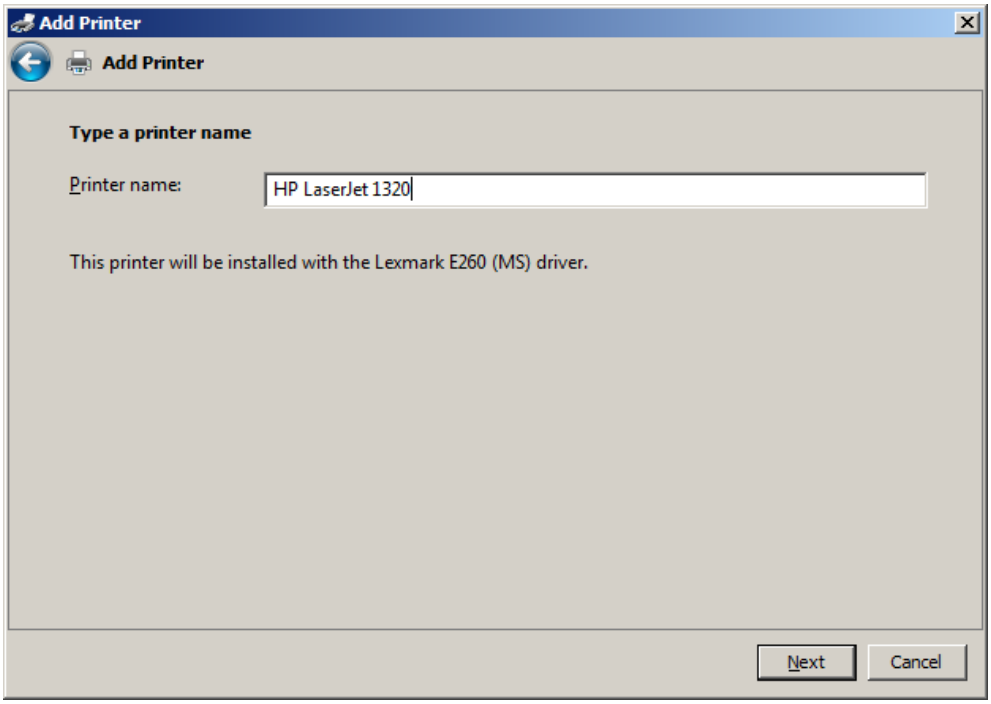


Figure 10.22 – Name printer

12) You may see a window that asks if you would like to share the printer. Do not share the printer! and select **Next.** See Figure 10.23.

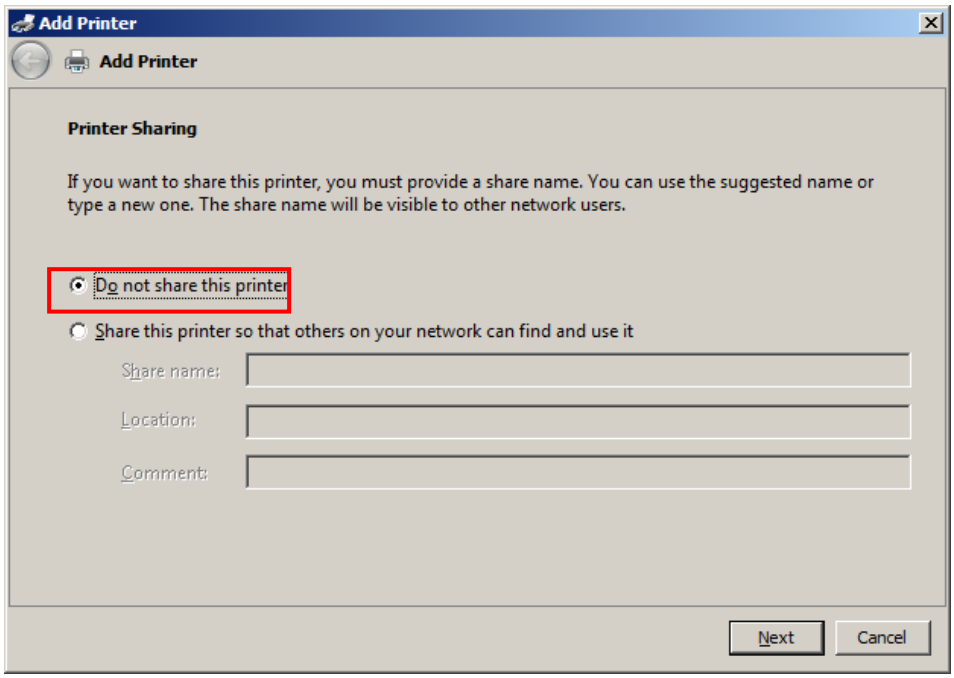


Figure 10.23 – Do not share this printer option

13) Click **Next**. Check the dialogue box for "**Setas the default printer**" and then click "**Print a test page**". and click Finish.

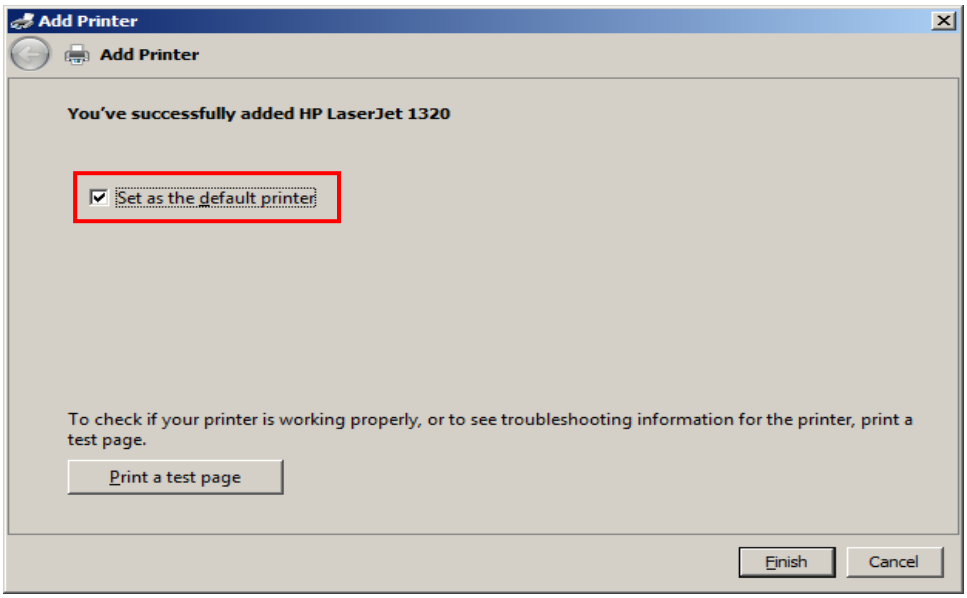


Figure 10.24 – Printer successfully added

Close the Devices and printers window by clicking the X in the top right hand corner of the window. This will return you to the digital density meter's Control Panel menu. Select **Turn Disk Protection On**. The system will display a message that the K86200 / K86201 will restart. Click **Yes** to continue.

After the system restarts, the K86200 / K86201 is ready to print to your printer.

10.5 Print to a TCP/IP Printer Attached to a Network

By default the digital density meter assumes that your network supports TCP/IP and is using DHCP (your server automatically assigns an IP (internet protocol) address to the digital density meter when you attach the density meter to your network via the RJ45 port on the back of the instrument).

To install a TCP/IP printer attached to a network follow the instructions below:

1) Connect the K86200 / K86201 to the TCP/IP network by connecting a patch cable to the RJ45 Network port on the back of the density meter.
2) Follow the Basic Steps to reach the Control Panel.
3) Once you are in the control panel select "Devices and Printers".
4) Select **Add a printer** from the menu at the top of the window. (see figure 10.25) below

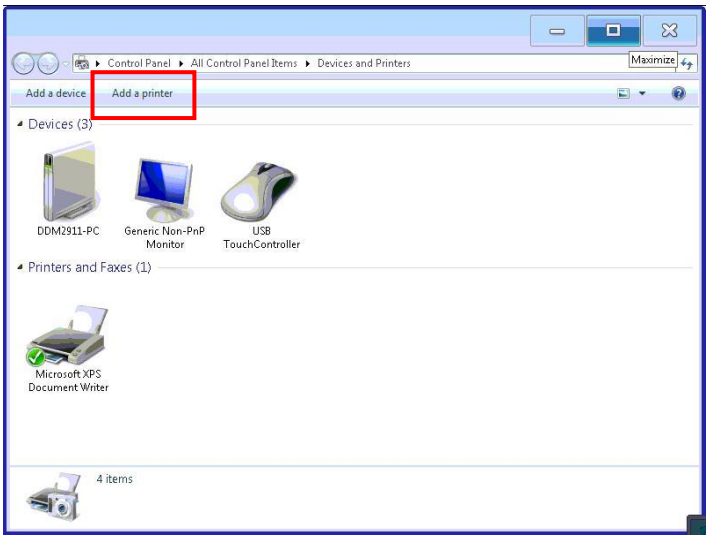


Figure 10.25 – Select add a printer

5) When the add a printer dialogue box pop up select "**Add a network, wireless or Bluetooth printer"**. (figure 10.26).

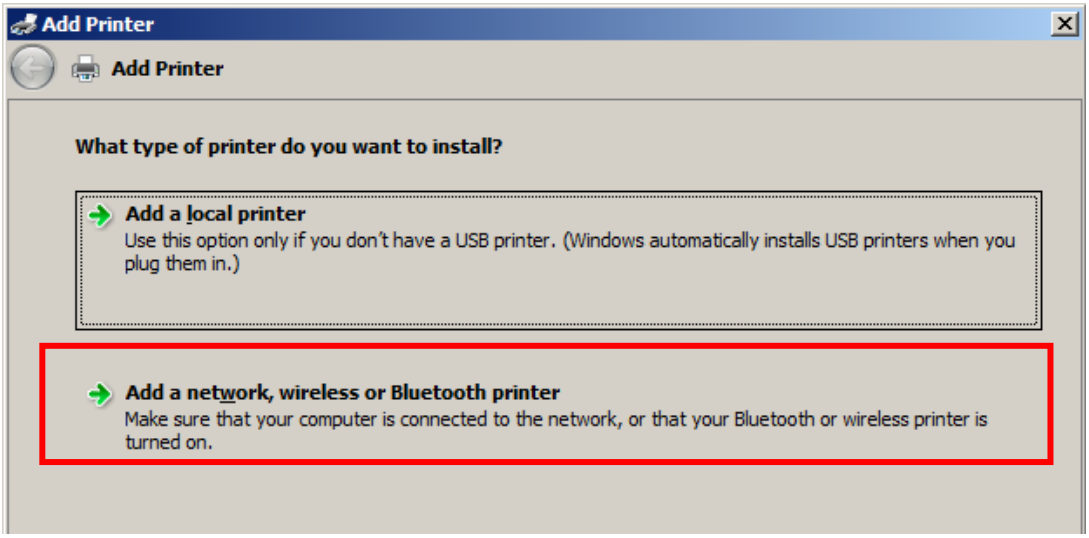


Figure 10.26 – Select "Add a network, wireless or Bluetooth printer".

6) If your network has printer discovery turned on a list of network printers will be displayed as shown in Figure 10.27 below.

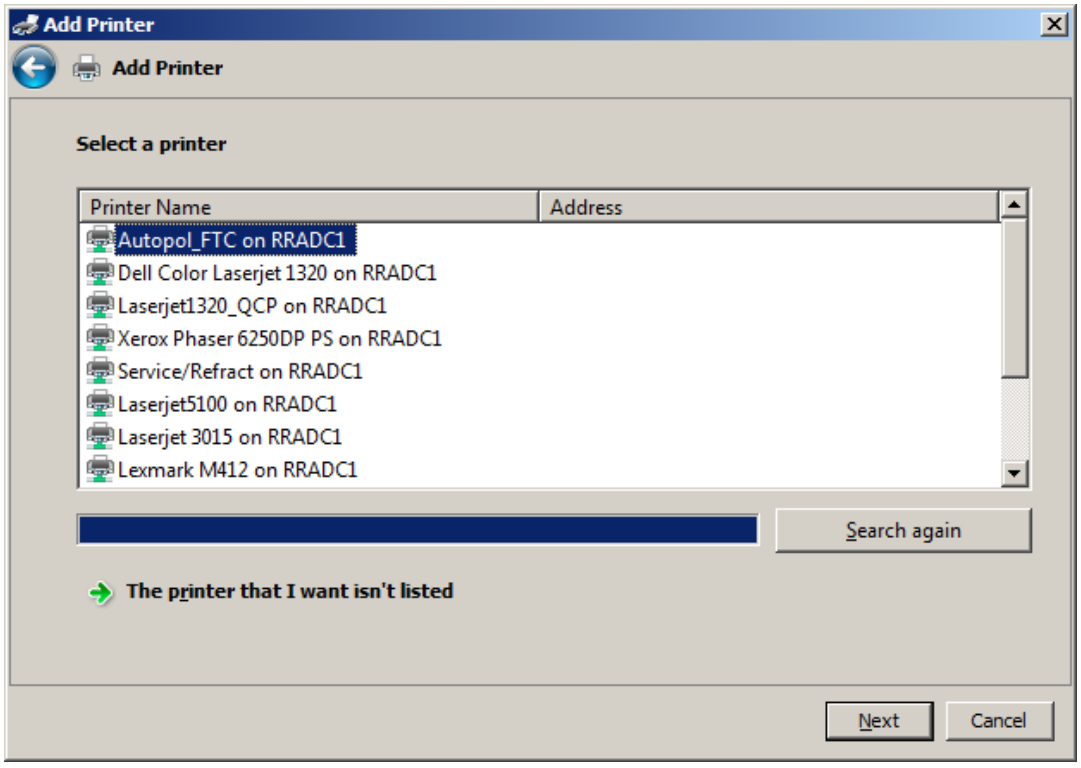


Figure 10.27 – Select a printer dialogue box

7) If the printer you want to add is shown in the list select it and click **next** and you can skip ahead to step 10. If the printer you want to add is not shown click "**The printer I want isn't listed**."
8) You will be presented with the "Find a printer by name or TCP/IP address" dialogue box with three options as shown below.

