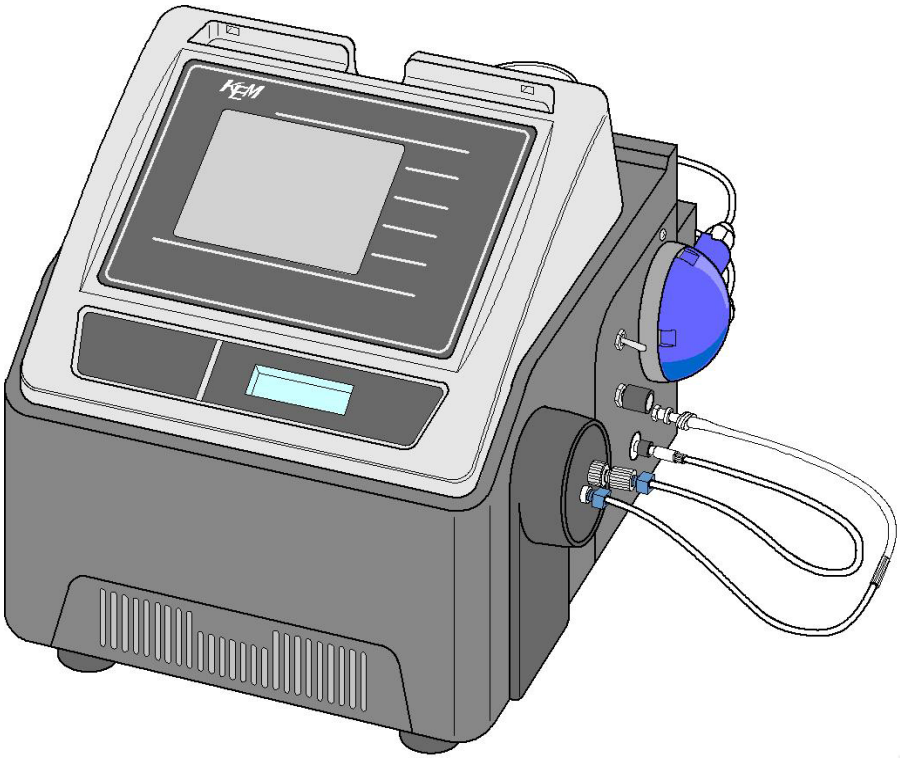
Density/Specific Gravity Meter

DA-650/DA-645/DA-640

Operation Manual



Read this operation manual thoroughly before use.

KYOTO ELECTRONICS MANUFACTURING CO., LTD.

http://www.kyoto-kem.com

Ver. 00 A/N 59-00051-01-48

Introduction

Thank you for choosing a KEM density/specific gravity meter.
This density/specific gravity meter (DA-650/DA-645/DA-640) measures density of liquid or gaseous sample with precision in a short span of time. Read this operation manual thoroughly before you use the equipment for correct measurement and for your safety.

Features

High reliability

- KEM is the Japan's only supplier of JCSS-accredited density standard liquids.
- Your equipment is traceable to national standard calibrated with JCSS reference.
- GLP/GMP conformed to measurement data recorded.
- High repeatability (DA-650: $\pm 1\times10^{-5}$ ~ DA-640: $\pm 1\times10^{-4}$g/cm^3)

Under broad range of environments

- High performance of temperature control adaptable to severe environment.
- The new reference sensor assures thermal stability in changing environment.

Short measurement time

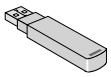
- The new algorithm enables the shortest measurement time ever in the world.
- Quickest measurement in 20 seconds where temperature is stable.

5.7-inch TFT LCD & touchscreen

- Easy and straightforward operation with icons on touchscreen panel.
- Customizable display colour & sound.

USB & LAN ports

- Easy connection to your PC through LAN.
- Easy transfer of measurement data to your PC with USB flash drive.
- Keyboard can also be connected for easy entry of sample name or numbers.



Other unique features

- Fully automated scan and computation of temperature compensation coefficient.
- One-point calibration mode can measure at temperatures without calibration.
- Replacement of desiccant is noticed by the built-in warning system.
- Barcode can easily select Method (measuring condition file).
- Highly secured by entry of password and ID key.
- Calibration Navigator detects the error (insufficient cleaning or wrong liquid).
- Concentration conversion table can easily be programmed.

After-the-sale service

- Free repair within one year after the date of purchase. (Some exceptions may apply.)

Sales in 30 years

- The latest model of KEM's highly-esteemed benchtop density/specific gravity meters for over 30 years throughout the world.

Application

1. Crude oil and petroleum products
   Density/SG of crude oil, fuel oil (heavy oil, light oil, kerosene, gasoline) or lubricant is measured to obtain reference value for product pricing or taxation.

2. Chemical products
   Density/SG is important for quality control and management in chemical industries. For organic substance of petroleum industry, it is used for QC of intermediate and finished products, and for inorganic substance of heavy chemical industry, it is for purity control or concentration check. Test method for density at 20°C or SG at 20/20°C is specified by JIS K 0061.

3. Beverages
   Density and Brix are measured for QC or line control of milk, dairy products, soft drinks, carbonated drinks, fruit juice or soy milk.

4. Alcoholic beverage
   For beer, sake, whisky, brandy, wine, distilled spirit, etc.: alcohol degree or concentration of extract is used in quality control. The alcohol degree is used in taxation.

5. Food
   Brix concentration is used in QC of food material like honeydew, extracts, saline solution, syrup or isomerized sugar. Brix is also used for QC of soy sauce, cooking sauce or gravy.

6. Fat and oil
   Density/SG is used for quality control of plant oil or animal fat.

7. Pharmaceutical products
   Japanese pharmacopoeia specifies QC and R&D by density measurement.

8. Flavour, fragrance, chemical products
   Density and refractive index are used for QC in perfumery. Your density meter can be connected to KEM's refractometer.

9. Electronic devices, semiconductor
   Density is used for QC of surface finishing material like etching solution or pickling.

10. Electrics
    Density is used for control of flux concentration or plating solution in production line.

11. Others
    Density, SG or Brix is used in quality control or concentration control of various liquid products.

Safety Precautions

Mandatory:

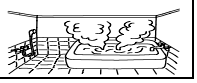
You must act on the following warnings for your safety and others as well as to protect the surrounding property.

Meaning of symbols

⚠	**Warning**	Danger of severe injury or possible death.
⚠	**Caution**	Risk of physical injury or property damage.
⃠		This symbol means Prohibition.
●		This symbol means Mandatory.

Place for installation

Avoid a place under any of the following conditions to avoid malfunction.

⚠ **Caution**					
⃠	Under vibration	⃠	Under direct sunlight 	⃠	Corrosive gas atmosphere
⃠	Heavily loaded and fluctuated or near power source or magnetic field	⃠	Excessive range of temperature other than specified	⃠	Ambient humidity exceeding 85%RH 

Power supply

⚠ **Caution**			
	Plug out power cord in case of unit malfunction or possible lightning. Otherwise, the unit may be broken.	Power source for this unit: AC 100-240 V Frequency: 50Hz/60Hz	⃠ Do not share power as shown below. 
		Supply power direct from power outlet. 	

Test sample

Warning	
 Some samples or chemicals require protective gloves, glasses and mask in a well ventilated room. Splashing chemicals may injure your eyes or skin. Windpipe may be hurt if toxic fume is inhaled.	 Do not use chemicals that may generate flammable gas or work in such atmosphere. Be aware of a risk of explosion inside the room.
Caution	
 Do not use strong base (such as NaOH, KOH), strong acid (such as HCl, H_2SO_4, HNO_3) or hydrofluoric acid as test sample or cleaner. It may corrode the measurement cell.	Samples of high viscosity or those that can easily generate air bubbles may lower repeatability or result in measurement error.
 Measuring cell will become hot. Do not touch hot surface or hot waste liquid.	Samples like milkfat may lower repeatability or result in measurement error as the nature of such samples can be changed by oscillation.

Storage

Caution		
Thoroughly clean and dry the measuring cell if you do not plan to use the equipment for a certain period of time.	Use our shipping box to store the equipment. 	 Do not store where temp is extremely high or low, where humidity is high or where is dusty.

Other cautions

Caution	
 Never overhaul or repair the equipment unless you are authorized to do so by KEM. Overhaul or repair by an unauthorized person may result in physical damage caused by electrical shock, fire or unexpected malfunction.	 Do not operate the unit in any way other than specified in this manual to avoid electric shock, fire or malfunctioning.
 Do not use solvent like alcohol, acetone or thinner for cleaning the unit. Using such solvents may deform,	 Do not touch the screen with a sharp pointed pen or pencil in order to avoid damage. Use the supplied stylus.

discolour or crack the equipment.	

Environmental conditions

This equipment shall be used under the following conditions classified in 1.4.1 of the CE marking (Low Voltage Directive 2006/95/EC, EN61010-1): Altitude 2000m or below, Overvoltage Category II, Pollution Degree 2.

About this manual

Please read through this manual before you use the equipment.
Keep the manual near your system for easy access to the information you need.
The following symbols appear from place to place in manual to raise your attention.

1. Warning

Warning	

This symbol means danger of possible death or severe injury.

2. Note

Note	

This symbol means the important information about the product.

3. Hint

Hint	

This symbol means technical tips for the best performance of your equipment.

- It is prohibited to copy a part or whole of the manual without prior consent.
- If you should find any ambiguous or missing description, please contact your local dealer or sales representative.
- Maker will not be liable for any loss or damage caused by the use of the product.
- This manual is written and compiled based on specification of standard model. For custom model, please refer to the specification that accompanies your unit.

Table of Contents

Measurement Procedures

Before measurement

How to measure

Series of Steps for Measurement

STEP 1 Unpack delivered carton

Check supplied parts with the parts list. See 1-1

STEP 2 Installation

Install the unit and accessories. See 1-2

STEP 3 Warming up unit

Warm up the unit for required length of time. See 3-1

STEP 4 Prepare materials for measurement

Ethanol for cleaning and drying, pure water for calibration, etc. See 3-2

STEP 5 Set up measure condition

Temperature, stability sense, limit time, etc. See 3-3

STEP 6 Calibration

Follow navigation guide on display for calibration. See 4

STEP 7 Measurement

Now ready to measure your sample. See 5

1. Preparation

The carton box contains the main unit of DA-650, DA-645 or DA-640 together with accessories and parts. Check the contents according to the below list.
If you should find any missing or broken part, please contact your local distributor.

1-1. Supplied parts

Open the carton box and check supplied parts with below parts list.

Unpack the carton

The box contains the main unit of DA-650, DA-645 or DA-640 together with accessories and parts including a copy of the operation manual. Check with the parts list shown below.
If you should find any missing or broken part, contact your local distributor.

Part Name	Part Number	Qty	Remarks
Main Unit	DA-640/DA-645/DA-650	1	
Tube Holder	12-00051-00-48	1	
Desiccant Container	12-01148-02-48	1	
Connecting Tube	12-01997-01-48	1	For drain (solenoid valve side)
Connecting Tube	12-01998-00-48	1	For drying
Connecting Tube	12-01999-00-48	1	For drain (cell outlet)
Connecting Tube	12-02000-00-48	1	For sampling
Connecting Tube	12-02699-00-48	1	For purge gas
Lure Adapter	20-05764-00-48	1	Adapter for syringe
Darin Tube	20-05789-01-48	1	For pump side
Operation Manual CD-ROM	12-02845-00-48	1	Incl. Operation Manual, Function Description & Quick Manual
Quick Manual	59-00053-01-48	1	
Silica Gel (500g)	61-00249-00-48	1	
AC Adapter*1	12-02833-01-48	1	For Europe 220~240 V
	12-02833-02-48		For U.K. 220~240 V
	12-02833-03-48		For U.S.A. 110~120 V
	12-02833-04-48		For China (PRC) 220~240 V
Syringe	66-00088-00-48	2	2 mL
Stylus	69-00444-00-48	1	
Pure Water (Density Standard Liquid)	-	1	2pcs/set
Warranty Card	-	1	
Inspection Certificate	-	1	

*1: Make sure your country's power requirement.