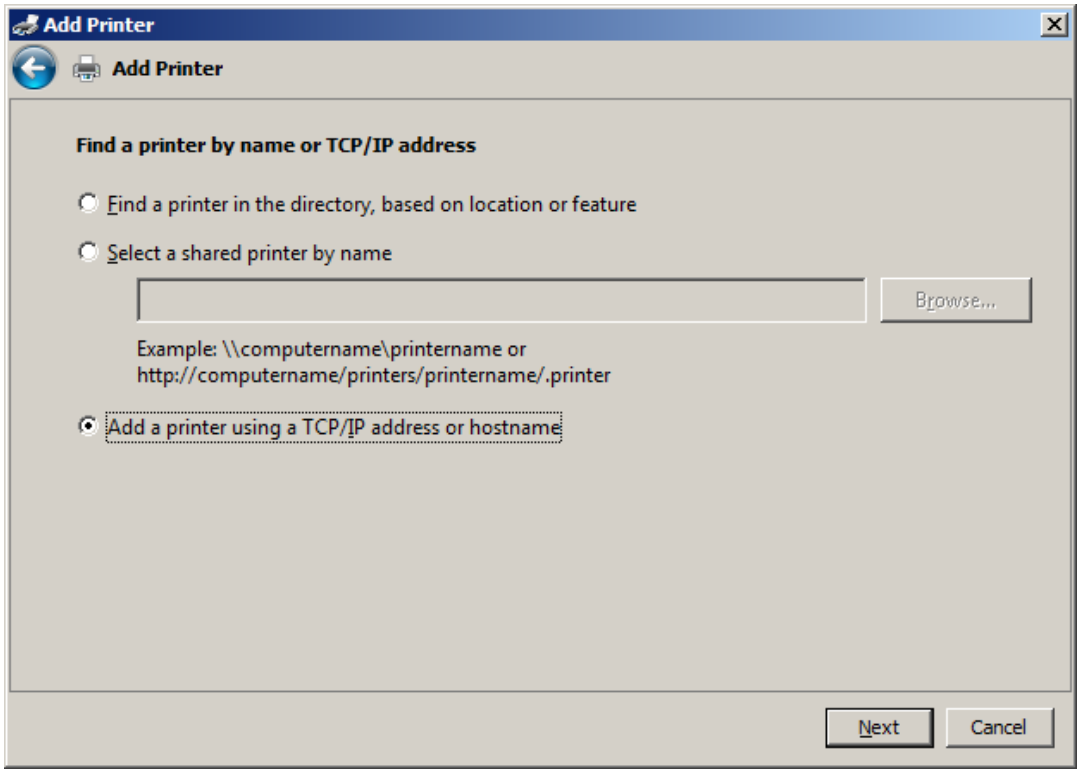


Figure 10.28 – Find a printer

9) Select whichever option is applicable. If you know the printers IP address select **Add a printer using TCP/IP address or hostname** as this is the preferred method and hit next.
10) On the next window for Device Type: **choose Autodetect**. For Hostname or IP address enter the Hostname or IP address. For Port name should automatically fill in as you enter the IP address as shown below in Figure 10.29
11) Make sure **Query the printer and automatically select the driver to use** is selected.

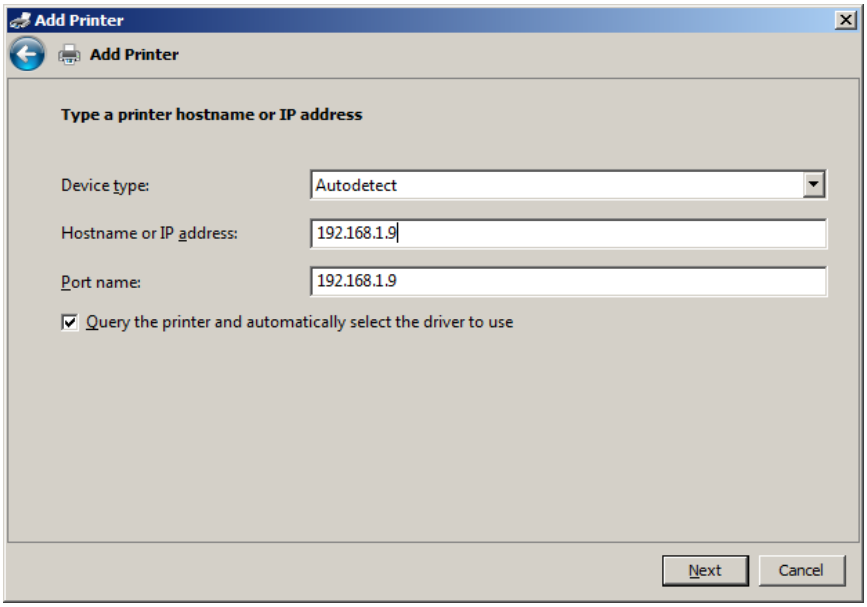


Figure 10.29 – Type a printer hostname or IP address

12) Click Next and select add a Local Printer. See Figure 10.30 below.

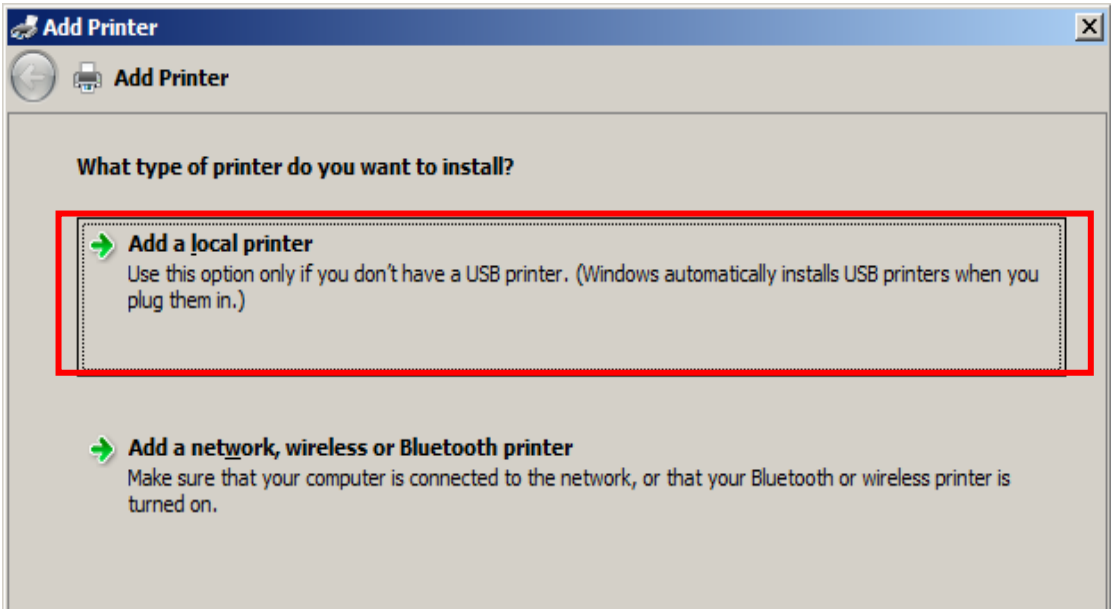


Figure 10.30 – Select Local Printer

13) Select **Create a new port:** Next to **Type of port:** select **Standard TCP/IP port** and click **Next** as shown in Figure 10.31.

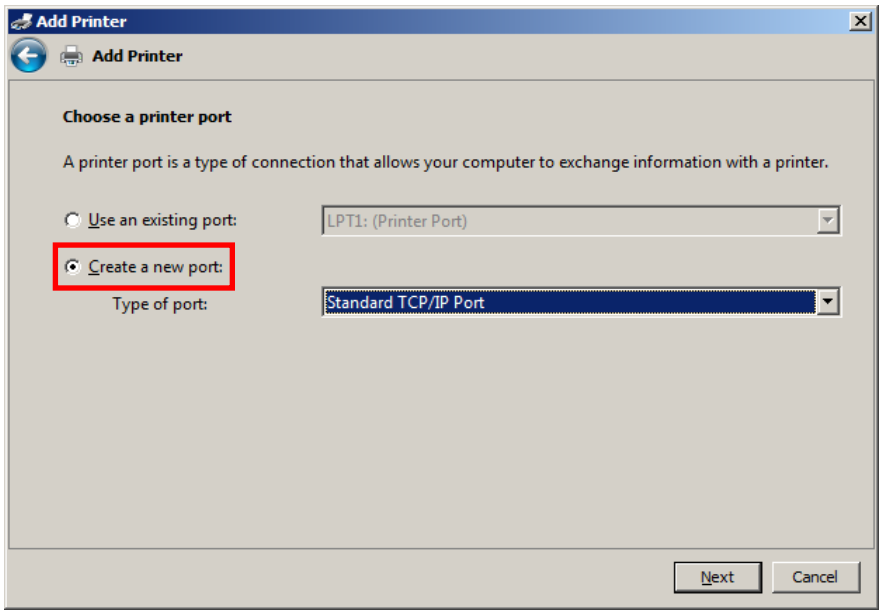


Figure 10.32 – Create a new TCP/IP Port

14) On the next window for Hostname or IP address enter the Hostname or IP address of the printer you want to add. Port name should automatically fill in as you enter the IP address as shown below in Figure 10.33. Make sure the "**Query the printer and automatically select the driver to use**" box is checked. Hit **next**.

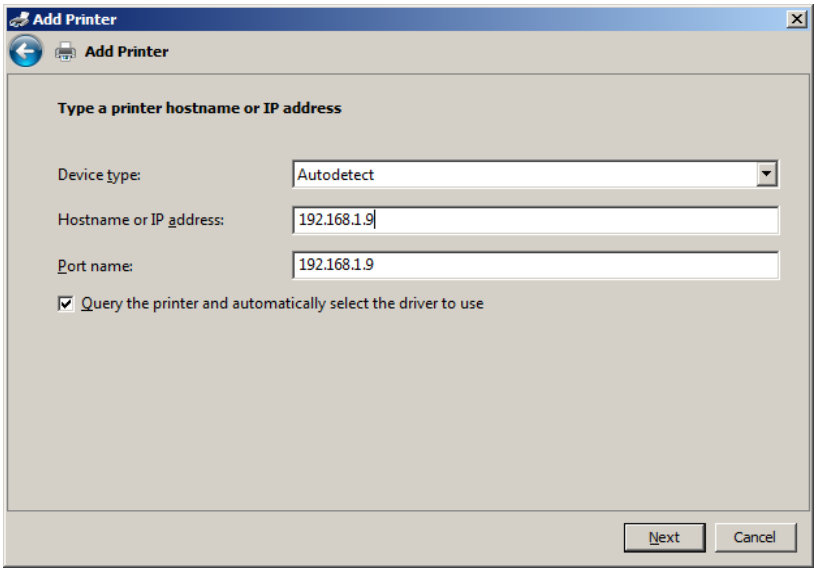


Figure 10.33 – Add Printer

15) If Windows was able to automatically configure the printer you will see a screen similar to Figure 10.34 below and you can click Next.

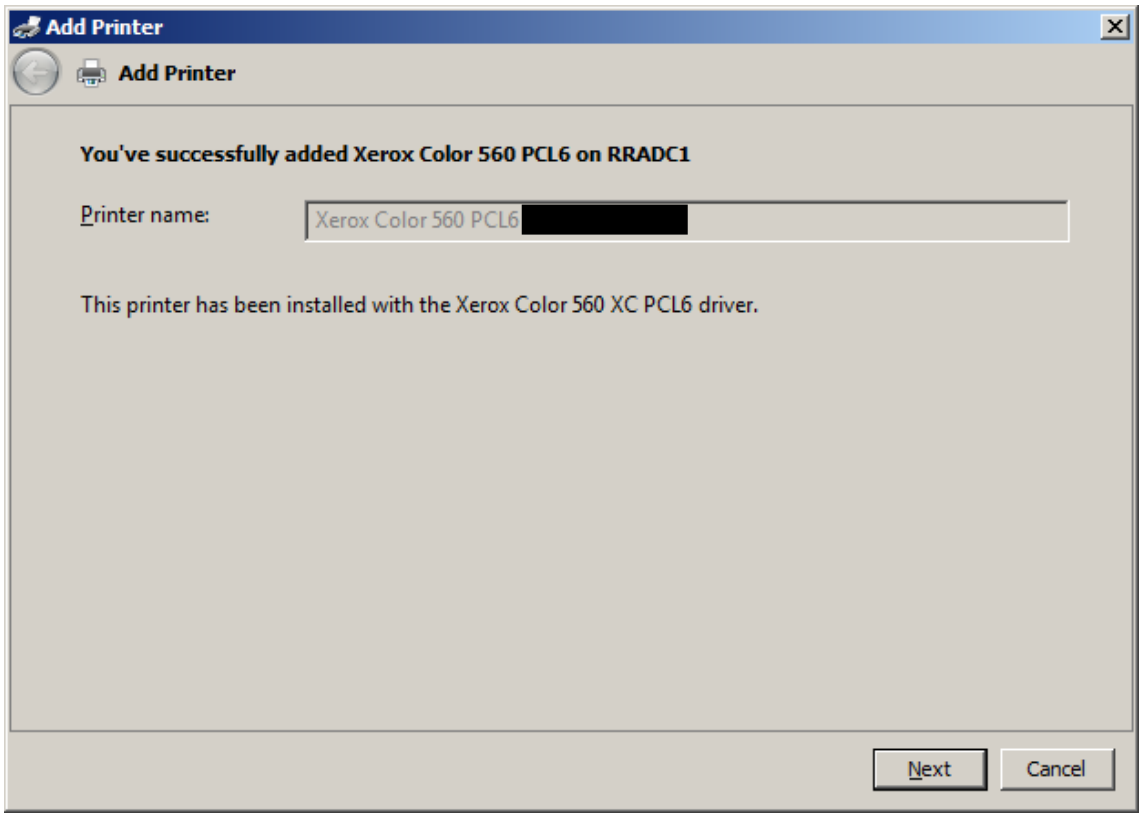


Figure 10.34 – Printer successfully added.

16) If windows was unable to automatically select the proper driver to use you will be presented with the same screen as shown in Figure 10.19and you will need to click "**Have Disk**" and specify a location where you have the printer driver saved.
17) Once you have selected the proper driver or the computer has automatically installed the proper driver you will be presented with Figure 10.35 as shown below indicating a successful printer installation.
18) Make sure "**Set as the default printer**" is checked and click "**print a test page**" and then click **"Finish**".

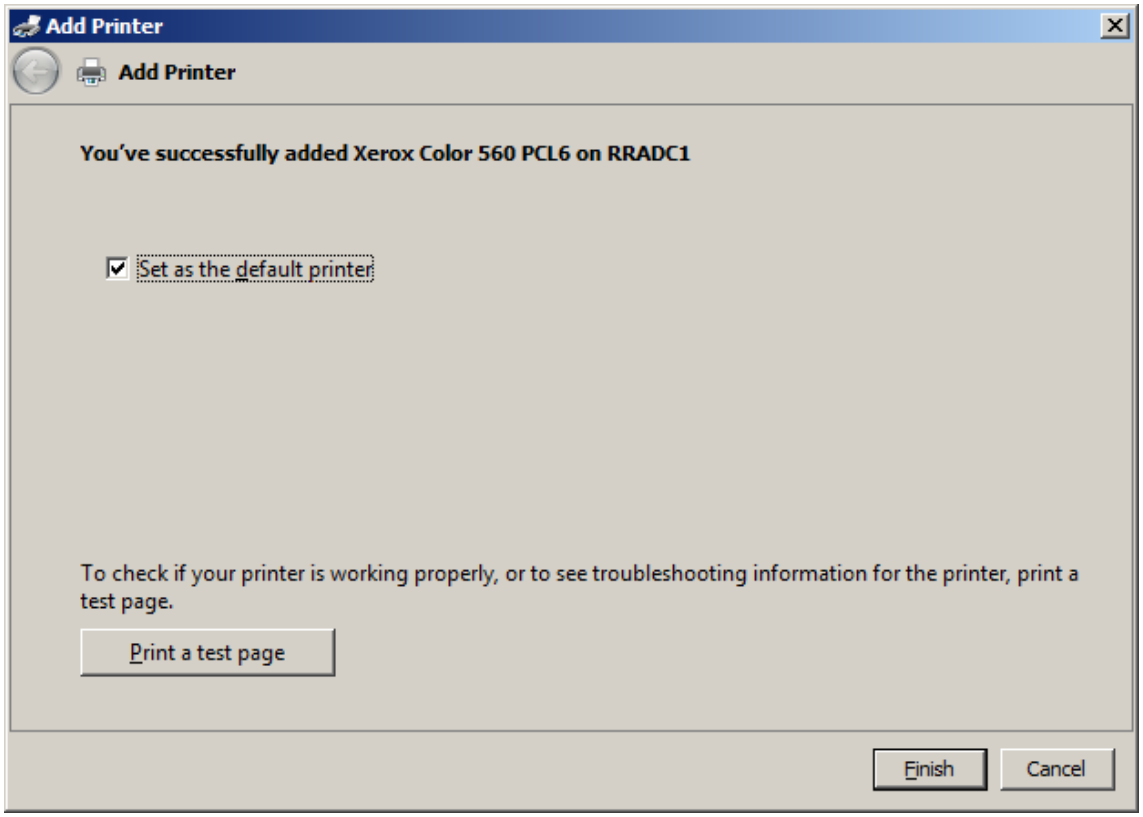


Figure 10.35 – Successful printer installation

10.6 Access Network Drives

The instructions for accessing a network drive with the K86200 / K86201 assume the following:

a. The network provides DHCP. It is possible to set a static IP, but the instructions assume the IP address is set dynamically. If you plug the K86200 / K86201 into your network via the RJ45 Ethernet jack (labeled Network) on the back of the density meter, the instrument will use DHCP to ask for an automatically assigned IP address.
b. The network drive is on a Windows based network.
c. The digital density meter is not currently designed to join a Windows domain. You can map to a network drive by just providing user credentials of someone who has security privileges to the network folder. There should be no reason to use the Windows Control Panel Network Connections feature.

1) Connect the K86200 / K86201 to the TCP/IP network by connecting a patch cable to the RJ45 Network port on the back of the density meter.

2) Follow the Basic Steps

3) Select **WindowsControl Panel** from the K86200 / K86201 digital density meter Control menu

4) Once in the control panel select the Address bar at the top of the screen and type in the computer name of your Density Meter and hit Enter as shown in Figure 10.36.

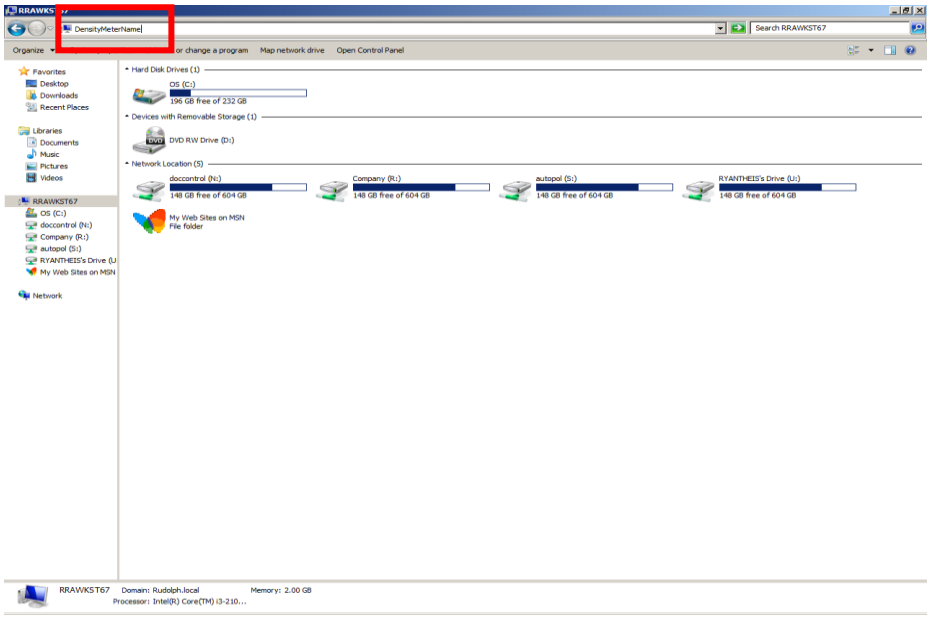


Figure 10.36 – Enter Density Meter name.

5) A screen similar to Figure 10.37 below should be displayed. Select Map Network Drive at the top of the screen.

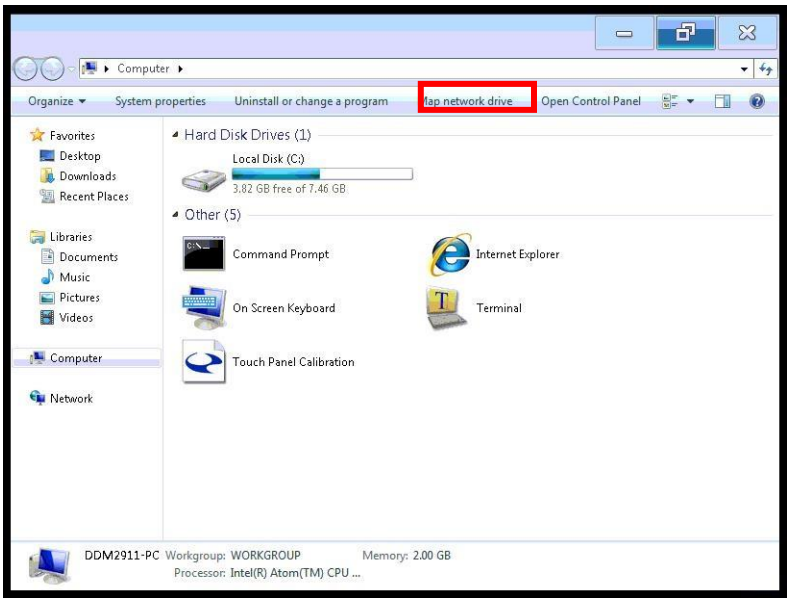


Figure 10.37 – Map Network Drive

6) Select the drive letter to assign to the network drive and enter the name of the network share. You may need to ask your Network Administrator for the network share name.

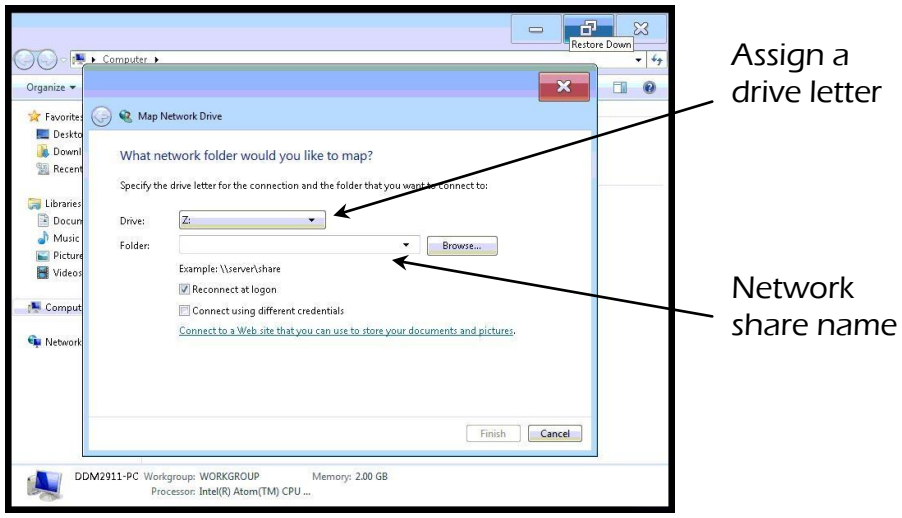


Figure 10.38 – Assign Drive Letter and Enter Network Share Name

7) Click on **Connect using a different user name**. Enter the user name and password of someone who has permission to access the network share and click **OK**.

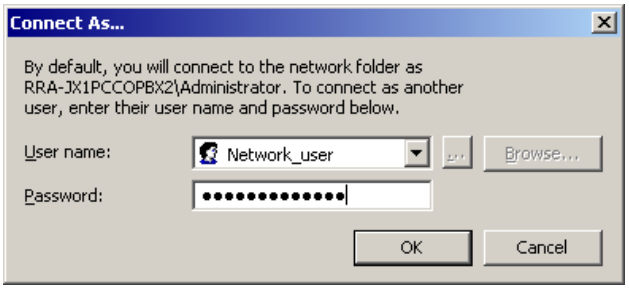


Figure 10.39 – Enter User Name and Password to Access Network Share.

8) Click **Finish**.

9) Close the Control Panel window by clicking the X in the top right hand corner of the windows. This will return you to the digital density meter control menu. Select **Turn Disk Protection On**. The system will display a message that the K86200 / K86201 will restart. Click Yes to continue.

This information is intended for the IT support personnel. Under certain instances the DDM may not remember the User name and Password combination used to map to the network drive. This can be overcome by using the Windows NET USE command. Perform the following actions:

1) Turn off the K86200 / K86201's Disk Protection (shown in steps 2 – 7).
2) Enter the Windows 7 Embedded Control Panel (shown in steps 8 – 11).
3) In the Control Panel address bar enter C:\Windows\System32\cmd.exe to bring up the command window.
4) At the command prompt type:

   NET USE y: \\server_name\share_name /savecred /persistent:yes

   Where:
   y: is the drive letter you want to map the share to.

   server_name is the name of the server the share resides on

   share_name is the name of the share you are mapping to

   /savecred will save the user credentials to be used to access the network share. **NOTE**: Access the mapped drive while still in control panel. The system will prompt you for the user credentials. Enter the credentials this one time and the system will remember the user credentials.

   /persistent:yes will make the mapping persist even with a system power down.

5) You will then be prompted to input the User Name and Password to be used to access the network share.
6) Turn disk protection back on and reboot the system.

After the system restarts, the K86200 / K86201 contains the mapping to the network share.

10.5 Importing/Exporting the Configuration Settings

Exporting the Configuration Settings

1) Enter the menu by pressing the **Menu** button.

Figure 10.40 – Menu

2) Select **Operational Parameters** from the menu.

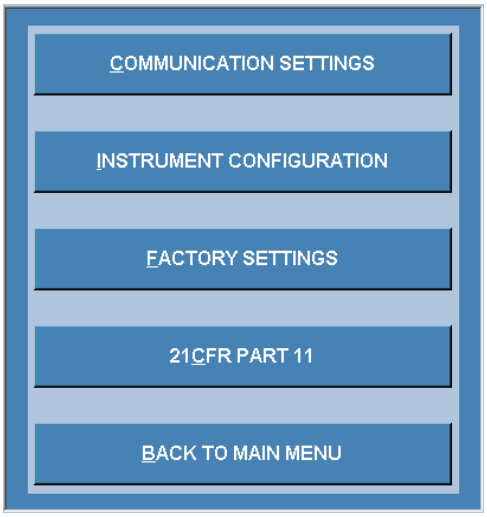


Figure 10.41 – Operational Parameters menu

3) Select Instrument Configuration from the Operational Parameters menu.