1-2. Installation

Here you install the main unit, parts and accessories.

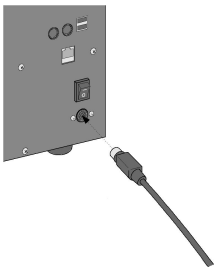
1 Check if power is OFF.

- Make sure the power switch is in OFF position.

2 Connect AC adapter.

- Connect the supplied AC power adapter to the power receptacle of main unit.

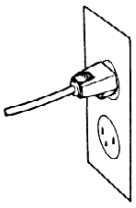
  Be sure to insert the adapter until you hear a click.



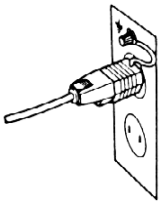
3 Connect power cord

- Connect the power cord to the power outlet.

  <for 3P outlet>
  The 3P outlet contains the earth terminal wired to the ground. There is no need to ground the earth.



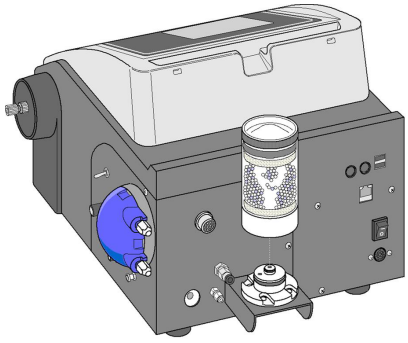
  <for 2P outlet>
  The 2P outlet needs grounding by adding an AC-3P adapter. Ground the earth by connecting the green wire to the earth terminal on the outlet.



4 Install the desiccant container.

- Install the desiccant onto main unit.

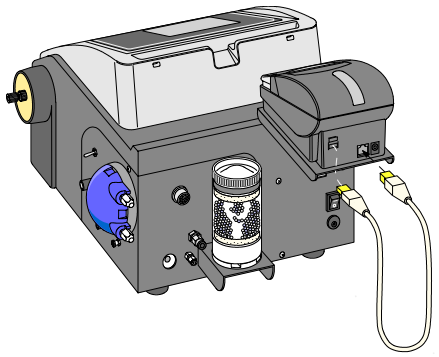
  Squeeze in the desiccant container.



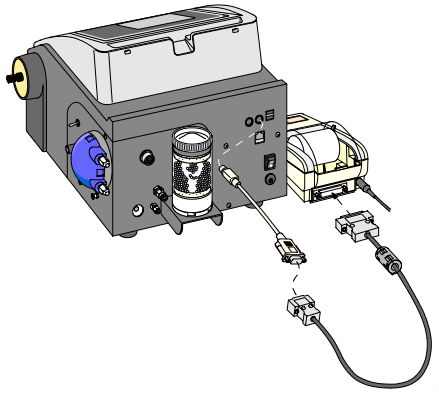
5 Install printer to main unit.

- Install a printer.
  (Printer is an option.)

<Thermal Printer>
Place the printer on the stand.
Put the AC adapter.
Plug the connecting cable (USB) into USB connector.
Turn on the power.



<Dot Matrix Printer>
Put the AC Adapter.
Plug the connecting cable (9P-25P, MiniDIN8P-DSUB9P) into RS-232C connector.
Turn on the power.

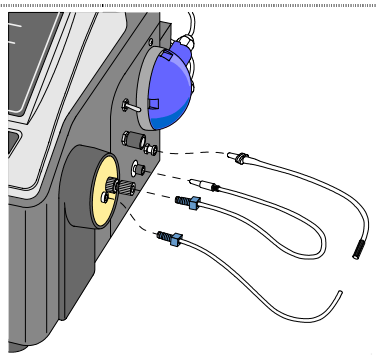


Setup condition of printer is shown below:

Item	What to do	Range	Default
Printer	Select whether use the printer or not.	0: None 2: DP 1: IDP 3: Other	2: DP
Interface	Select where to connect printer	0: COM1 2: COM3 1: COM2 3: COM4	1: COM2
Baud rate	Select digital configuration	0: 2400 3: 19200 1: 4800 4: 38400 2: 9600	1: 4800
Parity	Select digital configuration	0: None 2: Even 1: Odd	0: None
Stop bit	Select digital configuration	0: 0 2: 2 1: 1	0: 0
Data length	Select digital configuration	0: 7 1: 8	1: 8

Note	Printer must be installed on the rack in order to avoid the measuring cell influenced by printer magnet.

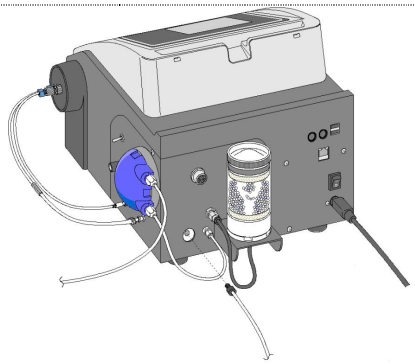
6 Connecting the tubes



- Squeeze sampling tube into sample inlet as shown.
- Connect drain tube to sample outlet and sampling pump port.
- Squeeze drying tube into purge air outlet.

To connect or remove joints, refer to 7-2 Maintenance.

7 Connecting vent air tube



- Connect the tube to the air vent with the other end going down to the waste container.

Warning	Since some sample liquid or solvent is harmful, the vent tube must be connected. The vent tube drains out waste liquid a little so that the other end of vent tube must be placed in the waste container just like drain tube.

8 Connecting drain tube

- Fix the drain tube from pump unit in waste container (a bottle or tank).

Warning	Place the waste container sufficiently away from the operator in case toxic gas is generated and remains harmful.

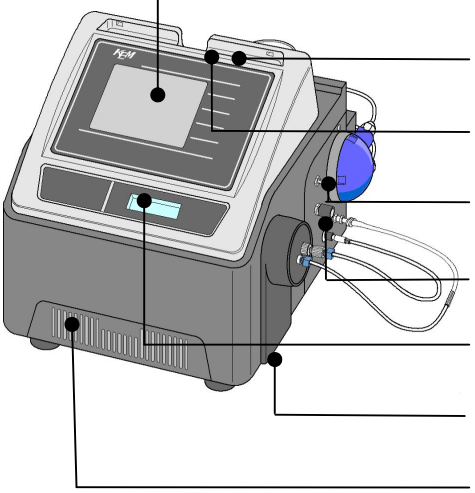
Warning	The waste container (an empty bottle or tank) must be made of resistant material. Handle with care if it is made of glass.

Note	Waste liquid is harmful. Drain it out when it reaches sixty (60) percent of the container.

2. Parts Configuration

Part names and respective locations are shown below.

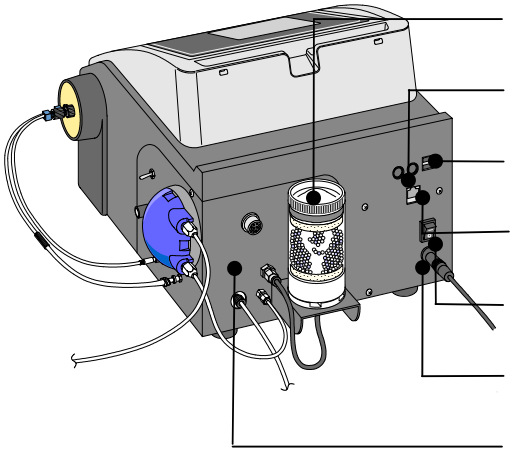
Front



1) Touch screen
2) Stylus Holder
3) Stylus
4) Sample/Drain Lever
5) Sampling Speed Controller
6) Cell Window
7) Exhaust Vent (at the bottom)
8) Intake Vent (Dustproof Filter)

No.	Part name	Function
1	Touchscreen	Density meter can be operated by a touch on screen.
2	Stylus Holder	Stylus can be stored here when it not in use.
3	Stylus	Use the stylus when you send commands on display screen.
4	Sample/Drain Lever	"Sample" position is for sampling event. Sampling speed can be controlled by turning the dial. To drain or rinse, turn it to "Drain" and execute at max speed. When turned downward, it sets in purge mode and sends dry air.
5	Sampling Speed Controller	Sampling speed can be controlled here. It works when switching lever is in "Sample" position and pumping is going on. When sample is highly viscous, use higher intake power. When viscosity is low, turn it down.
6	Cell Window	The inside U tube can be viewed. You can check here whether sample liquid contains air bubbles or not.
7	Exhaust Vent (at the bottom)	The air inside the unit is exhausted from here.
8	Intake Vent (Dustproof Filter)	The air inside the unit is ventilated for cooling. Do not block the vent. To change filter, refer to 7-2 Change dustproof filter.

Back



9) Desiccant Container
10) RS-232C Connector
11) USB Connector
12) LAN Connector
13) Power Switch
14) Power Connector (AC Adapter)
15) Sampling Unit

No.	Part Name	Function
9	Desiccant Container	Silica gel is filled. When coloured grains become red or purple, it is time to replace the silica gel.
10	RS-232C Connector	This port is used to connect Sample Changer or PC (for data acquisition by the optional software SOFT-CAP).
11	USB Connector	This port is for USB flash drive.
12	LAN Connector	This port is for PC data manipulation.
13	Power Switch	Power is turned On or Off by this switch.
14	Power Connector (AC Adapter)	The supplied AC adapter plug is connected here.
15	Sampling Unit	This unit is for sampling test liquid or solvent.

Main panel (Periphery)

PUMP key

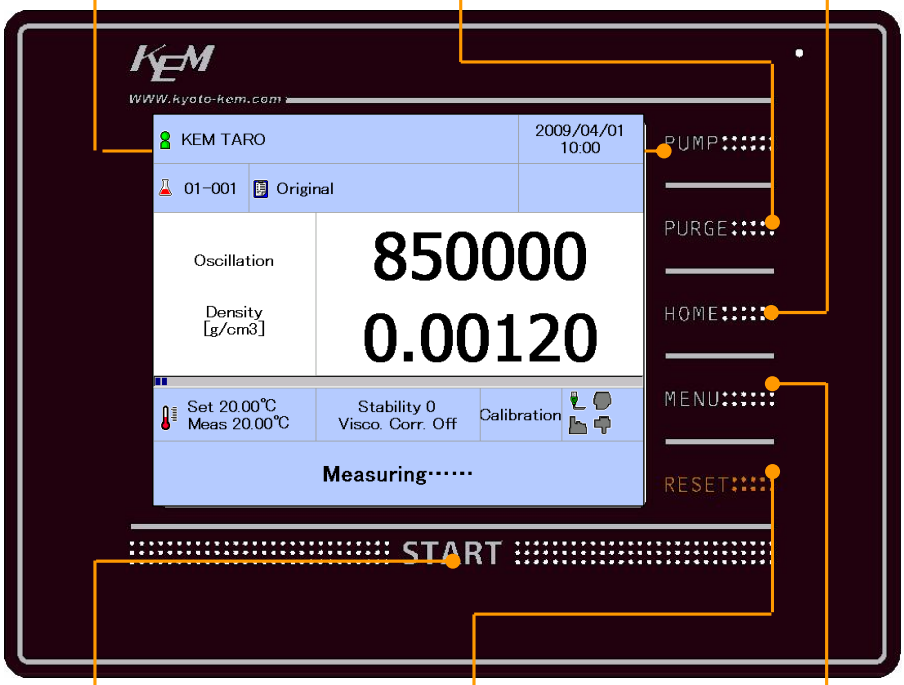
Sucks in sample liquid or solvent.

PURGE key

Sends dry air to measuring cell.

HOME key

Returns to main window.



START key

Starts measurement.

RESET key

Aborts measurement and returns to standby mode.

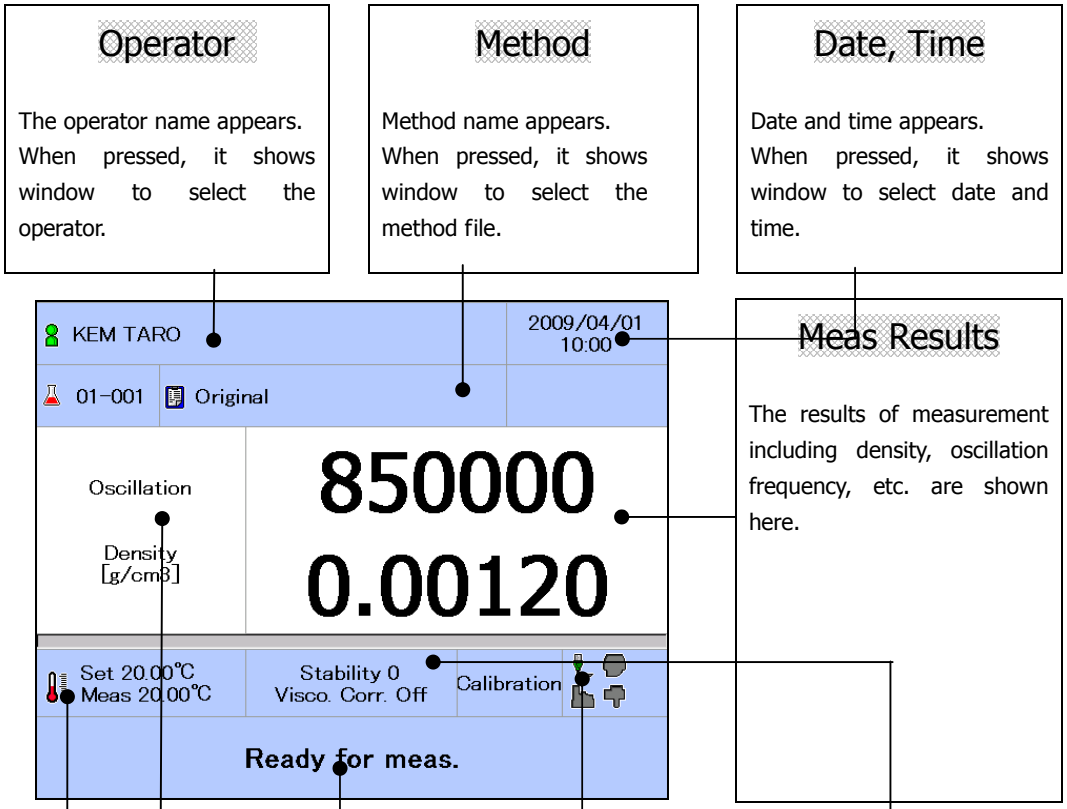
MENU key

Setup window appears to select method, sample, etc. See separate "Function manual".

Note	To operate the touch-screen, use the stylus or your finger. Do not use a sharp pointed pen or pencil. Otherwise, the screen may be damaged or broken.

Hint	If any part of screen other than button or two buttons are pressed at a time, it beeps but is no use. Touch the button securely one by one while watching the display screen.

Main panel (Touchscreen)



Operator

The operator name appears. When pressed, it shows window to select the operator.

Method

Method name appears. When pressed, it shows window to select the method file.

Date, Time

Date and time appears. When pressed, it shows window to select date and time.

Meas Results

The results of measurement including density, oscillation frequency, etc. are shown here.

Measurement Unit

Shows measurement unit. When pressed, it shows window to select the unit.
=> See 3-3 Set up measure condition.

Option

The connected optional unit is shown here. When pressed, it shows peripherals to select.

Stability

Shows stability (measurement mode). It determines the level of thermal stability at the end of measurement.
When pressed, it shows window to select the measure level.
=> See separate "Function Description" (6-1-2 Edit the method).

Temperature

Shows both current and setup temperature here. When pressed, it shows window to select measure temperature.
See 3-3 Set up measure condition.

Status

Shows current condition of the event like measurement underway or calibration in process, etc.

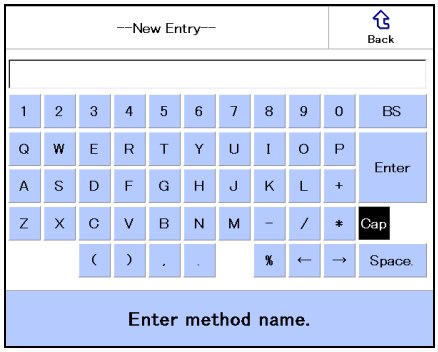
Entry window

Here is the window for entry of characters and numbers. Enter characters in alphabetical letters and numbers. To confirm the entry, press "Enter."

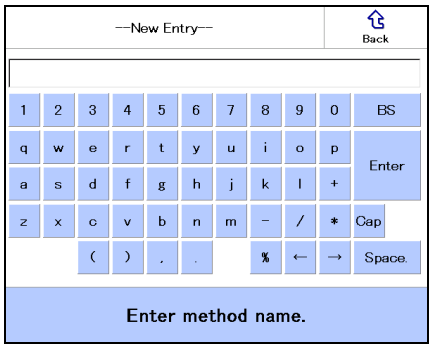
Capital or small letters can be selected. Up to 16 letters/numbers can be entered; sample ID can accept up to 32 characters.

Excess characters are shown with ~ mark.

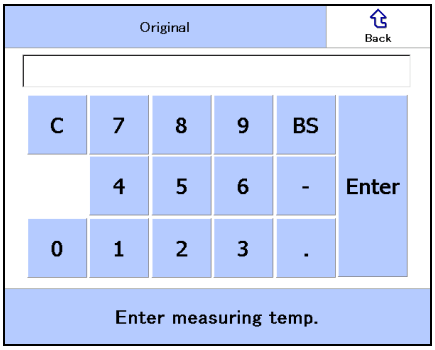
Alphabetical (Capital)



Alphabetical (Small)



Number



3. Preparation for Measurement

The following preparations are necessary before measurement.

3-1. Warm-up

To perform an accurate measurement, it is required to warm up the equipment until the temperature of the measurement cell becomes stable.

Warm-up of equipment is required until temperature of the measurement cell reaches the set temperature and becomes stable once you turn on the equipment or when you change the cell temperature with a difference of 30 °C or smaller from the previous one. Required warm-up time is as follows:

Model	Warm-up time
DA-650	Approx. 60 mins
DA-645	Approx. 30 mins
DA-640	Approx. 10 mins

* Ambient temperature: 20°C

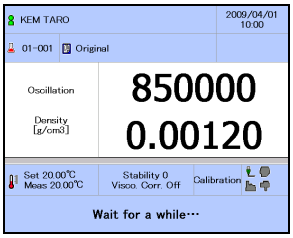
1 **Power ON**

- Turn on the power.

  The display on the right appears.

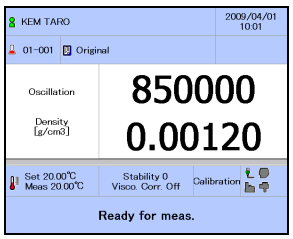
2 **Wait for stable cell temperature**

- "Wait for a while" message appears.



3 **Warm-up is over.**

- "Ready for meas." appears.



Note	The length of warm-up time depends on the ambient temperature and selected cell temperature.

3-2. Necessary tools

Prepare the following tools for measurement.

Tools for sampling

- Beaker
  A beaker is necessary when sampling test liquid by sampling pump.
- Sampling pipette, syringe
  Necessary for a viscous sample (lubricant, honey syrup, etc.) or liable with air bubble.

Tools for cleaning sampling tube

- Waste cloth
  Wipe off residual sample liquid or solvent in order to prevent from self-contamination.

Rinse solution for cleaning inside cell before sampling

- Rinse solution 1 (dissolution)
  Rinse solution 1 is for cleaning inside the cell.
  Use a solution n that dissolves remaining sample in the cell.
- Rinse solution 2 (drying)
  Rinse solution 2 is for drying the cell.
  Use a highly volatile solution that easily dissolves the rinse solution 1.

When satisfactory rinse solutions 1 and 2 are not available, add rinse solution 3 which can dissolve both rinse 1 and 2 used in between two steps.
A highly volatile solvent can be used not only as rinse solution 1 but also 2 as well.

Typical rinse solutions are as shown below: (Select as necessary for sample character)

	Beverage		Oil
	Soft drink	Wine	
Rinse solution 1 (dissolution)	Water (Warm water)	Water	Toluene
Rinse solution 2 (drying)	Ethanol	Ethanol	Acetone

Warming	Some sample liquid or solvent is harmful. Connect vent tube to exhaust fume for your safety.

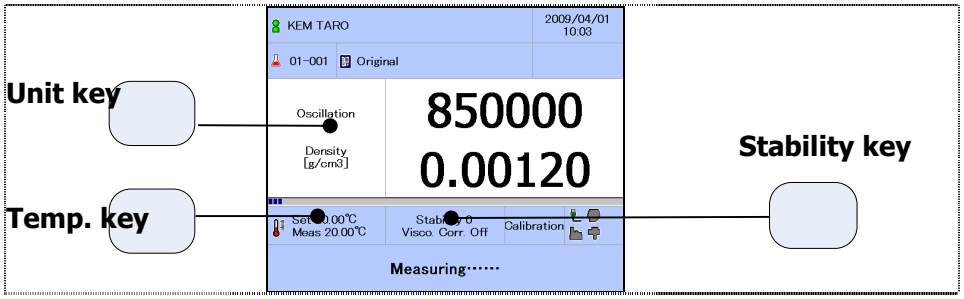
Warning	Be aware of danger of strong acid like sulfuric acid which generates heat when added to water.

Note	Use a solvent for drying the cell which also dissolves solvent for cleaning sample liquid.

Hint	The cell dries more quickly with acetone than ethanol since acetone is more volatile.

3-3. Set up measurement conditions (cell temperature, stability, limit time)

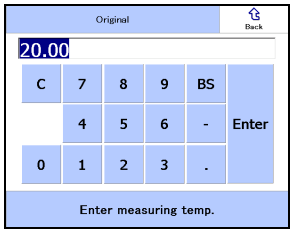
Here you select measurement conditions (temperature, stability, limit time) from main screen.



1 Select cell temperature

- Press "Temp." key

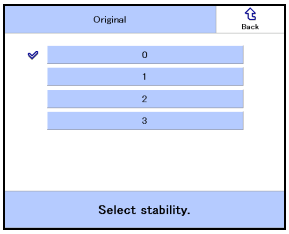
  Enter the measurement temp and press "Enter".



2 Select stability (meas mode)

- Press "Stability" key.

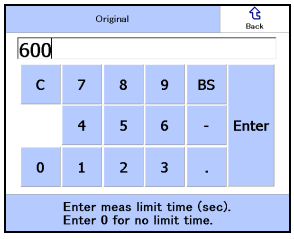
  Select stability from 0 ~ 3.
  (normal: 1)



3 Select limit time

- Select a limit time of measurement.

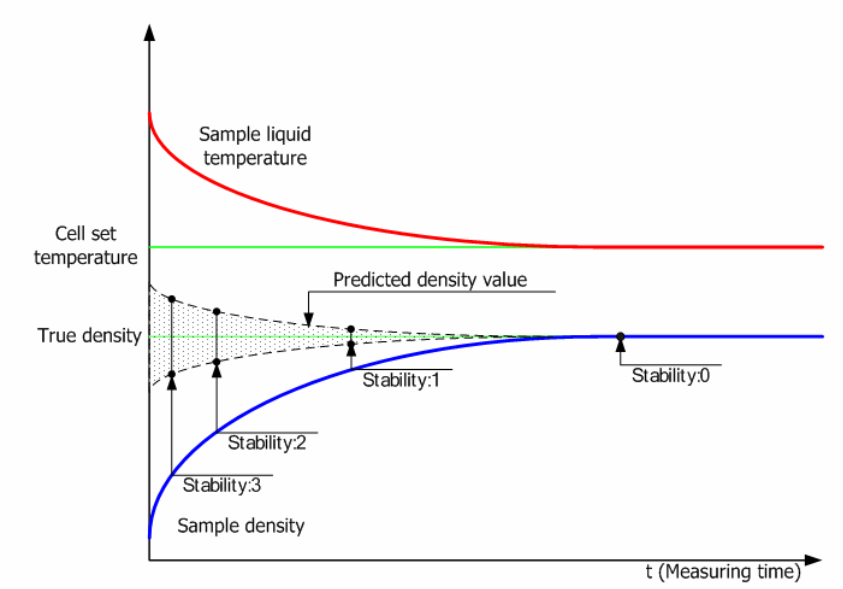
  When it exceeds the limit time, measurement is aborted with results on display. Range: 0 ~ 9999 sec.
  0 means ∞ (infinite), which does not abort measurement.