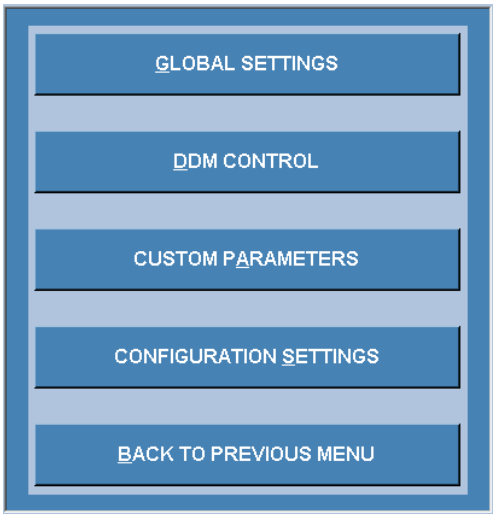


Figure 10.42 – Instrument Configuration menu

4) Select **Configuration Settings** from the Instrument Configuration menu.

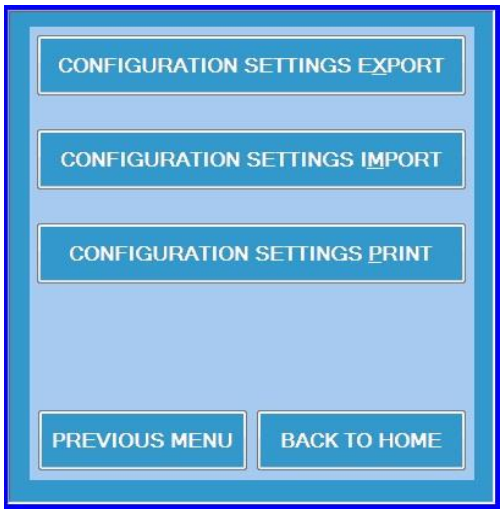


Figure 10.43 – Configuration Settings menu.

5) Select **Configuration Settings Export** from the Configuration Settings menu. Select the path to save the configuration settings file to. It is recommended that you save these files to a USB save device so that you have an external copy.

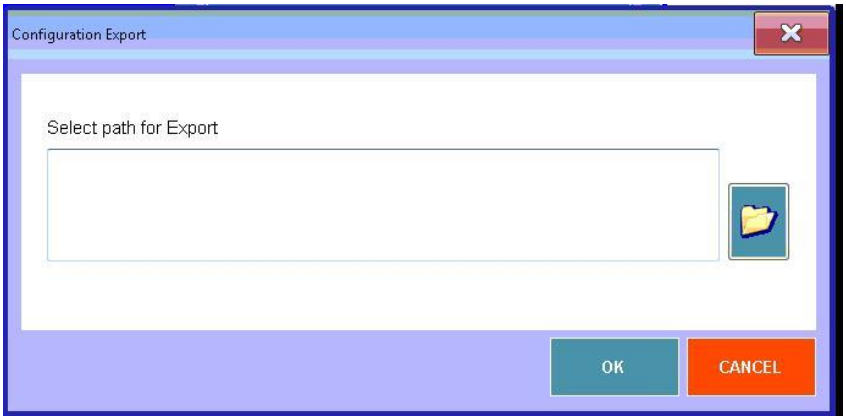


Figure 10.44– Configuration Export Path

6) When the export is successful you will see the screen shown in figure 10.45.

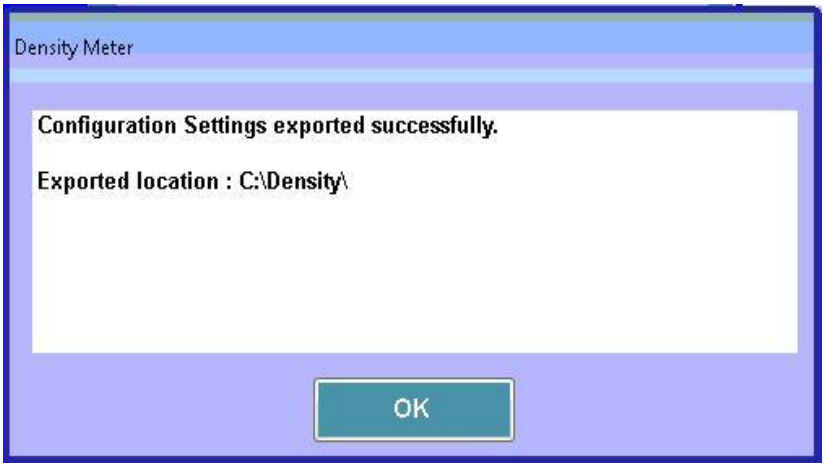


Figure 10.45– Successful Export

Importing the Configuration Settings

1) Enter the menu by pressing the menu button (see figure 10.65 above). Navigate the menus to the **Menu->Operational Parameters->Instrument Configuration->Configuration Settings** menu.

2) Click the **Configuration Settings Import** button and navigate to the location you saved the configuration files to. See figure 10.46 below.

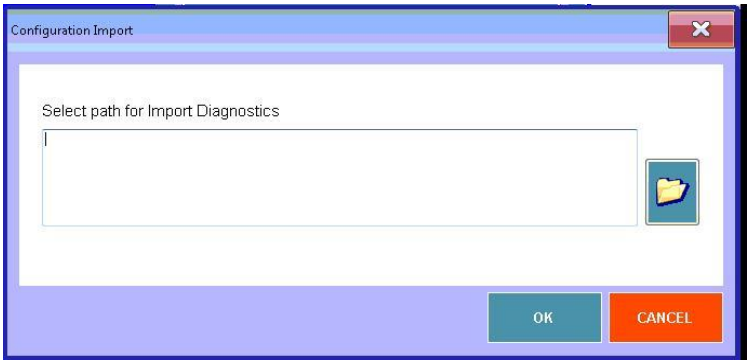


Figure 10.46 – Configuration Import Path

3) After the configuration settings have been imported you will see the screen shown in figure 10.47 below. Click the **OK** button and the instrument will reboot. The import is finished.

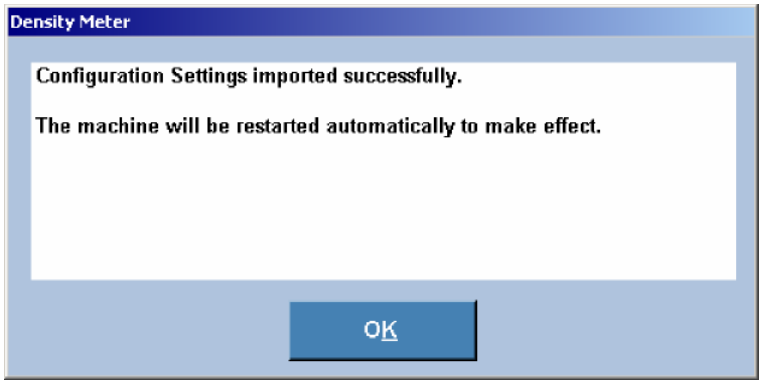


Figure 10.47 – Configuration Import Successful

11. 21CFR Part 11

11.1 Enable 21CFR

If purchased, this feature is password protected at several levels. By default the factory Administrator's password is 1234. It is very important that the Administrator changes this password as soon as possible. But it is also necessary for the Administrator to use this password to gain access into the menus by which this is possible.

From the Main menu Select; Operational Parameters. The following window will open.

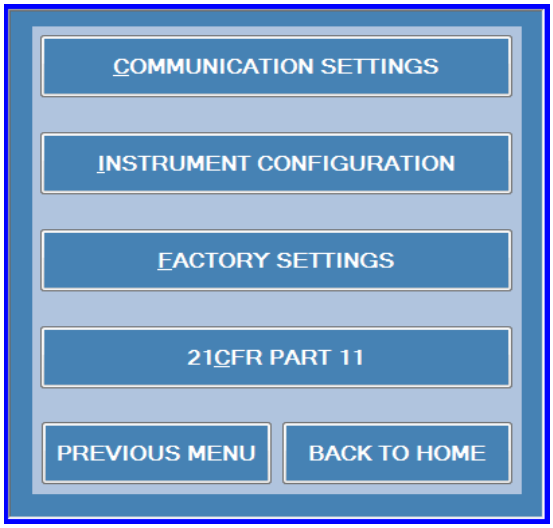


Figure 11.1. Gaining access to 21CFR Part 11

Select 21CFR Part 11 and the following window will open.

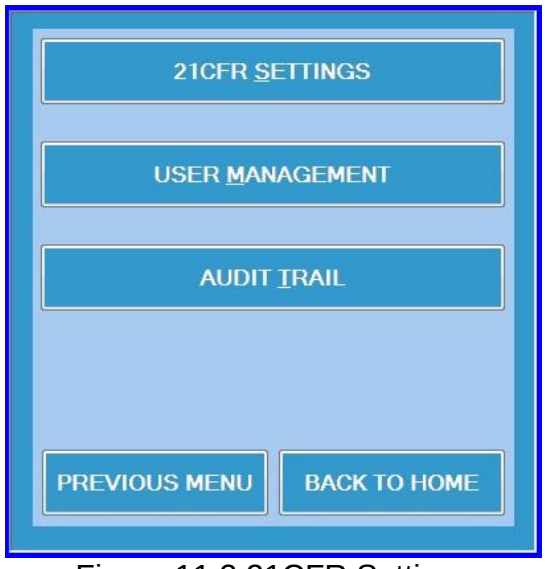


Figure 11.2 21CFR Settings

To enable 21CFR select 21CFR Settings.You will be asked to provide a User Name and a Password. Enter the default Administrator's password of 1234 and Click OK.

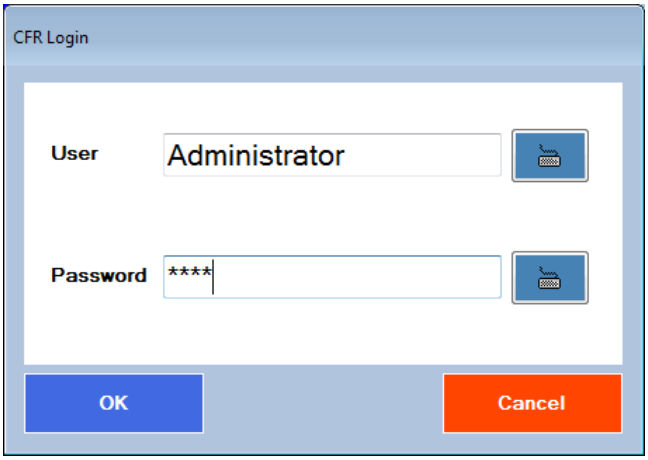


Figure 11.3. Enter password for gaining access to 21CFR settings

After entering the User Name and Password, the following Welcome Administrator window will open:

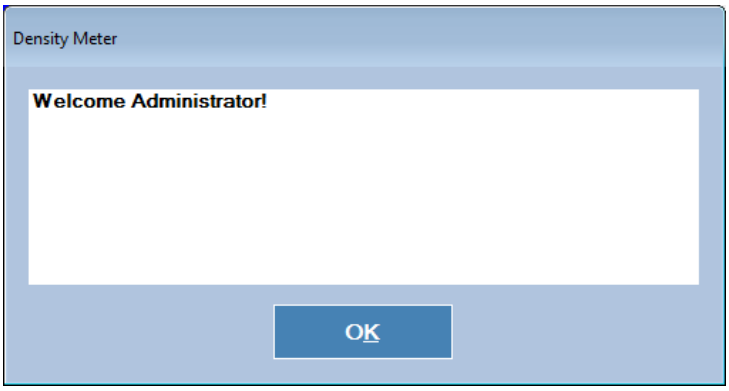


Figure 11.4

Click OK. And the following window will open. Click on the Red NO in "Enable 21CFR"to become a Green YES and then Click OK

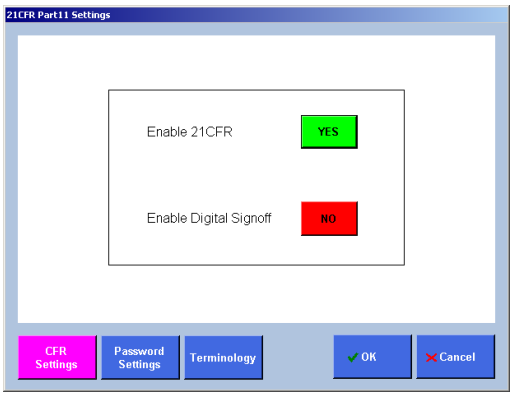


Figure 11.5. 21CFR Part11 Settings

21CFR is now Enabled. Once enabled, only the Administrator can access the Menu. You will now be at the same window as shown in Figure 11.2. Select User Management. Again, you will be asked to provide your Administrator's User Name and Password of 1234. After doing so and clicking OK, the following menu will open.

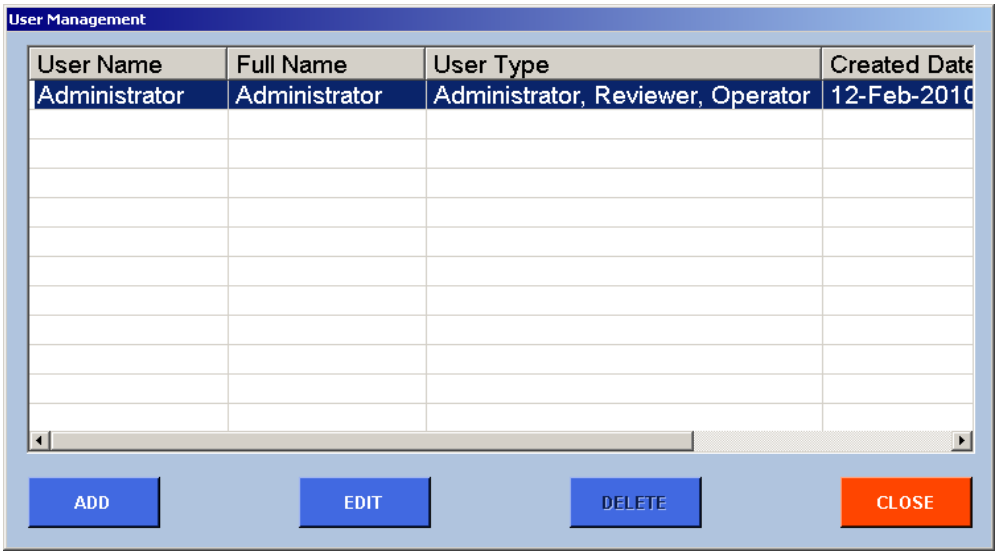


Figure 11.6. User management in 21CFR Part11

It is most important at this time to change the Administrator's Password. Highlight Administrator and Select EDIT.