Hint	For other details of setup, press Menu => Method. For details, refer to the separate Function Description.

List of stability (measurement mode)

Stability		Accuracy		
Level	Mode	DA-650	DA-645	DA-640
0	Slow	±0.00002	±0.00005	±0.00010
1	Normal	±0.00002	±0.00005	±0.00010
2	Fast	±0.00005	±0.00005	±0.00010
3	Quick	±0.00010	±0.00010	±0.00010



Level: 3 (Quick)
Oscillation frequency is predicted where temperature of sample and cell differs from each other to a large extent. Measuring time is very short but deviation is sharp.

Level: 2 (Fast)
Oscillation frequency is predicted where temperature of sample and cell differs from each other to some extent. Measuring time is short but deviation is substantial.

Level 1: (Normal)
Oscillation frequency is predicted where temperature of sample and cell is close to each other. This mode is typical and standard since accurate results can be expected in this mode.

Level: 0 (Slow)
Oscillation frequency is determined after temperature of sample and cell reaches equilibrium. Measuring time is long but highly accurate results can be obtained.

4. Calibration and Check

Density/Specific Gravity Meters require calibration and/or check for accurate measurement. Density value in relation to oscillation frequency is corrected by calibration. A change of oscillation frequency is verified by check. Calibration prior to everyday work is recommended. The past record of oscillation frequency of air and water at time of calibration can be reviewed.

4-1. Calibration

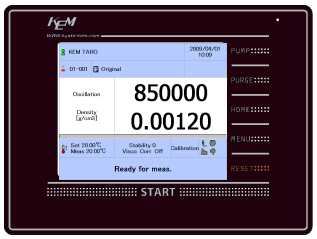
The sensitivity of the equipment can be calibrated with air and water. Calibration with air and water is necessary whenever a change occurs on the equipment such as installation place, cell temperature, etc.
Calibration is simple and easy. Just follow Calibration Navigator.

1 Select Calibration.

- Press "Calibration".
- Press "Next".

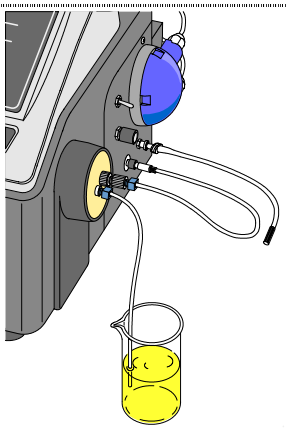
You will see a message: "Dry meas cell."

When <Check/Calibration>
Press "Check".
Press "Calibration Navigator".



2 Clean measuring cell (Rinse 2)

- Make sure the sample/drain lever is turned to "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol, acetone, etc.).
- Press "PUMP" to suck rinse 2 and clean the cell. (for about 10 sec)
- Press "PUMP" to stop pump operation.

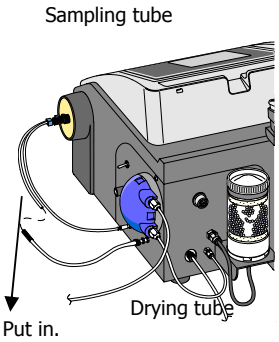


Hint	For quick cell cleaning: when rinsing the cell, suck air and water alternately by detaching sampling tube from water at intervals.

3 Dry the cell

- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

A message of "Auto drying" will appear, and equipment starts to dry the cell.
Once completed, equipment beeps and pump stops running.

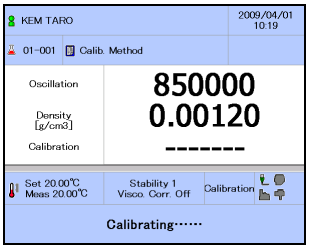


4 Air calibration

- Press "Start Calib" to start air calibration.

Once completed, equipment beeps.

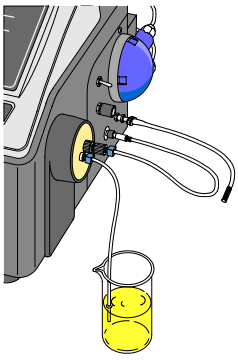
A message of "Start water calib" will appear.

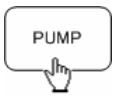


5 Sampling of pure water

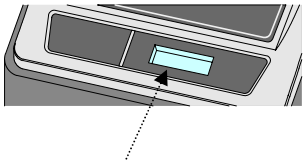
- Adjust sample/drain lever to "Sample."
- Adjust sampling speed controller to slowest (scale 0).
- Press "PUMP" to start sampling of pure water.
- Slowly turn the controller until you reach optimal speed for sampling.

* Do not stop turning the controller abruptly. Doing so may generate air bubbles in the sample.





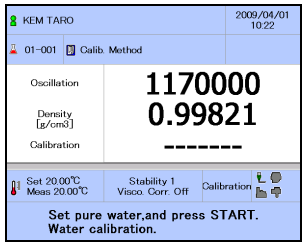
- Check through cell window to make sure there is no air bubble in the cell.
- Press "PUMP" again to stop sampling.



6 Water calibration

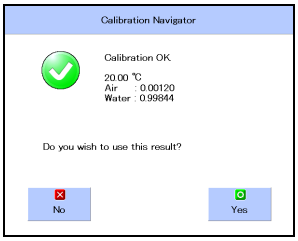
- Press "Start" to start water calibration.

  Once completed, equipment beeps.



7 Print out calibration results

Once calibration is completed, equipment beeps and main screen as shown on the right appears. Then calibration results and factors will be printed out.



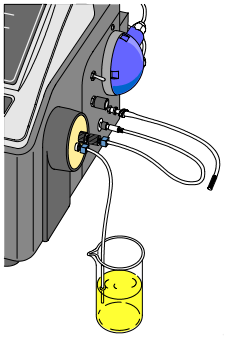
Printout example of calibration results

```
Model       : DA-650
Serial  No. : SEA00000
Version No. : 1.00
Sample:

    ------------------

[Calibration]        OK

Date : 2009/07/30 14:00

Temperature :  20.000 °C

      OLD ----> NEW
Air   :
 T    850000     850000
 d   0.00120    0.00120

Water :
 T   1170000   1170000
 d   0.99921   0.99821

Factor:
 T  1.542404  1.542404



Name:KEM TARO

     ---------------
```

"Failed" is shown when calibration fails.

8 Clean the cell (rinse 2)

- Press "PUMP" to start to drain, and wait until water is depleted from the cell.
- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.

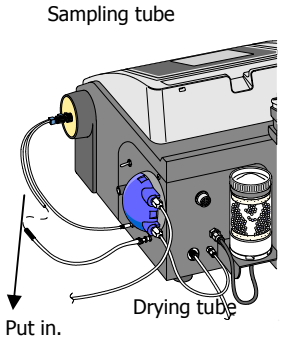


Hint	For quick cell cleaning: when rinsing the cell, suck air and water alternately by detaching sampling tube from water at intervals.

9 Dry the cell

- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

A message of "Auto drying" will appear, and equipment starts to dry the cell. Once completed, equipment beeps and pump stops running.



4-2. Check/Calibration

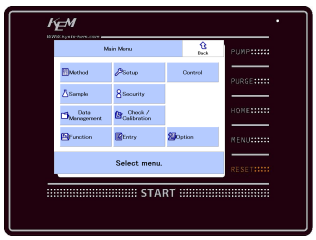
Check equipment to see if anything may be wrong with it.
We recommend that you check your equipment prior to everyday when there is no need for daily calibration (or when you do not wish).
Check is easy and simple. Just follow the instructions of the Navigator.

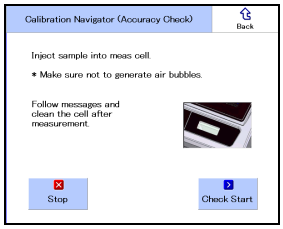
1 Select Check/Calibration.

- Press "Check/Calibration".
- Press "Next".

A message of "Dry the cell" will appear.

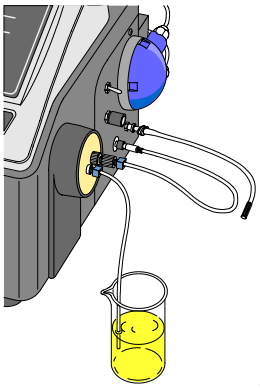
<When no "Check" button>
"MENU" → "Check/Calibration" → "Check/Calibration Setup" → "Calibration Setup". Then, turn ON "Check Before Calib".

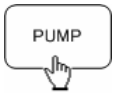




2 Clean the cell (rinse 2)

- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop operation.



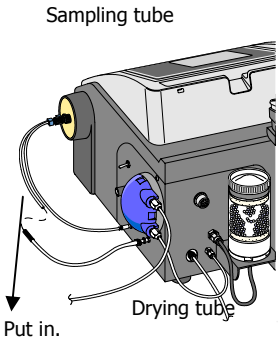


Hint	For quick cell cleaning: when rinsing the cell, suck air and water alternately by detaching sampling tube from water at intervals.

3 Dry the cell

- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

A message of "Auto drying" will appear, and equipment starts to dry the cell.
Once completed, equipment beeps and pump stops running.

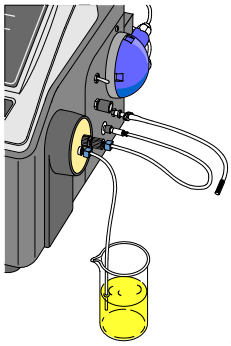


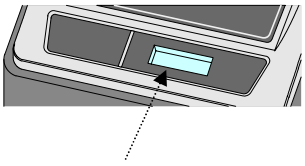
4 Sampling of pure water

- Adjust sample/drain lever to "Sample."
- Adjust sampling speed controller to slowest (scale 0).
- Press "PUMP" to start sampling of pure water.
- Slowly turn the controller until you reach optimal speed for sampling.

* Do not stop turning the controller abruptly. Doing so may generate air bubbles in the sample.

- Check through cell window to make sure there is no air bubble in the cell.
- Press "PUMP" again to stop sampling.



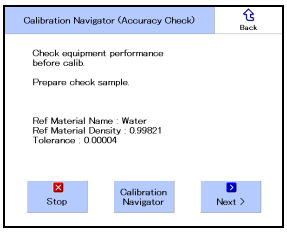


Check air bubbles.

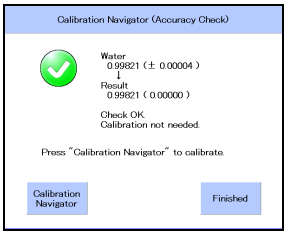
5 Check accuracy.

- Press "Next".

Accuracy check is started.

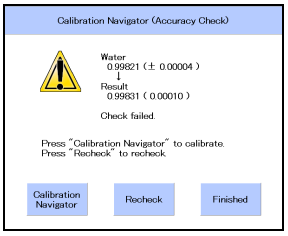


6 Check 'OK' or 'Failed'



Check OK

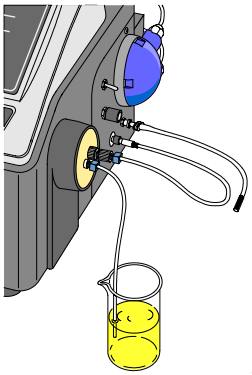
You will see the display as shown on the right when check has been OK.
In this case, no calibration is necessary.
Move to #7 below.