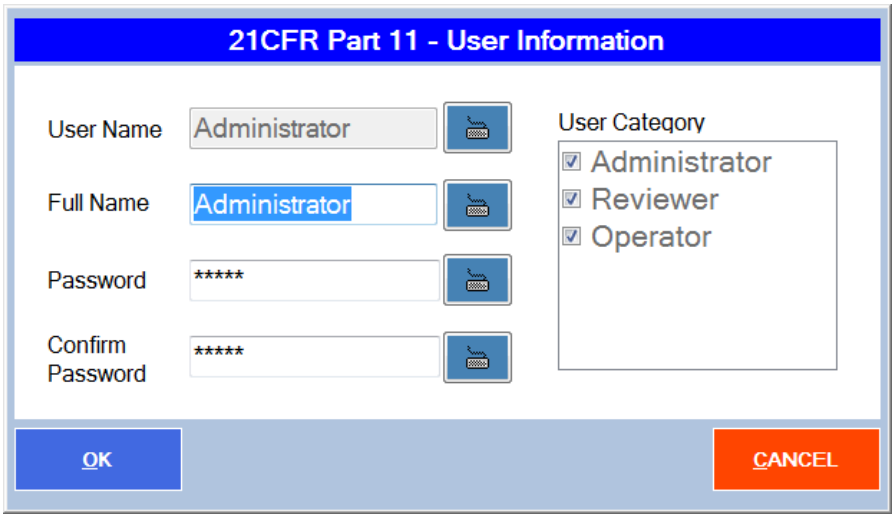


Figure 11.7. Changing the information of any user

You will need to type in a new password and then confirm the same. You may also wish to enter your Full Name at this time.

Now that 21CFR has been enabled and your Administrator's Password has been changed; the next step is to ADD Operators, and optionally, ADD Reviewers. See Chapter 11.2 for discussion concerning Reviewers.

From the window as shown in Figure 11.6 select ADD. You may now type in the User Name, Full Name, their Passwords (each user must have a different password) and select their User Type. There are 3 different User Types:

Administrator: Only the administrator may ADD, EDIT, or DELETE users.
Operator: An operator can make measurements and select methods, but cannot make changes to those methods.
Reviewer: A reviewer can only accept or reject results which have been made by another at an earlier time. A reviewer can make comments that are attached to those results which are reviewed.

It is possible that a User may have more than one User Type.

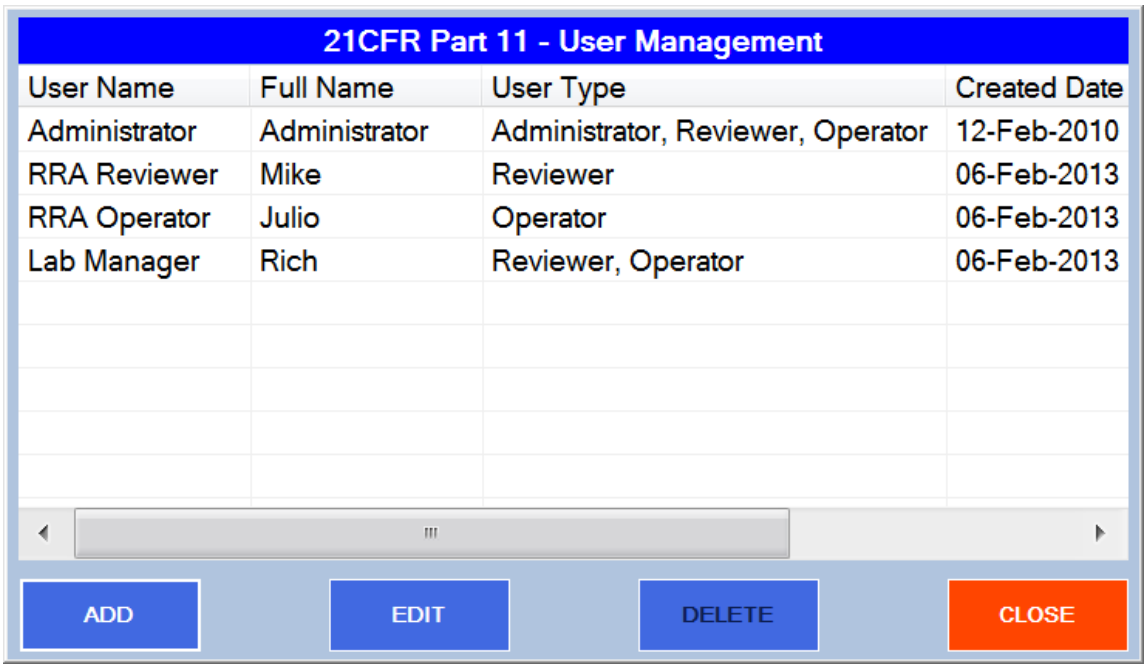


Figure 11.8. Different Privileges

It is possible at this time for the Administrator to go back into 21CFR Settings as shown in Figure 11.5 and establish the rules for the use of passwords. The character length of the passwords, expiration, and number of false attempts to entire a menu with the incorrect passwords can be set. See Figure 11.9

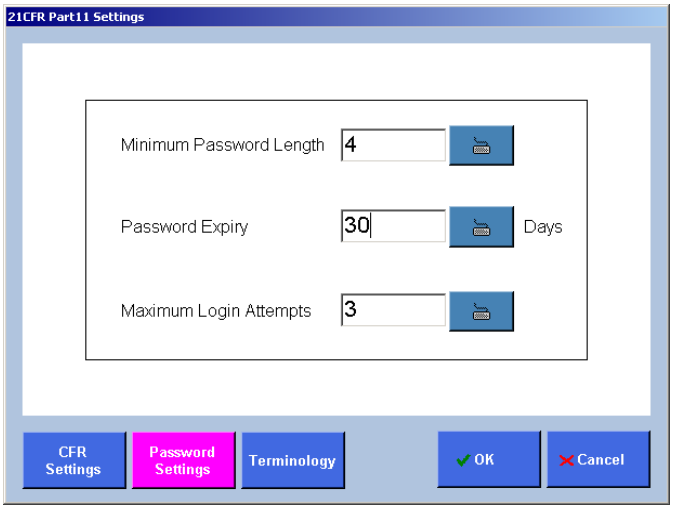


Figure 11.9. Additional rules for 21CFR users

11.2 Enable Digital Signoff

This feature provides the ability to have results done by an Operator to be Reviewed. This review will be digitally attached to those results indicating the Reviewer's Name, the date and time and whether those results were accepted or rejected.

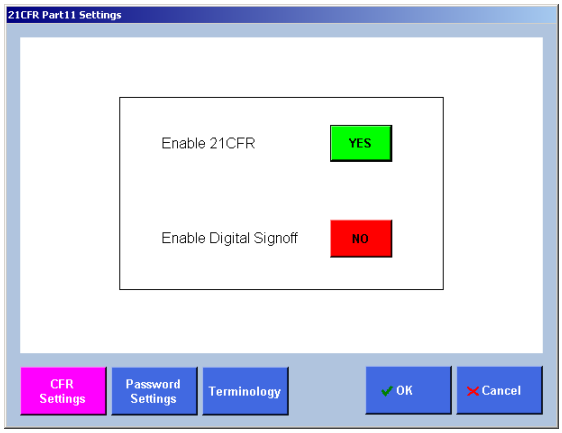


Figure 11.10. Enabling digital signoff

Enable this feature by clicking on the red NO so that it becomes a Green Yes. Only those person(s) who were identified by the Administrator as Reviewers per Chapter 11.1 can accept or reject measurement results. No results, however, can by deleted. The terminology of the acceptance or rejection may be modified by the Administrator.

This Digital Signoff by the Reviewer will be indicated both in the Print Out of the results and in all Exported Data. If Digital Signoff is enabled but the results were not reviewed, this too will be indicated on both hard copy of results and electronic data saved or exported.

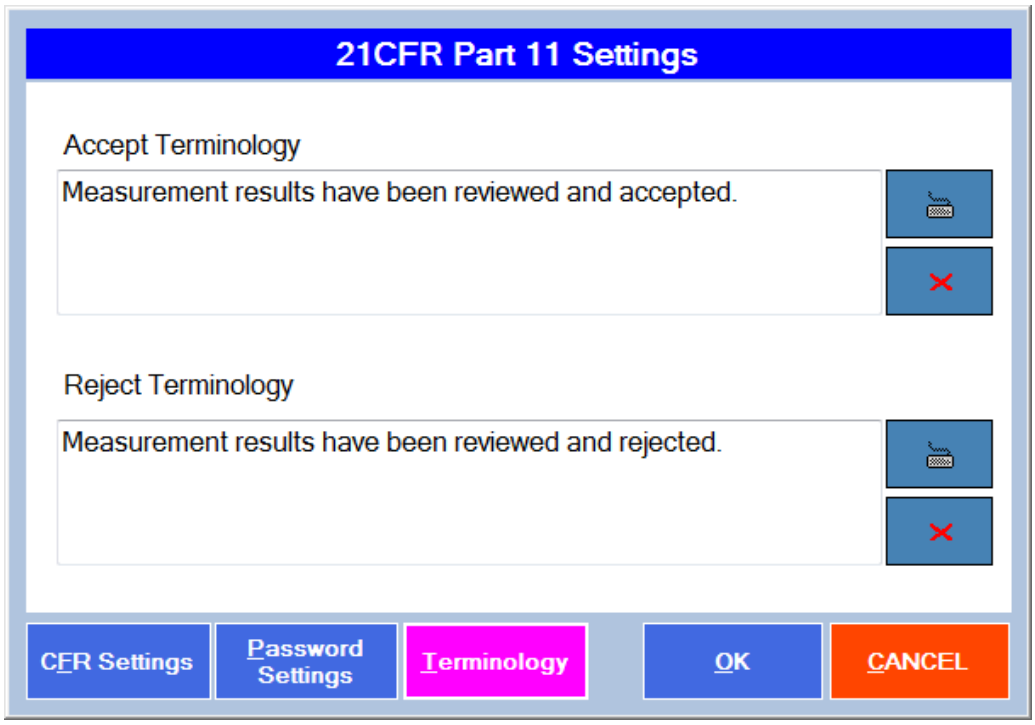


Figure 11.12. Acceptance terminology

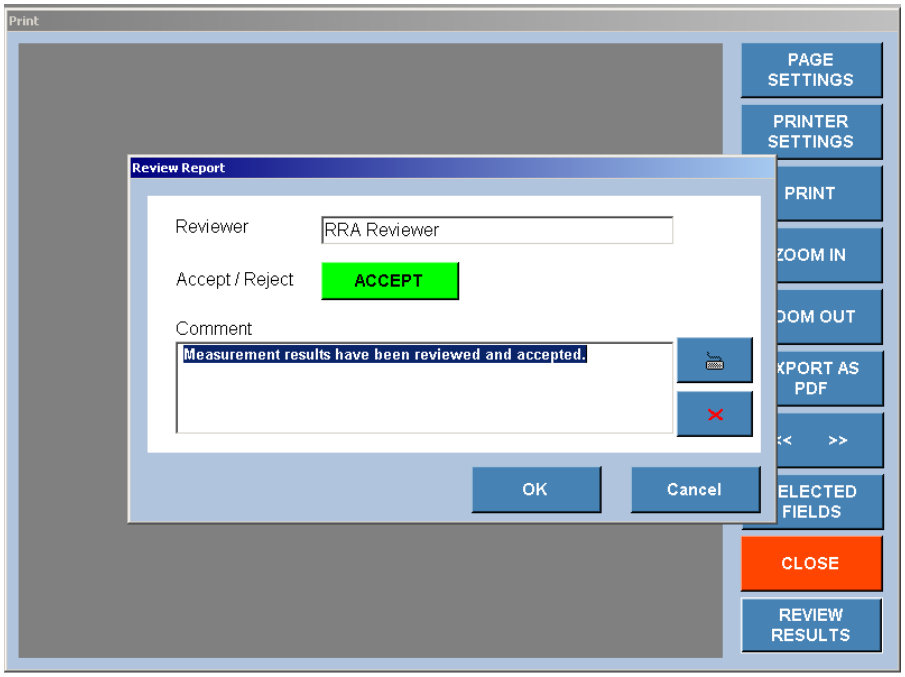


Figure 11.13. Rejection terminology (same as acceptance)

11.3 Audit Trail

Select 21CFR Part 11 and the following window will open

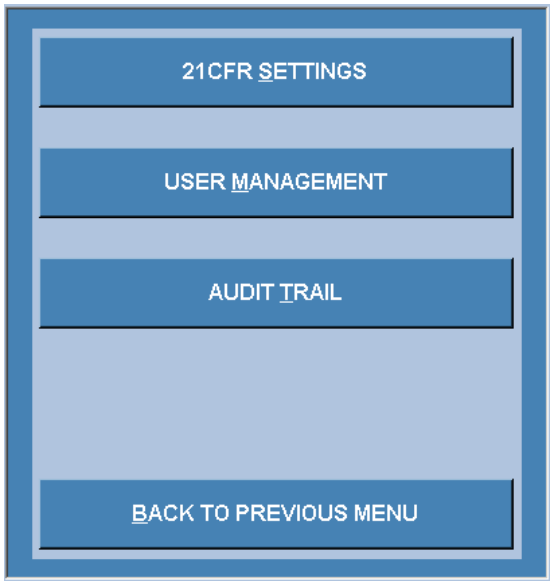
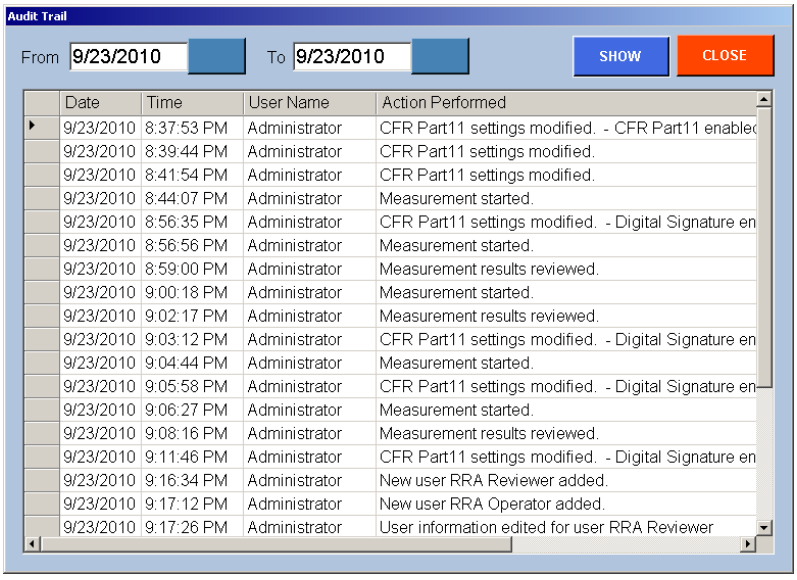


Figure 11.14. 21CFR Part 11 menu

Select audit trail and you will be able to look at the entire audit trail.



Date	Time	User Name	Action Performed
9/23/2010	8:37:53 PM	Administrator	CFR Part11 settings modified. - CFR Part11 enable
9/23/2010	8:39:44 PM	Administrator	CFR Part11 settings modified.
9/23/2010	8:41:54 PM	Administrator	CFR Part11 settings modified.
9/23/2010	8:44:07 PM	Administrator	Measurement started.
9/23/2010	8:56:35 PM	Administrator	CFR Part11 settings modified. - Digital Signature en
9/23/2010	8:56:56 PM	Administrator	Measurement started.
9/23/2010	8:59:00 PM	Administrator	Measurement results reviewed.
9/23/2010	9:00:18 PM	Administrator	Measurement started.
9/23/2010	9:02:17 PM	Administrator	Measurement results reviewed.
9/23/2010	9:03:12 PM	Administrator	CFR Part11 settings modified. - Digital Signature en
9/23/2010	9:04:44 PM	Administrator	Measurement started.
9/23/2010	9:05:58 PM	Administrator	CFR Part11 settings modified. - Digital Signature en
9/23/2010	9:06:27 PM	Administrator	Measurement started.
9/23/2010	9:08:16 PM	Administrator	Measurement results reviewed.
9/23/2010	9:11:46 PM	Administrator	CFR Part11 settings modified. - Digital Signature en
9/23/2010	9:16:34 PM	Administrator	New user RRA Reviewer added.
9/23/2010	9:17:12 PM	Administrator	New user RRA Operator added.
9/23/2010	9:17:26 PM	Administrator	User information edited for user RRA Reviewer

Figure 11.15. Audit trail

12. Automation

A variety of different automated systems are available to use with the K86200 and K86201. These systems may be heated to handle higher viscosity materials. Options of pressure or vacuum for loading samples are available. The system can automate single samples or as many as 240 samples. All systems are modular and can be upgraded at any time. They also have the ability to combine in tandem several different instruments; density meter, refractometer, colorimeter, pH meter, and polarimeter. These systems are summarized below.

12.1 Access to Optional Automation in the K86200 and K86201

From the main screen on the digital density meter push the button at the bottom right, Accessories. The Accessories Menu with now opens as shown in Figure 12.1.

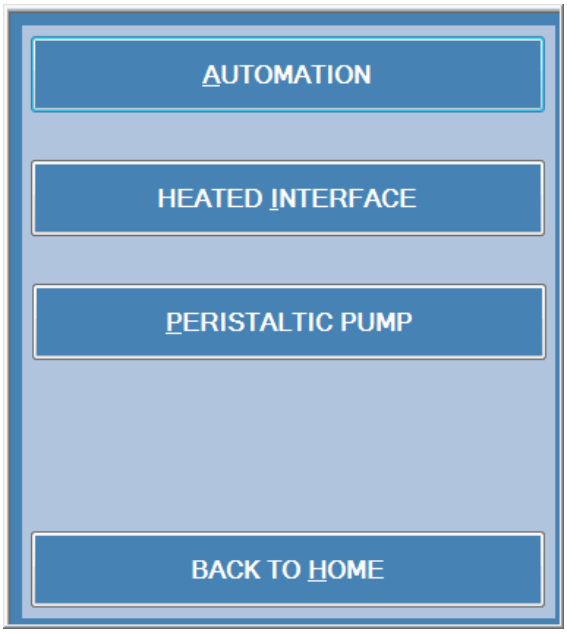


Figure 12.1. Accessories menu

All Accessories are option equipments and they do not come with the standard K86200 or K86201 density meters. Each of these options requires special hardware and software. Please contact your sales representative for more information.

If these options have not been purchased the window as below will appear:

Figure 12.2. Automation not installed message

12.2 Automation Options for the Digital Density Meters

Other than the K86200 and K86201; all other automation option are modular and can be purchased with the original instrument or may be upgraded at the customer's site at a later time. Each of these various automation options are fully covered separated in the Automation Manual. Photos of two of the most popular Automation options are shown below in Figure 12.13. and 12.14. There are numerous other automation options and possibilities; for more information please contact your Koehler Instrument Company Sales Representative.

12.2.1 The ECS Automation Option

This option completely automates the measurement of a single sample.

Figure 12.13. The ECS – Easy Clean System

12.2.2 The Peristaltic Pump Option

This option is only activated when the instrument has been shipped with an external peristaltic pump. Please refer to Figure 12.14.

Figure 12.14. Peristaltic pump option

12.2.3 Full Automation with various Lab Instruments in Tandem

Automation Systems have unmatched flexibility and functionality.

Fig.12.15 A Flavor-Fragrance System for the Simultaneous Measurements of Specific Gravity, Refractive Index, Color, and Optical Rotation. As shown this system can handle up to 120 samples.

12.3.3 Connections from Digital Density Meter to Automation and/or other Instruments

Automation/Manual feed kit for Digital Density Meter Assembly PN: K86243 as shown below is just one method of making secure and quick connections between the Digital Density Meter and other instruments.

Parts Required

1. PN: K86244 - Fitting, Female Luer, ¼-28 male, stainless steel
2. PN: K86245 - Quick Connect, Modified, Luer Lock, ¼-28 female, peek
3. Thread seal, Teflon tape

Figure 12.16 – Parts illustration

Upgrading a system

1. Disconnect the fittings from the density meter
2. Install the 2 stainless fittings in the density meter
3. Install the 2 black and red fittings to the tubing lines
4. Connect the twist lock fittings to the stainless fittings

Switching from automation to manual feed

1. Close the Rudolph Automation GUI.
2. Disconnect the black and red fittings from the stainless fittings. Make sure the stainless fittings stay connected to the density meter.
3. Use a syringe to feed the sample and solvents to the density meter.
4. Use the built in density meter air pump to dry the U-tube.

Figure 12.17 – Assembled &Connected to Digital Density Meter

13. Factory Testing – QC – Electronic Copy of Manual

A variety of menus and information is available on the digital density meters to assist with confirming proper documentation.

13.1 System Information

To learn the instrument's Serial Number, Software and Firmware Versions:

Select **Menu** from the Main Screen > Select **System Information**

A Window, similar to the following, will open providing all this information.

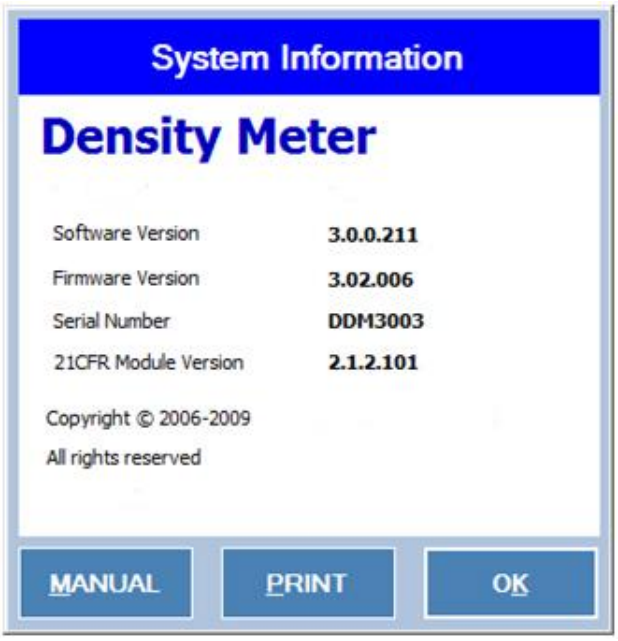


Figure 13.1. System information

13.2 QC Procedure at Factory IQ/OQ/PQ

From the Method Management option you can select "Factory QC Testing" method and then select "RESULTS". You will get a window similar to the Figure 13.2.

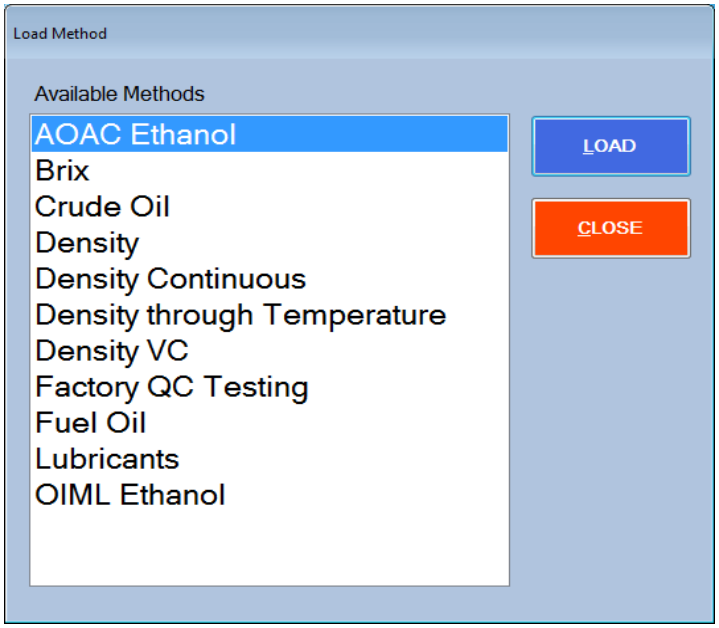


Figure 13.2. Factory QC Results

All measurement results can be viewed within this Method. This is a Read Only Document and cannot be deleted or altered.

13.3 Electronic Copy of User's Manual

As can be seen in Figure 13.1 above a electronic copy of the User's Manual is also available. From that Window select **Manual**.

There is also a F.A.Q section that may also be found with the **Help** button located in the upper right of the main screen.

The following Window will open as shown in Figure 13.3. Help content is similar to the one shown in Figure 13.4

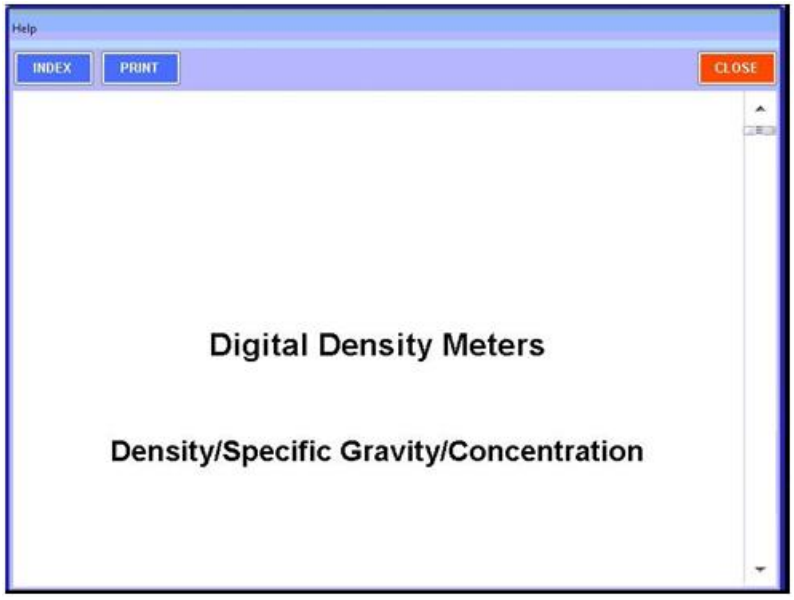


Figure 13.3. Digital copy of the user's manual

Figure 13.4. Help content

Just click on the topic or chapter of interest and the program will immediately jump to that area.

13.4 Help

Access to Help is from the Main Screen in the upper right hand corner. When you push Help you will see a window as shown in Figure 13.5.

Within Help you may found the User's Manual, Contact names, phone numbers and email addresses.

There is also information about a remote desktop sharing program; TeamViewer™. This software permits both training of operators as well as troubleshooting done at remote location.