Check Failed

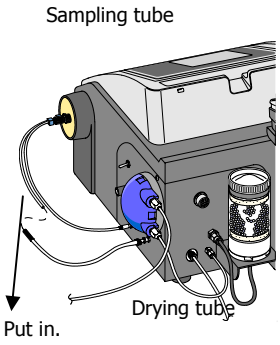
You will see the display as shown on the right when check has been failed.
In this case, calibration is required.
Go to step 4-1 for calibration.

7 Clean the cell (rinse 2)



- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.

8 Dry the cell



- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

A message of "Auto drying" will appear, and equipment starts to dry the cell.
Once completed, equipment beeps and pump stops running.

Hint	For quick cell cleaning: when rinsing the cell, suck air and water alternately by detaching sampling tube from water at intervals.

Hint	The criteria of determining OK or NG by Check can be configured on "Menu" "Check & Calibrate". For details, refer to the separate Function Description.

Hint	The check record is stored on "Menu" "Data control" "Check data". For details, refer to the separate Function Description.

5. Measurement

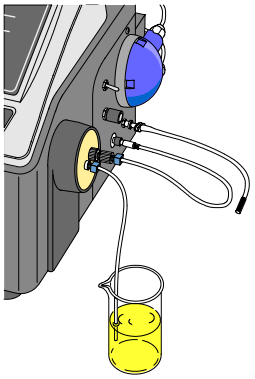
Sample measurement.

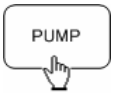
5-1. Normal measurement

Measurement with sampling pump for low-viscosity samples or samples that hardly generate air bubbles. Very convenient measurement: no need to prepare a syringe; easy to clean and dry the measurement cell.

1 Clean the cell (rinse 2)

- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.



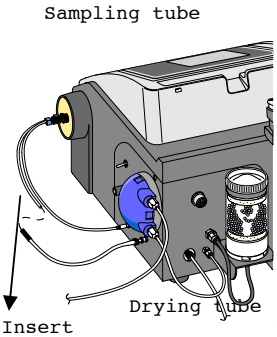


Hint	For quick cell cleaning: when rinsing the cell, suck air and water alternately by detaching sampling tube from water at intervals.

2 Dry the cell

- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

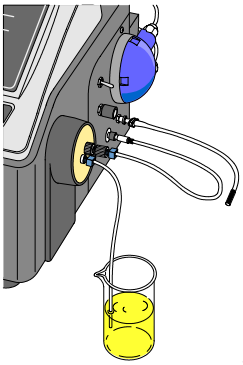
A message of "Auto drying" will appear, and equipment starts to dry the cell.
Once completed, equipment beeps and pump stops running.

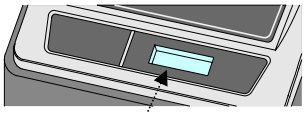


3 Sampling

- Adjust sample/drain lever to "Sample."
- Adjust sampling speed controller to slowest (scale 0).
- Press "PUMP" to start sampling.
- Slowly turn the controller until you reach optimal speed for sampling.

- Check through cell window to make sure there is no air bubble in the cell.
- Press "PUMP" again to stop sampling.





Check air bubbles.

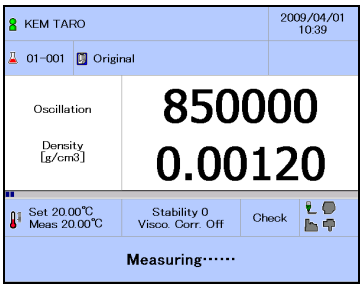
Hint	Be careful when sampling speed is increased abruptly (e.g. scale 0 → 5), air bubbles may be formed.

Hint	For a series of measurements of the same sample, continue sampling at the same speed. For a different type of sample, start sampling by adjusting speed first.

4 Start measurement

- Press "START".

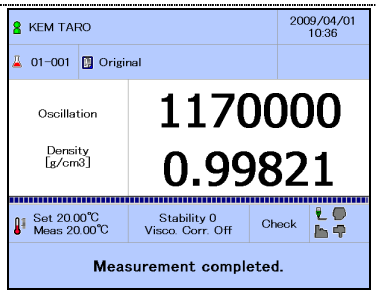
  A message of "Measuring" will appear.



5 Measurement ends

- Once oscillation frequency becomes stable, measurement comes to an end and result (density of sample) will be shown.

  Result will be printed out when printer is connected.



Printout example of measurement results

When measurement comes to an end, results appear on main screen and are printed out as the following example:

```
Model       : DA-650
Serial  No. : SEA00000
Version No. : 1.00
Sample:

    ------------------

*** R e s u l t ***

Sample No.    01-001

Date : 2009/07/30 14:00
Sample ID   :
Method Name : Original
Meas.Temp.  :   20.00 °C
d[g/cm3]    :    0.99821


Meas.Time   : 00:01:00



Name:KEM TARO

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```
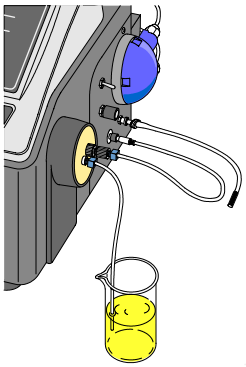

6 Drain sample

- Adjust sample/drain lever to "Drain."
- Remove sampling tube from sample.
- Press "PUMP" to drain sample.

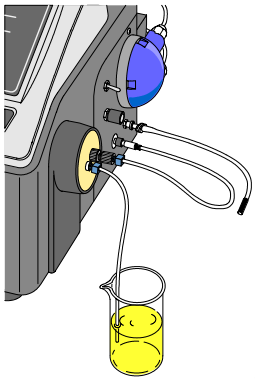
7 Clean the cell (rinse 1)



- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 1 (pure water or toluene).
- Press "PUMP" to clean the cell with rinse 1. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.

8 Clean the cell (rinse 2)

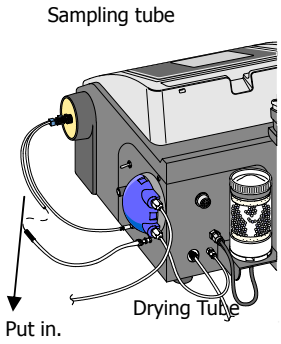
- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.



9 Dry the cell

- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

A message of "Auto drying" will appear, and equipment starts to dry the cell. Once completed, equipment beeps and pump stops running.



Hint	For continued measurements: For self-cleaning, repeat step 3 to 6 For cleaning each time, repeat step 3 to 9

Hint	For those samples liable to form air bubble, slow down the sampling speed, and suck in excessive sample liquid for successful measurement.

Hint	For quick cell cleaning: when rinsing the cell, suck air and water alternately by detaching sampling tube from water at intervals.

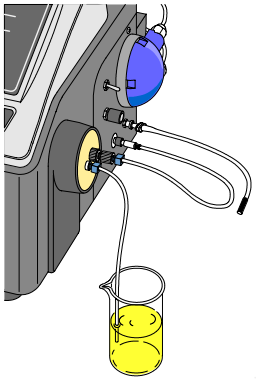
5-2. Measurement with syringe

Measurement with syringe for high-viscosity samples or samples that can easily generate air bubbles. Useful to obtain measurement results with good repeatability.

1

Clean the cell (rinse 2)

- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.

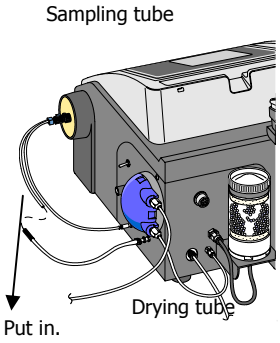


2

Dry the cell

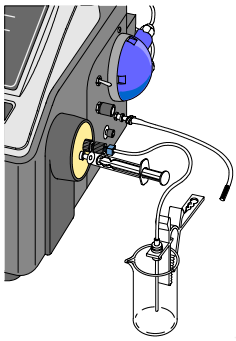
- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

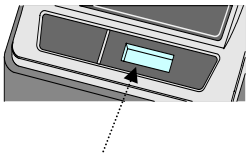
A message of "Auto drying" will appear, and equipment starts to dry the cell. Once completed, equipment beeps and pump stops running.



3 Inject sample

- Remove sampling tube, and put a syringe adapter in sample inlet.
- Insert syringe that contains sample in syringe adapter.
- Inject sample into measuring cell.
- Put a beaker at the end of drain tube.
  (If you wish to use supplied tube holder, put tip of drain tube in tube holder beforehand.)
- Check through cell window to make sure there is no air bubble in the cell.



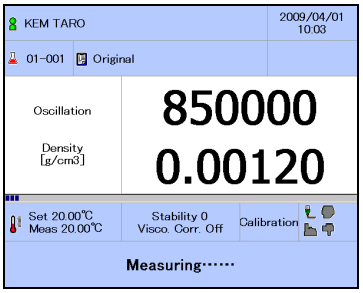


Check air bubbles.

4 Start measurement

- Press "START".

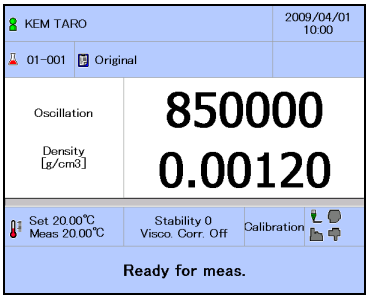
  "Measuring…" message appears.



5 Measurement ends

- Once oscillation frequency becomes stable, measurement comes to an end and result (density of sample) will be shown.

  Result will be printed out when printer is connected.



Note	To cancel hold of display of measurement results, press any key on screen.

Printout example of measurement results

When measurement comes to an end, results appear on main screen and are printed out as the following example:

```
Model       : DA-650
Serial  No. : SEA00000
Version No. : 1.00
Sample:

    ------------------

*** R e s u l t ***

Sample No.    01-001

Date : 2009/07/30 14:00
Sample ID   :
Method Name : Original
Meas.Temp.  :   20.00 °C
d[g/cm3]    :    0.99821