The most frequently asked questions regarding the measurements and applications of the K86200 and K86201 are answered here and you may gain access by clicking on any topic of your interest

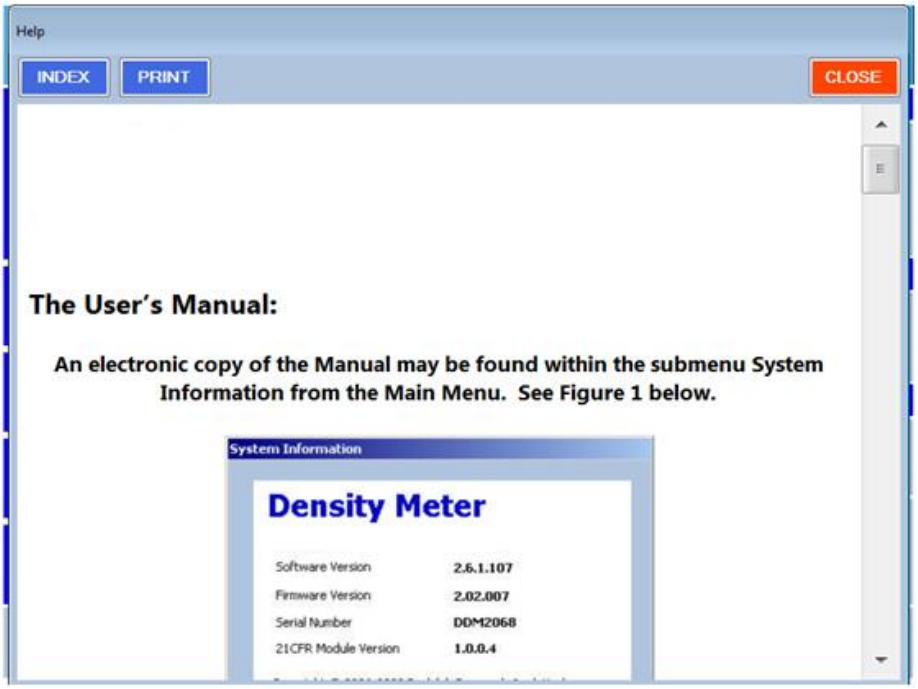


Figure 13.5. Help button

Appendix A – Technical Specifications

Measurement Ranges:	Density: **0 to 3 g/cm^3** Temperature: **0 °C to 90 °C** Pressure: **0 to 10 bars**
Measurement Modes:	**Continuous, Single, Multiple**
Measurement Technique:	Mechanical Oscillator Method
Accuracy, K86200	Density: **0.00005 g/cm^3** Temperature: **0.03 °C**
Accuracy, K86201	Density: **0.0001 g/cm^3** Temperature: **0.05ºC**
Repeatability, K86200	Density: **0.00001 g/cm^3** Temperature: **0.01 °C**
Repeatability, K86201	Density: **0.00005 g/cm^3** Temperature: **0.02 ºC**
Resolution:	Density: **0.00001 g/cm^3** Temperature: **0.01 °C**
Minimum Sample Volume:	1 ml, approximately
Wetted Materials:	Borosilicate glass, PTFE, ECTFE (Halar)
Display:	10.4 inch diagonal, 800-600 pixels, color, Flat Panel Monitor with Chemical & Scratch Resistant Touch Screen Interface, 300 bit brightness, gasketted for spill protection, with anti-glare wide viewing angle.
Communication Interface:	Touch Screen User Interface 5 – USB Ports 1 – Ethernet Port 2 – RS232 Ports Keyboard, Bar Code Scanner, Mouse, Network Capabilities
Video Magnification	VideoView^{TM} Video-assisted view of cell, capable of 10X magnification with Scanning Camera providing an entire view of the measuring cell
Internal Memory	8 GB non-removable Compact Flash
Dimensions	18"(L) x 10" (W) x 13" (H) 45.7cm x 25.4 cm x 33 cm
Weight	40 lbs. (18.1 kg)
Power Supply	85-260 VAC; 48-62 Hz
Power Consumption	140 Watts at Peak

Appendix B – Water Density Table

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.999840	0.999846	0.999853	0.999859	0.999865	0.999871	0.999877	0.999883	0.999888	0.999893
1	0.999899	0.999903	0.999908	0.999913	0.999917	0.999921	0.999925	0.999929	0.999933	0.999937
2	0.999940	0.999943	0.999946	0.999949	0.999952	0.999954	0.999956	0.999959	0.999961	0.999962
3	0.999964	0.999966	0.999967	0.999968	0.999969	0.999970	0.999971	0.999971	0.999972	0.999972
4	0.999972	0.999972	0.999972	0.999971	0.999971	0.999970	0.999969	0.999968	0.999967	0.999965
5	0.999964	0.999962	0.999960	0.999958	0.999956	0.999954	0.999951	0.999949	0.999946	0.999943
6	0.999940	0.999937	0.999934	0.999930	0.999926	0.999923	0.999919	0.999915	0.999910	0.999906
7	0.999901	0.999897	0.999892	0.999887	0.999882	0.999877	0.999871	0.999866	0.999860	0.999854
8	0.999848	0.999842	0.999836	0.999829	0.999823	0.999816	0.999809	0.999802	0.999795	0.999788
9	0.999781	0.999773	0.999766	0.999758	0.999750	0.999742	0.999734	0.999725	0.999717	0.999708
10	0.999699	0.999691	0.999682	0.999672	0.999663	0.999654	0.999644	0.999635	0.999625	0.999615
11	0.999605	0.999595	0.999584	0.999574	0.999563	0.999553	0.999542	0.999531	0.999520	0.999508
12	0.999497	0.999486	0.999474	0.999462	0.999450	0.999438	0.999426	0.999414	0.999402	0.999389
13	0.999377	0.999364	0.999351	0.999338	0.999325	0.999312	0.999298	0.999285	0.999271	0.999258
14	0.999244	0.999230	0.999216	0.999202	0.999187	0.999173	0.999158	0.999144	0.999129	0.999114
15	0.999099	0.999084	0.999069	0.999053	0.999038	0.999022	0.999006	0.998991	0.998975	0.998959
16	0.998942	0.998926	0.998910	0.998893	0.998876	0.998860	0.998843	0.998826	0.998809	0.998792
17	0.998774	0.998757	0.998739	0.998722	0.998704	0.998686	0.998668	0.998650	0.998632	0.998613
18	0.998595	0.998576	0.998558	0.998539	0.998520	0.998501	0.998482	0.998463	0.998443	0.998424
19	0.998404	0.998385	0.998365	0.998345	0.998325	0.998305	0.998285	0.998265	0.998244	0.998224
20	0.998203	0.998182	0.998162	0.998141	0.998120	0.998099	0.998077	0.998056	0.998035	0.998013
21	0.997991	0.997970	0.997948	0.997926	0.997904	0.997882	0.997859	0.997837	0.997815	0.997792
22	0.997769	0.997747	0.997724	0.997701	0.997678	0.997654	0.997631	0.997608	0.997584	0.997561
23	0.997537	0.997513	0.997490	0.997466	0.997442	0.997417	0.997393	0.997369	0.997344	0.997320
24	0.997295	0.997270	0.997246	0.997221	0.997196	0.997170	0.997145	0.997120	0.997094	0.997069
25	0.997043	0.997018	0.996992	0.996966	0.996940	0.996914	0.996888	0.996861	0.996835	0.996809
26	0.996782	0.996755	0.996729	0.996702	0.996675	0.996648	0.996621	0.996594	0.996566	0.996539

27	0.996511	0.996484	0.996456	0.996428	0.996400	0.996373	0.996344	0.996316	0.996288	0.996260
°C	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
28	0.996232	0.996203	0.996174	0.996146	0.996117	0.996088	0.996059	0.996030	0.996001	0.995972
29	0.995943	0.995913	0.995884	0.995854	0.995825	0.995795	0.995765	0.995735	0.995705	0.995675
30	0.995645	0.995615	0.995584	0.995554	0.995523	0.995493	0.995462	0.995431	0.995401	0.995370
31	0.995339	0.995307	0.995276	0.995245	0.995214	0.995182	0.995151	0.995119	0.995087	0.995056
32	0.995024	0.994992	0.994960	0.994928	0.994895	0.994863	0.994831	0.994798	0.994766	0.994733
33	0.994700	0.994667	0.994635	0.994602	0.994569	0.994535	0.994502	0.994469	0.994436	0.994402
34	0.994369	0.994335	0.994301	0.994268	0.994234	0.994200	0.994166	0.994132	0.994097	0.994063
35	0.994029	0.993994	0.993960	0.993925	0.993891	0.993856	0.993821	0.993786	0.993751	0.993716
36	0.993681	0.993646	0.993610	0.993575	0.993540	0.993504	0.993468	0.993433	0.993397	0.993361
37	0.993325	0.993289	0.993253	0.993217	0.993181	0.993144	0.993108	0.993072	0.993035	0.992998
38	0.992962	0.992925	0.992888	0.992851	0.992814	0.992777	0.992740	0.992703	0.992665	0.992628
39	0.992591	0.992553	0.992515	0.992478	0.992440	0.992402	0.992364	0.992326	0.992288	0.992250
40	0.992212	0.992174	0.992135	0.992097	0.992058	0.992020	0.991981	0.991942	0.991904	0.991865
41	0.991826	0.991787	0.991748	0.991708	0.991669	0.991630	0.991590	0.991551	0.991511	0.991472
42	.991432 ,	0.991392	0.991353	0.991313	0.991273	0.991233	0.991193	0.991152	0.991112	0.991072
43	0.991031	0.990991	0.990950	0.990910	0.990869	0.990828	0.990787	0.990747	0.990706	0.990665
44	0.990623	0.990582	0.990541	0.990500	0.990458	0.990417	0.990375	0.990334	0.990292	0.990250
45	0.990208	0.990167	0.990125	0.990083	0.990040	0.989998	0.989956	0.989914	0.989871	0.989829
46	0.989786	0.989744	0.989701	0.989658	0.989616	0.989573	0.989530	0.989487	0.989444	0.989401
47	0.989358	0.989314	0.989271	0.989228	0.989184	0.989141	0.989097	0.989053	0.989010	0.988966
48	0.988922	0.988878	0.988834	0.988790	0.988746	0.988702	0.988657	0.988613	0.988569	0.988524
49	0.988480	0.988435	0.988390	0.988346	0.988301	0.988256	0.988211	0.988166	0.988121	0.988076
50	0.988030	0.987985	0.987940	0.987894	0.987849	0.987804	0.987758	0.987712	0.987667	0.987621
51	0.987575	0.987529	0.987483	0.987437	0.987391	0.987345	0.987298	0.987252	0.987206	0.987159
52	0.987113	0.987066	0.987020	0.986973	0.986926	0.986879	0.986833	0.986786	0.986739	0.986692
53	0.986644	0.986597	0.986550	0.986503	0.986455	0.986408	0.986360	0.986313	0.986265	0.986217
54	0.986170	0.986122	0.986074	0.986026	0.985978	0.985930	0.985882	0.985833	0.985785	0.985737
55	0.985688	0.985640	0.985591	0.985543	0.985494	0.985446	0.985397	0.985348	0.985299	0.985250

56	0.985201	0.985152	0.985103	0.985054	0.985004	0.984955	0.984906	0.984856	0.984807	0.984757
57	0.984708	0.984658	0.984608	0.984558	0.984509	0.984459	0.984409	0.984359	0.984308	0.984258
°C	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
58	0.984208	0.984158	0.984107	0.984057	0.984007	0.983956	0.983905	0.983855	0.983804	0.983753
59	0.983702	0.983652	0.983601	0.983550	0.983499	0.983448	0.983396	0.983345	0.983294	0.983242
60	0.983191	0.983140	0.983088	0.983036	0.982985	0.982933	0.982881	0.982829	0.982778	0.982726
61	0.982674	0.982621	0.982569	0.982517	0.982465	0.982413	0.982360	0.982308	0.982255	0.982203
62	0.982150	0.982098	0.982045	0.981992	0.981939	0.981886	0.981834	0.981780	0.981727	0.981674
63	0.981621	0.981568	0.981515	0.981461	0.981408	0.981354	0.981301	0.981247	0.981194	0.981140
64	0.981086	0.981032	0.980979	0.980925	0.980871	0.980817	0.980763	0.980708	0.980654	0.980600
65	0.980546	0.980491	0.980437	0.980382	0.980328	0.980273	0.980219	0.980164	0.980109	0.980054
66	0.980000	0.979945	0.979890	0.979835	0.979780	0.979724	0.979669	0.979614	0.979559	0.979503
67	0.979448	0.979392	0.979337	0.979281	0.979226	0.979170	0.979114	0.979058	0.979002	0.978946
68	0.978890	0.978834	0.978778	0.978722	0.978666	0.978610	0.978553	0.978497	0.978441	0.978384
69	0.978328	0.978271	0.978214	0.978158	0.978101	0.978044	0.977987	0.977930	0.977874	0.977816
70	0.977759	0.977702	0.977645	0.977588	0.977531	0.977473	0.977416	0.977358	0.977301	0.977243
71	0.977186	0.977128	0.977070	0.977012	0.976955	0.976897	0.976839	0.976781	0.976723	0.976665
72	0.976607	0.976548	0.976490	0.976432	0.976374	0.976315	0.976257	0.976198	0.976140	0.976081
73	0.976022	0.975963	0.975905	0.975846	0.975787	0.975728	0.975669	0.975610	0.975551	0.975492
74	0.975432	0.975373	0.975314	0.975255	0.975195	0.975136	0.975076	0.975017	0.974957	0.974897
75	0.974838	0.974778	0.974718	0.974658	0.974598	0.974538	0.974478	0.974418	0.974358	0.974298
76	0.974237	' .974177	0.974117	0.974056	0.973996	0.973935	0.973875	0.973814	0.973753	0.973693
77	0.973632	0.973571	0.973510	0.973449	0.973388	0.973327	0.973266	0.973205	0.973144	0.973083
78	0.973021	0.972960	0.972899	0.972837	0.972776	0.972714	0.972653	0.972591	0.972529	0.972468
79	0.972406	0.972344	0.972282	0.972220	0.972158	0.972096	0.972034	0.971972	0.971910	0.971847
80	0.971785	0.971723	0.971660	0.971598	0.971535	0.971473	0.971410	0.971348	0.971285	0.971222
81	0.971159	0.971096	0.971034	0.970971	0.970908	0.970844	0.970781	0.970718	0.970655	0.970592
82	0.970528	0.970465	0.970402	0.970338	0.970275	0.970211	0.970148	0.970084	0.970020	0.969956
83	0.969893	0.969829	0.969765	0.969701	0.969637	0.969573	0.969509	0.969445	0.969380	0.969316
84	0.969252	0.969188	0.969123	0.969059	0.968994	0.968930	0.968865	0.968800	0.968736	0.968671