Meas.Time   : 00:01:00



Name:KEM TARO

     ---------------
```

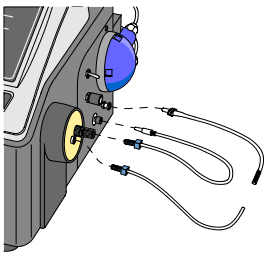
6 Drain sample

- Remove syringe from sample inlet.
- Wipe off taint around sample inlet with tissue.

Hint	For better cleaning the cell, first suck in sample liquid in cell with syringe.

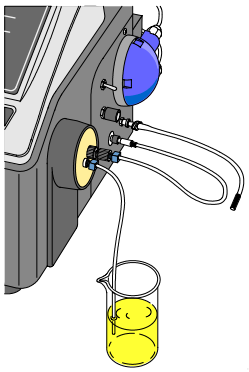
7 Drain sample

- Put drain tube in sampling pump.
- Put sampling pump in sample inlet.
- Adjust sample/drain lever to "Drain."
- Press "PUMP" to drain sample.



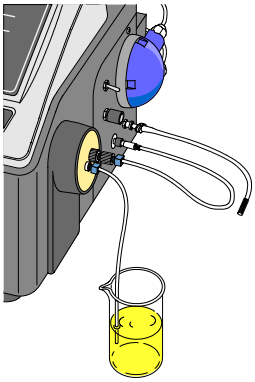
8 Clean the cell (rinse 1)

- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 1 (pure water or toluene).
- Press "PUMP" to clean the cell with rinse 1. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.



9 Clean the cell (rinse 2)

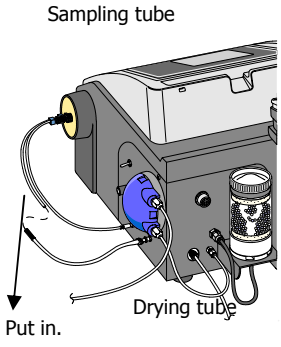
- Make sure sample/drain lever is on "Drain."
- Wipe off tip of sampling tube with waste cloth.
- Put the tube in rinse 2 (ethanol or acetone).
- Press "PUMP" to clean the cell with rinse 2. (for about 10 sec)
- Once completed, press "PUMP" to stop pump operation.



10 Dry the cell

- Wipe off sampling tube with waste cloth and put it in drying tube.
- Press "PURGE" twice.

A message of "Auto drying" will appear, and equipment starts to dry the cell. Once completed, equipment beeps and pump stops running.



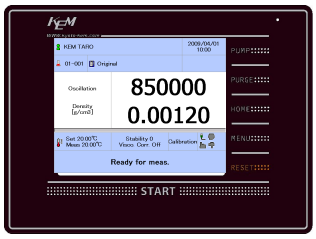
Hint	For continued measurements: For self-cleaning, repeat step 3 to 5 For cleaning each time, repeat step 3 to 10

6. Convenient & Useful Functions

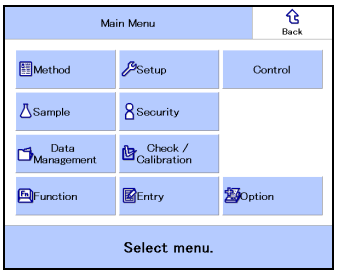
Various functions can be selected from main menu for your convenience.
Details of each function are described in this section.

1 Select from menu.

- Press "MENU".



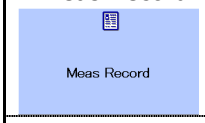
- Make a selection.



Described below is each function.
(For more details, refer to the separate Function Description.)

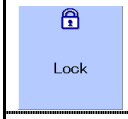
Menu	Submenu	Description
6-1 Method 	Outline	Method is a group of measuring conditions (temperature, stability sense (measure mode), rinse sequence, etc.). By creating Method for each sample, the sample is measured effectively. You can select method files, and register, copy or delete them. Also you can edit conditions of stored method files. For most frequently measured samples like oil and Brix, the appropriate methods are provided and stored as standard. (To use standard methods, see 6-5-4 Industry Segments)
	6-1-1 Selection of method, entry, delete	You can select, register, copy or delete method files in Method window. Up to 100 files are available.
	6-1-2 Method editing	You can edit parameters of stored methods including "Measure", "Display item", "Sequence, "Temperature compensation", "Report" and "Barcode".

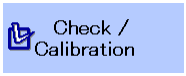
Menu	Submenu	Description
6-2 Sample 	Outline	Effective work by skipping setups and data manipulation on a number of different samples is made possible, and convenient tools are provided including sample files for continuous measurement both in single mode and multi-mode with sample changer, the auto-mode of barcode reader, concentration scanning to a create table and temperature scanning to create compensation formula.
	6-2-1 Sample mode	Select a function out of them available in a sample.
	6-2-2 Single mode	The initial mode is Single mode (default). The lowest digit of sample number is incremented each time of measurement.
	6-2-3 Sample file	Easy to set up measure condition by selecting registered sample file. You can select, register, copy or delete sample file.
	6-2-4 Auto mode	Auto mode is effective when selected for sample mode. Useful with barcode reader. (See 6-9-4 Barcode reader) Barcode reader can call for method name and file, user name, etc.
	6-2-5 Concentration scan	This mode creates working curve for concentration from density or SG. Concentration table (relation of concentration to density) is created and saved easily by measuring a few samples of which concentration is known. The concentration of unknown sample can also be calculated from density in the table.
	6-2-6 Temperature scan	Thermal character of sample (liquid temperature vs. density) is obtained by this mode. Temperature compensation formula can be easily created from a few thermal points and shown as a result of measurement. Calculation of density at temperatures different from actual measurement can be made on this table.

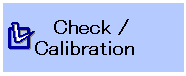
Menu	Submenu	Description
6-3 Data management 	Outline	Check and print out measurement data, past record of check and calibration as well as store data of USB flash drive (USB1.1 compatible). You can erase stored data or parameters by memory clear, and return them to default.
	6-3-1 Meas Record 	Check and print out up to 300 data of measurement. You can save in USB flash drive or search for data. Data stored in USB can be processed on PC.
	6-3-2 Calibration Record 	You can view 10 years' record of calibration (changes of oscillation frequency) in graph, and check past 20 data files, print or save in USB flash drive, which can be manipulated on PC.
	6-3-3 Check Record 	You can view 10 years' record of check (changes of oscillation frequency) in graph, and check past 20 data files, print or save in USB flash drive, which can be manipulated on PC.
	6-3-4 Memory Clear 	You can delete data (past record of measurement, check and calibration) and initialize all the measure conditions (method and sample file) to default. **(Note) It is recommended to keep those data separately.**

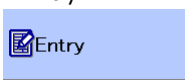
Menu	Submenu	Description
6-4 Function 	Outline	These functions described here provide user with convenient tools including the automatic start, which is most useful for QC at lab or in production line.
	6-4-1 Multiple Measurement 	Permeability of air bubble can be determined by the automatic mode which offers a plural number of measurements of a sample placed in a far different position at intervals or repeated measurements by positioning the sample slightly different in place. The auto mode is also useful to check on time dependency of sample character. This mode does not work when a multiple sample changer is connected.
	6-4-2 Auto Statistics 	It is necessary to renew Mean value, SD or RSD when sample number (high order) or method is changed. These values can be easily batch processed by the auto computation and printed out.
	6-4-3 Recalculation 	You can select conditions and sort out, recalculate (concentration conversion formula) or print out data both at present and in the past.
	6-4-4 Statistics 	You can batch calculate data to obtain mean value, SD and RSD. This is useful for quality control by data processing.
	6-4-5 Save, Import Parameters 	Measurement related information including results can be saved or captured from USB flash drive.
	6-4-6 Maintenance 	You can view the accumulated used hours of desiccant, system fan and sampling pump. This is useful in maintenance planning.
	6-4-7 Others 	The other functions are as follows: "Temperature adjustment" to alarm abnormal thermal control. "Tau meter" to check status of unit. "Memory information" to check on memory.

Menu	Submenu	Description
6-5 Setup 	Outline	Setup functions include "Date, time," "Colour, sound," "International," "Industry segments," "Temperature control" (Cell ON/OFF and Timer) and "Multipoint calibration" (for higher accuracy). Be aware the parameters selected on Setup are significant to all methods as well as all users.
	6-5-1 Date, Time	The built-in electronic clock provides current date and time as well as yearly calendar, which appear on display or printout together with measurement data.
	6-5-2 Colour, Sound	Background and font colours, and beep sound can be selected. When a plural number of units are operated, each unit can be identified by different settings for these functions. A unique feature is the white LED of high intensity for those sample liquids which may be affected under normal lighting. (To customize sound, refer to 6-8-7.)
	6-5-3 International	Selection of language from English, Japanese or additional language. Notation of date and temperature unit (Celsius or Fahrenheit) and air pressure for calibration are user's choice.
	6-5-4 Industry Segments	Those method files most frequently used in some industries (foods, petroleum, etc.) are available including measure condition and concentration conversion formula. The standard methods used in the industry appear when selected.
	6-5-5 Temp Control	The energy saving cell temperature control is built in. The temperature control (T/C) turns on or off by itself or by user programmed timer. All these functions are selectable by user.
	6-5-6 Version	Serial No. and software version of equipment are shown.

Menu	Submenu	Description
6-6 Security 	Outline	Security protects your equipment, which can be used only by the operator who has a password just like a personal computer. The authority of operator differs from manager who controls the authority. Therefore, the operator is the user who is authorized only to operate the equipment.
	6-6-1 User 	User function clarifies the authority of user whose record of operation remains in memory. The user's name appears on display and on printout. Background and font colours can be customized by user. Users of the equipment can be selected from the list. (See 6-8-5 for registration of user)
	6-6-2 Logon 	Setup of logon function allows user to use the equipment with password for logon/off or key lock on/off. Logon function is option. Once logon is significant, a password is required each time a different user works on the unit.
	6-6-3 Logoff 	Logoff can be made by a user who has a password. To change the operator, the function of logon and logoff is required.
	6-6-4 Auto Logoff 	The unit turns off automatically when the selected length of time elapses. This function is optional.
	6-6-5 Lock 	The unit can be locked by user who has the password. By locking the unit, the equipment cannot be operated temporarily.
	6-6-6 Supervisor Setting 	Supervisor can be distinguished from operator. Supervisor (one person) has the higher level of authority than operator who is specialized in use of the unit. Supervisor is optional, and a password for the supervisor is selected here.

Menu	Submenu	Description
6-7 Check/Calibration 	Outline	Calibration (Check) is required for correct measurement. Calibration with air and water corrects the precision of equipment while Check verifies the correctness of unit with water. Just follow the navigation for calibration or check. The detailed condition for calibration can be selected. The alarm of due time for calibration or check can also be selected.
	6-7-1 Check/Calibration 	The precision of density meter can be corrected by calibration while Check verifies the calibrated unit some time after calibrated. Calibration uses air and water while Check uses only water. Calibration is required and performed first in the morning prior to the day's work while Check can be performed any time after calibration or when calibration is unable. Here you select calibration.
	6-7-2 Alarm Setup 	This function alarms the operator about calibration (check). You can select on or off of alarm and due time for calibration (check).
	6-7-3 Calibration Setup 	Calibration usually uses air and water but density standard liquid of which density is known can also be used. Here you select sample (normally air and water) and measure condition for calibration. (for calibration sample, refer to 6-1-2 Edit method)
	6-7-4 Check Setup 	Check usually uses pure water but density standard liquid of which density is known can also be used. Precision of Check is assured if the density of sample is away from check point (pure water). Here you select the sample (normally pure water) and measure condition for check.
	6-7-5 Calibration Record 	You can view in graph the calibration record of past 10 years (changes of oscillation frequency). Up to 20 record of calibration can be printed out or stored in USB flash drive. Data stored in USB can be manipulated on PC.

Menu	Submenu	Description
6-7 Check/Calibration 	6-7-6 Check Record 	You can view in graph the check record of past 10 years (changes of oscillation frequency). Up to 20 record of check can be printed out or stored in USB flash drive. Data stored in USB can be manipulated on PC.
	6-7-7 Factor 	Factor of substance is entered here. Density and oscillation frequency of air and water or standard liquid can be entered for verification.

Menu	Submenu	Description
6-8 Entry 	Outline	To simplify settings, various files are provided in advance. Once such settings are registered, only necessary items can be selected from next time onward. Those items are "Method," "Sample," "Concentration conversion," "Sequence," "User," "Report," "Sound" and "Language."
	6-8-1 Method 	The purpose of method is to simplify measurement setup by grouping measuring conditions including measure temperature, stability, rinse sequence, etc. Method file is registered, selected, copied or deleted here. Measuring conditions in file can also be edited. The most frequently used methods for oil or Brix are provided as standard method. (See 6-1.)
	6-8-2 Sample File 	Continouos measurement of a plural number of samples can be simplified by skipping setup of various conditions each time with the method filed in advance. Most useful when a multiple sample changer is used for various samples at a time. The sample file is registered, selected, copied or deleted, and method or sample number is entered here.

Menu	Submenu	Description
6-8 Entry 	6-8-3 Conc Conversion 	Concentration of an unknown sample can be calculated from density in the concentration table. The table can be registered, selected, copied or deleted here. The concentration formula and result unit are also entered here. Standard conversion formulas are provided for measurement of API (petroleum products), Alcohol degree and Brix. (See 6-1-2.) Use concentration scanning to create the table for unknown concentration table. (See 6-2-5.)
	6-8-4 Sequence 	Sequence file can be registered, selected, copied or deleted for a series of events from sampling, measure, to drain. When the optional sample changer is connected, sequence of sampling, measure, drain, rinse 1, rinse 2 and drying for up to 12 samples can be automated.
	6-8-5 User 	User function clarifies the use by the operator recorded in memory. The user of unit is registered, selected, copied or deleted, and appears on display and printout. User with password can lock or unlock unit, and customize background and font colours of display for easy identification.
	6-8-6 Report 	Report function selects print format among from Off, Short, GLP and Custom. When customize form is chosen, it can be stored with an individual name. Thus, repetition of printout in the same format is made easier. Report file can be registered, selected, copied or deleted. The printed contents can be tailored if custom form is chosen.
	6-8-7 Sound 	Beep at the end of measurement, calibration or drying can be changed for identification when a plural number of units are operated at a time. (See 6-5-2.) A new sound can be registered here.
	6-8-8 Temp Comp 	The temperature compensation (T/C) works when measurement is impractical at a temperature, the sample is measured at different degrees and the density is obtained by correcting it to original temperature. You can select and register the formula for T/C here.

Menu	Submenu	Description
6-9 Option 	Outline	The convenient optional peripherals are available other than standard supplied printer. They are: Auto sampling unit, Multiple sample changer, External cell, Barcode reader, Data acquisition software. They are connected to your density meter by matching digital configuration.
	6-9-1 Changer 	The auto sampling unit automates the sequence of sampling, measure, rinse and drying. When a multiple sample changer is connected, a plural number of samples can be measured unattended. Bar code reader identifies vials on changer rack.
	6-9-2 Cell 	When the external cell is connected, you can measure a sample at different temperature at a time. (You have to wait for temperature equilibrium without it.) (External cell is made-to-order.)
	6-9-3 Printer 	Other than standard supplied printer, various types of printer are available. All of them are conformed to GLP/GMP.
	6-9-4 Barcode 	When the optional barcode reader is connected to the unit, it reads and calls for registered method name, user name, measure conditions, etc. automatically.
	6-9-5 PC 	When the optional data acquisition software SOFT-CAP (Windows® compatible) is installed in your PC, measurement results can be downloaded and manipulated in workbook of Microsoft® Excel or stored in CSV format.

Menu	Submenu	Description
6-10 Control Control	Outline	The optional auto sampling unit (DCU-551, DCU-600) and multiple sample changer (CHD-502) work in combination with DCU-600 for manual operation on display screen. Selection of rinse and purge can be selected and executed.
	6-10-1 DCU	When the optional auto sampling unit DCU-600 is connected to density meter, DCU can be operated on display screen of density meter. Change nozzle position, sampling, rinse and purge can be activated.
	6-10-2 Rinse & Purge	When the optional auto sampling unit (DCU-551, DCU-600) or multiple sample changer (CHD-502) is connected, the event of rinse and purge dry can be commanded on display screen of density meter.

7. Maintenance

Since such precision scientific instrument like density meter is liable to be affected by how, where and for what application the unit has been in use. Therefore, daily and periodic maintenance is necessary as prescribed below.

7-1. Check list

Below is the list of daily and periodic maintenance for your information.

Daily check

Daily check is necessary to make sure of correct measurement in practice before an actual sample is tested first in the morning for the day's work.

Periodic check

Periodic check is required in order to maintain standard criteria of performance and functions of the instrument once a year. When the unit is verified and validated by a KEM authorized service person, a JCSS-accredited certificate of calibration is issued.

Daily/Periodic check list (before measurement)

Check item	Daily	Periodic	Criteria
Auto scanning	Yes	Yes	When the power is turned on, the opening message appears without error. When an error should be found, refer to 8-1. Troubleshooting.
Check/Calibration	Yes	Yes	Oscillation by check/calibration does not change for a time (the same direction). It may change with corrosive liquid (strong alkali or hydrofluoric acid) in contact. See 4. Calibration for how to check.
Dustproof filter	Yes	Yes	No dust accumulation is observed on the filter. See 7-2. Maintenance.
Silica gel	Yes	Yes	Silica gel must be blue in colour. See 7-2. Maintenance
Sampling pump	Yes	Yes	Pure water is taken in without problems like slow flow or leak from deterioration. See 7-2. Maintenance for how to replace pump tube.
Tube connection	Yes	Yes	Sampling tube, drain tube, vent tube, etc. are connected securely.
Vent tube	Yes	Yes	Vent tube exhausts air in normal condition.
Tube lines	Yes	Yes	No bent, dent or any damage is observed.
Sampling speed	Yes	Yes	Sampling speed changes by the speed controller.

Check item	Daily	Periodic	Criteria
Temp stability	Yes	Yes	The difference between temperature reading and set temperature must be within the following ranges: DA-650: ±0.02°C (When set temp is 10~30°C.) ±0.05°C (whole range) DA-645: ±0.03°C (When set temp is 10~30°C.) ±0.05°C (whole range) DA-640: ±0.05°C
Connecting cable		Yes	The connecting cables must be securely connected in place.
Repeatability		Yes	The repeatability of measurement of air and water is within specified range.
Linearity		Yes	When density standard liquids (pure water, isooctane, 2,4-dichlorotoluene) are measured, the difference of density between measured and labeled must be within specified range.
Viscosity correction		Yes	When density standard (e.g.: JS100, JS500) is measured with viscosity correction, the difference of results from label must be within specified range.

Daily/Periodic check list (after measurement)

Check item	Daily	Periodic	Criteria
Cell cleaning	Yes	Yes	The cell must be clean after rinsed and dried. See 3-2. Preparation.
Waste liquid	Yes	Yes	Waste liquid must not remain in bottle. (Waste liquid must be discarded when it occupies more than 60% of waste bottle.)
Taint on housing	Yes	Yes	Housing must not be dirty. If dirty, wipe off with soft cloth wet with neutral detergent. (Do not use solvent like alcohol, acetone or thinner.)

Contact your local distributor when the results of daily or periodic check are found to be deviated from specified range (accuracy).

Customer support service (paid service)

KEM provides customer support service for your Density/Specific Gravity Meter according to the ISO 9001, International Standard for Quality Management System.

We also supply Density Standard Liquids.
It is recommended that our JCSS-accredited Density Standard Liquids be used.

JCSS-accredited Density Standard Liquid

JCSS 0115 Logo mark is the symbol of an accredited calibration laboratory based on the Measurement Law. Our Density Standard Liquid Laboratory is accredited by JCSS (Japan Calibration Service System) as an accredited calibration laboratory in the field of density. (The number "0115" is the JCSS accreditation number assigned to our density standard liquid laboratory.) JCSS-accredited calibration laboratories are assessed on JIS Q 17025:2000 (ISO/IEC 17025:1999).
JCSS-accredited density standard liquids can be used to guarantee the quality of calibration on oscillating-type density meters. The Density Standard Liquid Laboratory at KEM (JCSS Accreditation No. 0115) uses a submerged weighing equipment to supply the JCSS-accredited Density Standard Liquids traceable to the specific standard (single crystal silicon sphere) of the National Measurement Standard.

Density Standard Liquid	Density (at 20°C)	Uncertainty
Pure Water	0.99*** g/cm^3	±0.00003 g/cm^3

Part No.	Description
98-811-0076	2 vials of density standard liquid

7-2. Maintenance

Routine maintenance of equipment by user is important to keep the unit in normal condition before and after the day's work.

Daily maintenance must be practiced as part of your measurement work.

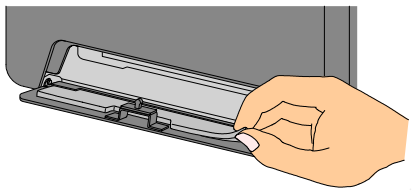
Replacement of dustproof filter

Dust from the system cooling fan eventually accumulates on dustproof filter. Clean or change it once every month or two.

Push the bottom of front to open the cover, and pull out the filter.

1 **Replace the filter.**

- Push and open the cover.
- Clean or change the filter.

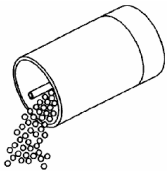


Replacement of silica gel

When blue grains of silica gel turn to pink, purple or red, replace the silica gel with new one. Or you can dry the old one so as to reuse it.

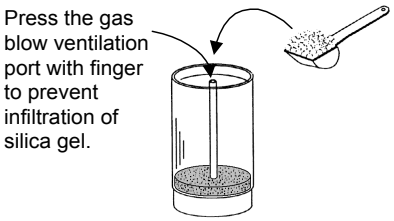
1 **Discard the old silica gel.**

- Take out the old one from container.



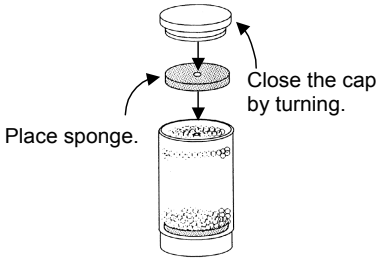
2 **Fill out new one.**

- Put your finger on top of vent hole not to allow silica gel to enter there.



3 **Close the cover.**

- Once filled, put the sponge on the top and close the cover.

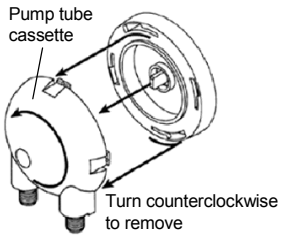


Replacement of pump tube

The pump tube may deteriorate over time. Replace it as appropriate.
The initial flow rate by pump is approximately 7mL/10 sec. As pump tube deteriorates, flow rate goes down, and eventually sample liquid may leak. If sample leaks from tube end, the tube must be changed with new one.
Follow the below instruction to change pump tube.

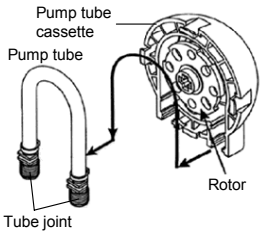
1 **Remove the cassette.**

- Remove the tubes connected to cassette.
- Turn the cassette to the left and pull it toward you.



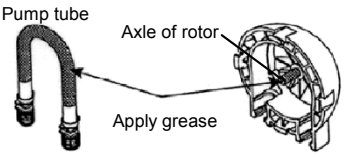
2 **Remove the tube.**

- Hold one end of tube joint and pull it toward you. (As the arrow indicates the way how it is removed.)



3 **Apply grease.**

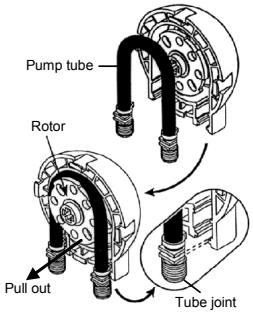
- Apply the supplied grease around the new tube and axle of cassette.



4 **Fit pump tube.**

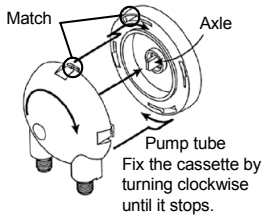
- Fit the new pump tube onto the rotor.

  To fit, draw the rotor toward you as shown in figure.
  The tube joint must be pushed in securely along the groove.