85	0.968606	0.968541	0.968477	0.968412	0.968347	0.968282	0.968216	0.968151	0.968086	0.968021
86	0.967956	0.967890	0.967825	0.967760	0.967694	0.967629	0.967563	0.967497	0.967432	0.967366
87	0.967300	0.967234	0.967169	0.967103	0.967037	0.966971	0.966905	0.966838	0.966772	0.966706
°C	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
88	0.966640	0.966574	0.966507	0.966441	0.966374	0.966308	0.966241	0.966175	0.966108	0.966042
89	0.965975	0.965908	0.965841	0.965774	0.965707	0.965640	0.965573	0.965506	0.965439	0.965372
90	0.965305	0.965238	0.965170	0.965103	0.965036	0.964968	0.964901	0.964833	0.964765	0.964698
91	0.964630	0.964562	0.964495	0.964427	0.964359	0.964291	0.964223	0.964155	0.964087	0.964019
92	0.963951	0.963882	0.963814	0.963746	0.963677	0.963609	0.963541	0.963472	0.963404	0.963335
93	0.963266	0.963198	0.963129	0.963060	0.962991	0.962922	0.962854	0.962785	0.962716	0.962646
94	0.962577	0.962508	0.962439	0.962370	0.962300	0.962231	0.962162	0.962092	0.962023	0.961953
95	0.961884	0.961814	0.961744	0.961675	0.961605	0.961535	0.961465	0.961395	0.961325	0.961255
96	0.961185	0.961115	0.961045	0.960975	0.960905	0.960834	0.960764	0.960694	0.960623	0.960553
97	0.960482	0.960412	0.960341	0.960271	0.960200	0.960129	0.960058	0.959988	0.959917	0.959846
98	0.959775	0.959704	0.959633	0.959562	0.959490	0.959419	0.959348	0.959277	0.959205	0.959134
99	0.959062	0.958991	0.958920	0.958848	0.958776	0.958705	0.958633	0.958561	0.958489	0.958418
100	0.958346	0.958273	0.958201	0.958129	0.958057	0.957985	0.957913	0.957840	0.957768	0.957696

Appendix C – Air Density Table

°C	Density in g/cm^3 at the pressure in mbar (=hPa)							
	900	920	940	960	980	1000	1013.25	1050
-10	0.001192	0.001219	0.001245	0.001272	0.001298	0.001325	0.001342	0.001391
-5	0.001170	0.001196	0.001222	0.001248	0.001274	0.001300	0.001317	0.001365
0	0.001148	0.001174	0.001200	0.001225	0.001251	0.001276	0.001293	0.001340
5	0.001128	0.001153	0.001178	0.001203	0.001228	0.001253	0.001270	0.001316
10	0.001108	0.001132	0.001157	0.001182	0.001206	0.001231	0.001247	0.001293
15	0.001088	0.001113	0.001137	0.001161	0.001185	0.001210	0.001226	0.001270
20	0.001070	0.001094	0.001117	0.001141	0.001165	0.001189	0.001205	0.001248
25	0.001052	0.001075	0.001099	0.001122	0.001145	0.001169	0.001184	0.001227
30	0.001035	0.001058	0.001081	0.001104	0.001127	0.001150	0.001165	0.001207
35	0.001018	0.001040	0.001063	0.001086	0.001108	0.001131	0.001146	0.001187
40	0.001001	0.001024	0.001046	0.001068	0.001090	0.001113	0.001127	0.001168
45	0.000986	0.001008	0.001029	0.001051	0.001073	0.001095	0.001110	0.001150
50	0.000970	0.000992	0.001014	0.001035	0.001057	0.001078	0.001093	0.001132
55	0.000956	0.000977	0.000998	0.001019	0.001041	0.001062	0.001076	0.001115
60	0.000941	0.000962	0.000983	0.001004	0.001025	0.001046	0.001060	0.001098
65	0.000927	0.000948	0.000968	0.000989	0.001010	0.001030	0.001044	0.001082
70	0.000914	0.000934	0.000954	0.000975	0.000995	0.001015	0.001029	0.001066
75	0.000901	0.000921	0.000941	0.000961	0.000981	0.001001	0.001014	0.001051
80	0.000888	0.000908	0.000927	0.000947	0.000967	0.000986	0.000999	0.001036
85	0.000875	0.000895	0.000914	0.000934	0.000953	0.000973	0.000986	0.001021
90	0.000863	0.000882	0.000902	0.000921	0.000940	0.000959	0.000972	0.001007

Air density is affected by the air pressure, temperature and humidity. The density of the air is reduced by decreased air pressure, increased temperatures and increased moisture. Putting this relationship on a table could only be done using 3-D graphing, or using a separate graph for each of the three parameters. One can also calculate air density at various temperatures using the formula

$$\text{Density} = \frac{0.0012930}{1 + 0.00367 \times t} \times \frac{\text{Pressure in mbar}}{1013.25}$$

Where t is temperature in ˚C. Relative Humidity is not accounted for in this formula as it assumes DRY air.

Appendix D – Printers Supported by Windows 7

According to the Windows Embedded Standard 7 documentation, the following printer drivers have been included in the Windows build:

Epson Printers:

EPSON_PX-V630_(M)
Epson_Stylus_C67_Series_(M)
Epson_Stylus_C68_Series_(M)
Epson_Stylus_C87_Series_(M)
Epson_Stylus_C88_Series_(M)
Epson_Stylus_D68_Series_(M)
Epson_Stylus_D88_Series_(M)

Hewlett Packard Printers:

HP_910
HP_915
HP_Business_Inkjet_1000
HP_Business_Inkjet_1200
HP_Business_Inkjet_2200/2250_(HPA)
HP_Business_Inkjet_2230/2280_HPA
HP_CM8000_Color_MFP_Series_PCL6
HP_Color_Inkjet_cp1700
HP_Color_LaserJet_2700_Series_PCL6
HP_Color_LaserJet_2800_Series_PS
HP_Color_LaserJet_9500_PCL_6
HP_Color_LaserJet_CM3530_MFP_PCL6
HP_Color_LaserJet_CM6030_MFP_PCL6
HP_Color_LaserJet_CM6040_MFP_PCL6
HP_Color_LaserJet_CP1510_Series_PCL6
HP_Color_LaserJet_CP2020_Series_PCL6
HP_Color_LaserJet_CP3505_PCL6
HP_Color_LaserJet_CP3525_PCL6
HP_Color_LaserJet_CP4005_PCL6
HP_Color_LaserJet_CP5220_Series_PCL6
HP_Color_LaserJet_CP6015_PCL6
HP_DeskJet_450
HP_DeskJet_460_Series
HP_DeskJet_5100
HP_DeskJet_5550
HP_DeskJet_5600
HP_DeskJet_6940
HP_DeskJet_6940_Series
HP_DeskJet_6980
HP_DeskJet_6980_Series

HP_DeskJet_9800_Printer
HP_DeskJet_D1300_Series
HP_DeskJet_D1400_Series
HP_DeskJet_D1500_Series
HP_DeskJet_D2300_Series
HP_DeskJet_D2400_Series
HP_DeskJet_D2500_Series
HP_DeskJet_D2600_Series
HP_DeskJet_D4100_Series
HP_DeskJet_D4200_Series
HP_DeskJet_D4300_Series
HP_DeskJet_D730
HP_DeskJet_F2100_Series
HP_DeskJet_F2200_Series
HP_DeskJet_F300_Series
HP_DeskJet_F4100_Series
HP_DeskJet_F4200_Series
HP_DeskJet_F4400_Series
HP_DeskJet_F735
HP_Digital_Copier_410
HP_LaserJet_2200_Series_PCL_5
HP_LaserJet_2300_Series_PS
HP_LaserJet_2300L_PS
HP_LaserJet_3050_PCL5
HP_LaserJet_3052_PCL5
HP_LaserJet_3055_PCL5
HP_LaserJet_3390/3392_PCL5
HP_LaserJet_4100_Series_PCL6
HP_LaserJet_4200/4300_PCL6
HP_LaserJet_4250_PCL6
HP_LaserJet_5200_Series_PCL_5
HP_LaserJet_5200L_Series_PCL_5
HP_LaserJet_9050_mfp_PCL6
HP_LaserJet_CP6015_PCL6
HP_LaserJet_M3027_mfp_PCL6
HP_LaserJet_M3035_mfp_PCL6
HP_LaserJet_M4345_mfp_PCL6
HP_LaserJet_M5025_mfp_PCL6
HP_LaserJet_M5035_mfp_PCL6
HP_LaserJet_M9040_MFP_PCL6
HP_LaserJet_M9050_MFP_PCL6
HP_LaserJet_P2015_PCL6
HP_LaserJet_P2050_Series_PCL6
HP_LaserJet_P3004_PCL6
HP_LaserJet_P3005_PCL6
HP_LaserJet_P3011/P3015_PCL6
HP_LaserJet_P4014/P4015_PCL6
HP_LaserJet_P4515_PCL6

HP_OfficeJet_4300_Series
HP_OfficeJet_5600_Series
HP_OfficeJet_6000_E609a_Series
HP_OfficeJet_6000_E609n_Series
HP_OfficeJet_6100_Series
HP_OfficeJet_6200_Series
HP_OfficeJet_6300_Series
HP_OfficeJet_6500_E709a_Series
HP_OfficeJet_6500_E709n_Series
HP_OfficeJet_7100_Series
HP_OfficeJet_7200_Series
HP_OfficeJet_7300_Series
HP_OfficeJet_7400_Series
HP_OfficeJet_D_Series
HP_OfficeJet_H470_Series
HP_OfficeJet_J3500_Series
HP_OfficeJet_J3600_Series
HP_OfficeJet_J4500_Series
HP_OfficeJet_J4660_Series
HP_OfficeJet_J4680_Series
HP_OfficeJet_J5500_Series
HP_OfficeJet_J5700_Series
HP_OfficeJet_J6400_Series
HP_OfficeJet_K7100_Series
HP_OfficeJet_Pro_8000_A809_Series
HP_OfficeJet_Pro_8500_A909a_Series
HP_OfficeJet_Pro_8500_A909g_Series
HP_OfficeJet_Pro_8500_A909n_Series
HP_OfficeJet_Pro_K5300_Series
HP_OfficeJet_Pro_K5400_Series
HP_OfficeJet_Pro_K550_Series
HP_OfficeJet_Pro_K850_Series
HP_OfficeJet_Pro_K8600_Series
HP_OfficeJet_Pro_L7300_Series
HP_OfficeJet_Pro_L7400_Series
HP_OfficeJet_Pro_L7500_Series
HP_OfficeJet_Pro_L7600_Series
HP_OfficeJet_Pro_L7700_Series
HP_Photosmart_2600_Series
HP_Photosmart_2700_Series
HP_Photosmart_3100_Series
HP_Photosmart_3200_Series
HP_Photosmart_3300_Series
HP_Photosmart_8100_Series
HP_Photosmart_8200_Series
HP_Photosmart_8400_Series
HP_Photosmart_8700_Series
HP_Photosmart_A310_Series

HP_Photosmart_A320_Series
HP_Photosmart_A430_Series
HP_Photosmart_A440_Series
HP_Photosmart_A510_Series
HP_Photosmart_A520_Series
HP_Photosmart_A610_Series
HP_Photosmart_A620_Series
HP_Photosmart_A710_Series
HP_Photosmart_A820_Series
HP_Photosmart_B8500_Series
HP_Photosmart_C309a_Series
HP_Photosmart_C3100_Series
HP_Photosmart_C4100_Series
HP_Photosmart_C4200_Series
HP_Photosmart_C4340_Series
HP_Photosmart_C4380_Series
HP_Photosmart_C4400_Series
HP_Photosmart_C4500_Series
HP_Photosmart_C4600_Series
HP_Photosmart_C5100_Series
HP_Photosmart_C5200_Series
HP_Photosmart_C5300_Series
HP_Photosmart_C5500_Series
HP_Photosmart_C6100_Series
HP_Photosmart_C6200_Series
HP_Photosmart_C6300_Series
HP_Photosmart_C7100_Series
HP_Photosmart_C7200_Series
HP_Photosmart_C8100_Series
HP_Photosmart_D5060_Series
HP_Photosmart_D5100_Series
HP_Photosmart_D5300_Series
HP_Photosmart_D5400_Series
HP_Photosmart_D6100_Series
HP_Photosmart_D7100_Series
HP_Photosmart_D7200_Series
HP_Photosmart_D7300_Series
HP_Photosmart_D7400_Series
HP_Photosmart_D7500_Series
HP_Photosmart_Pro_B8300_Series
HP_PSC_1500_Series
HP_PSC_1600_Series

Lexmark:

Lexmark_E120n_(MS)
Lexmark_E232_(MS)
Lexmark_E234_(MS)
Lexmark_E234n_(MS)

Lexmark_E238_(MS)
Lexmark_E240_(MS)
Lexmark_E240n_(MS)
Lexmark_E250d_(MS)
Lexmark_E250dn_(MS)
Lexmark_E260_(MS)
Lexmark_E260d_(MS)
Lexmark_E260dn_(MS)
Lexmark_E323_(MS)
Lexmark_E330_(MS)
Lexmark_E332n_(MS)
Lexmark_E340_(MS)
Lexmark_E342n_(MS)
Lexmark_E350d_(MS)
Lexmark_E352dn_(MS)
Lexmark_E360d_(MS)
Lexmark_E360dn_(MS)
Lexmark_E450dn_(MS)
Lexmark_E460dn_(MS)
Lexmark_E460dw_(MS)
Lexmark_T650_(MS)
Lexmark_T652_(MS)
Lexmark_T654_(MS)