5 **Fit in the cassette.**

- Align the axle and rotor, and turn to the right until it stops.



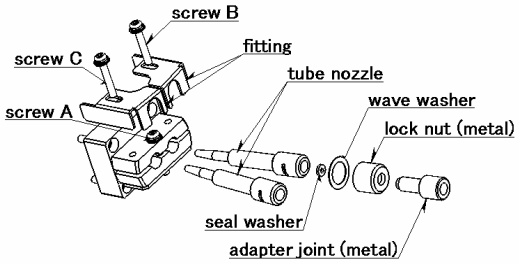
Note	Some liquids cannot be used or may deteriorate pump tube earlier. Study sample character and determine when to change the pump tube.

Connect/Disconnect the tube nozzle

The tube nozzle needs to be disconnected from tube for cleaning.

1 **Disconnect the nozzle.**

- Loosen lock nut.
- Remove adapter joint.
- Loosen screw A.
- Loosen screw B and C.
- Remove the fitting.
- Remove tube nozzle.

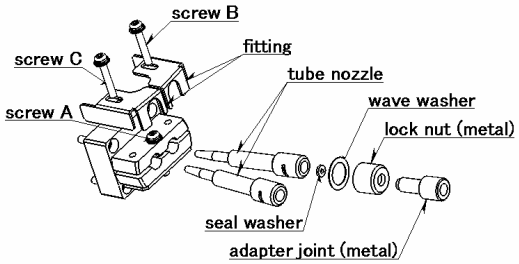


Connect the tube nozzle

Connect the nozzle as shown below.

1 **Connect the nozzle.**

- Insert tube nozzle.
- Tighten screw A.
- Tighten screw B and C.



2 **Connect lock nut and adapter.**

- Fix the adapter with lock nut tentatively.
- Put on seal washer.
- Put on wave washer.
- Tighten the adapter joint (with lock nut).
- Tighten lock nut.

Note	Do not tighten the adapter nut and lock nut too hard. Otherwise, the tube may be broken.

8. Troubleshooting

Some of typical problems you may encounter would be: "Measurement is not started," "Measurement does not come to an end," or "Results are not stable." Refer to the following troubleshooting as necessary at time of trouble.

8-1. Error message

The error message appears on display as follows.

The list below describes the error message showing the nature of trouble with possible or likely cause and countermeasures for the trouble.

No.	Error message	Possible cause	Action
1	Wrong USB Flash Drive.	You may have tried to import the KEM-supplied table (paid) with any USB flash drive other than the one supplied by KEM.	Use KEM-supplied USB flash drive.
2	Error detected. Code E-1xxxx. Contact your local agent.	Hardware may have been defective.	Turn off and turn on the equipment. Still the same error occurs, contact your local distributor.
3	Sensor error detected. Contact your local agent. (Code E-2xxx.)	Hardware may have been defective.	Turn off and turn on the equipment. Still the same error occurs, contact your local distributor.
4	Calibration required.	Calibration may have not been conducted.	Conduct a calibration.
5	Calibrate with viscosity correction on.	Calibration may have not been conducted with viscosity correction on though viscosity correction is on in measurement parameter.	Conduct a calibration with viscosity correction on.
6	Calibration failed.	Calibration may have failed.	Make sure not to allow air bubbles to enter the cell. Widen pass/fail criteria.
		Calibration result may have not been adopted.	Redo calibration.
		Calibration may have not come to an end even after exceeding limit time.	Make sure not to allow air bubbles to enter the cell. Extend limit time.

No.	Error message	Possible cause	Action
6	Calibration failed.	There may be no difference between oscillation frequency of calibration points 1 and 2.	Clean and dry the cell before calibration. Make sure not to allow air bubbles to enter the cell.
7	Check failed.	Check result may have exceeded tolerance.	Make sure not to allow air bubbles to enter the cell. Widen tolerance.
8	Uncalib method remains. Conduct calib.	The error appears when sample file, temperature scan or concentration scan has found temperature that is not calibrated.	Calibrate at required temperature before measurement. Use one-point calibration mode, which is useful for all temperatures.
9	Unable to start temp scan. Check temp scan table.	The error appears if wrong concentration scanning has been set in.	Review the temperature scan table as below: More than 2 points for linear, more than 3 for quadratic, more than 4 for cubic equation.
10	Changer communication error. Check cable.	Communication with sample changer, when connected, may have failed.	Check if communication cable is properly connected. Also check setting of communication port.
		CHD-502 is set in sequence mode and keeps turning round without a single vial on turntable.	Test vials whether single or plural must be put on turntable of CHD-502 if it is in sequence mode.
		The alarm appears when the cable to (sample changer or any other option unit) is not connected or configured.	Make sure of cable connection. Check from your Density/Specific Gravity Meter as follows: "MENU" -> "Option" -> "Changer" -> "Model". Then make sure if CHD-502, DCU-551 or DCU-600 is selected.

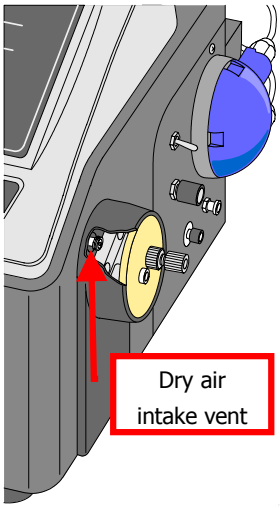
No.	Error message	Possible cause	Action
11	Periodic check overdue.	The alarm appears when the date for check or calibration is overdue.	Periodic check schedule is overdue, so check or calibrate now, and you can cancel the alarm. The message will disappear. When day interval is changed, it will be effective only after check or calibration is finished.
12	Periodic check overdue. Do you wish to continue?	The message appears if you attempt to continue without check or calibration.	Periodic check schedule is overdue, so check or calibrate now, and you can cancel the alarm. The message will disappear. When day interval is changed, it will be effective only after check or calibration is finished.
13	X days left until periodic check.	The message appears when the due date is approaching.	Check or calibrate now, and you can cancel the alarm. The message will disappear. When day interval is changed, it will be effective only after check or calibration is finished.
14	Periodic Check -- Today!	The alarm appears when it is the day of periodic check or calibration.	Check or calibrate now, and you can cancel the alarm. The message will disappear. When day interval is changed, it will be effective only after check or calibration is finished.
15	Nozzle error. Clear clog.	The alarm appears when the nozzle of sample changer does not maneuver.	Remove any obstacle. If the nozzle is bent or damaged, change it. Press [Stop] to cancel the error.
16	Table error. Set table.	The alarm appears when the turntable does not revolve in normal condition.	Remove any obstacle. Press [Stop] to cancel the error.

8-2. Technical tips

Here is the list of technical tips to help solve your measuring problems like "Measurement does not end" or "The result is not stable".

The result of density measurement mostly depends on sample character and condition. Understanding the nature of density meter is the key for correct measurement.

Sample type	Technical tips
Air bubble appears.	The air bubble is liable when cell temperature is higher than sample. Warm the sample first.
Air bubble is formed.	The tube line leaks somewhere. After dried, overhaul the joints and clean with tissue.
Air bubble is blended.	When sampling viscous liquid by pump, air bubble may be blended. Use syringe instead.
Solid is deposited.	When cell temperature is lower than sample, dissolved substance may be solidified. Raise cell temperature to the same level as sample.
The result is unstable.	Concentration distribution may not be even in viscous sample (e.g. sucrose). Carefully stir sample liquid to equalize concentration. Repeatability of separated liquid is not stable.
	When the solvent does not dissolve in sample liquid, measurement result may not be stable with contaminated measuring cell. Change the solvent.
Measuring time is long.	If temperature compensation is not necessary, turn it off to shorten measuring time.
Measuring time is long with viscosity correction off.	Stability (measurement mode) may be set to zero (0). Measurement time can be shortened if you set stability to one (1). (Note that measurement accuracy with stability 1 is ±0.0001g/cm^3.)
Sampling by pump takes a long time.	When the sample is highly viscous, sampling by pump takes a long time. Use syringe instead.
It does not print out.	Digital configuration with printer may be wrong. Refer to separate Function Description (6-9-3).

Sample type	Technical tips
Cell window mists.	When running for many hours (e.g. 24h) while ambient temperature and humidity are high (e.g. 35°C, 85%RH) and the cell temperature is low (e.g. 15°C), the cell window may mist. Blow dry air through the air intake vent for about 10 minutes. 

Hint	If the problem with density measurement persists even after the above countermeasure taken, contact your local distributor.

9. Additional Information

This chapter shows "Parts and Consumables," "Glossary and reference," "Optional devices," "Basic specifications," "Corresponding standards" and "Index."

9-1. Parts and consumables

Here is the list of parts and consumables with part number. Please refer to the list when you place an order.

Parts and consumables for DA-650/DA-645/DA-640 are as shown below:

Parts

Part Name	Part Number	Qty	Remarks
Tube Holder	12-00051-00-48	1	
Desiccant Container	12-01148-02-48	1	
Connecting Tube	12-01997-01-48	1	For drain (solenoid valve side)
Connecting Tube	12-01998-00-48	1	For drying
Connecting Tube	12-01999-00-48	1	For drain (cell outlet)
Connecting Tube	12-02000-00-48	1	For sampling
Connecting Tube	12-02699-00-48	1	For purge gas
Rubber Cover	20-05748-00-48	1	For sample opening
Lure Adapter	20-05764-00-48	1	Adapter for syringe
Drain Tube	20-05789-01-48	1	For pump side
Protective Rubber	20-05915-00-48	1	Round for sample opening
Operation Manual CD-ROM	12-02845-00-48	1	Incl. Operation Manual, Function Description & Quick Manual
Quick Manual	59-00053-01-48	1	
AC Adapter*1	12-02833-01-48	1	For Europe 220~240V
	12-02833-02-48	1	For U.K. 220~240V
	12-02833-03-48	1	For U.S.A. 110~120V
	12-02833-04-48	1	For China(PRC) 220~240V
Stylus	69-00444-00-48	1	

*1: Make sure your country's power requirement.

Consumables

Part Name	Part Number	Qty	Remarks
Filter	20-05665-00-48	1	
Silica gel (500g)	61-00249-00-48	1	
Syringe	66-00088-00-48	2	2ml
Thermal print paper roll (10 rolls/set)	69-00522-01-48	1	For thermal printer
Thermal print paper roll (longer life) (10 rolls/set)	69-00522-11-48	1	For thermal printer

Options

Part Name	Part Number	Qty	Remarks
Auto Sampling Unit	DCU-600 (upcoming)	1	
Multiple Sample Changer Normal Type Heating Type Cooling Type	CHD-502N(E) CHD-502H(E) CHD-502C(E)	1	Incl. vials and septa. * Separate connecting kit required.
Auto Clean & Sampling Unit Normal Type Heating Type	DCU-551N(E) DCU-551H(E)	1	Incl. vials and septa. * DTS-100C required.
Density/Specific Gravity Meter Connecting Kit	12-02763-00-48	1	To connect with CHD-502N/C.
	12-02764-00-48	1	To connect with CHD-502H.
	12-02763-01-48	1	To connect with DCU-551N.
	12-02764-01-48	1	To connect with DCU-551H.
ID Key	(upcoming)	1	With USB flash drive
Data Capture Software	SOFT-CAP(E)	1	
Dot Matrix Printer (AC 100V)*	12-02028-00-48	1	Incl. connecting cables (9P-25P, MiniDIN8P-DSUB9P).
Dot Matrix Printer (AC 120V) *	12-02028-01-48	1	Incl. connecting cables (9P-25P, MiniDIN8P-DSUB9P).
Dot Matrix Printer (AC 230V) *	12-02028-02-48	1	Incl. connecting cables (9P-25P, MiniDIN8P-DSUB9P).
Connecting Cable (9P-9P)	12-02012-00-48	1	
Connecting Cable (9P-25P)	12-02013-00-48	1	
Connecting Cable (MiniDIN8P-DSUB9P)	64-00625-00-48	1	
USB Serial Converter	64-00177-00-48	1	
Thermal Printer (Incl. connecting cables)	12-02618-01-48	1	For Europe 220~240V
	12-02618-02-48	1	For U.K. 220~240V
	12-02618-03-48	1	For U.S.A. 110~120V
	12-02618-04-48	1	For China (PRC) 220~240V
Thermal Printer Stand	12-02850-00-48	1	Incl. fixing screws.

*If you wish to connect your IDP-100, which had been connected with your DA-520/-510/-505/-500, with the DA-650/-645/-640, an optional connecting cable (MiniDIN8P-DSUB9P:64-00625-00-48) is required.

JCSS-accredited Density Standard Liquid

Part Name	Part Number	g/cm^3 at 20°C	Remarks
Pure water	98-811-0076	0.99821	2 bottles/set
Isooctane	98-811-0077	0.691**	Pure water and isooctane (one bottle each)
Dichlorotoluene	98-811-0078	1.249**	Pure water & Dichlorotoluene (one bottle each)
Bromobenzene	98-811-0079	1.494**	Water & Bromobenzene (one bottle each)

* Each liquid is in a 10mL vial.

JCSS-accredited Density Standard Liquid (Viscosity Liquid)

Part Name	Part Number	g/cm^3 at 20°C	Remarks
Viscosity liquid 5	61-00025-00-48	0.882**	Pure water & viscosity liquid (5mPa·s) (one bottle each)
Viscosity liquid 20	61-00026-00-48	0.839**	Pure water & viscosity liquid (20mPa·s) (one bottle each)
Viscosity liquid 50	61-00027-00-48	0.848**	Pure water & viscosity liquid (50mPa·s) (one bottle each)
Viscosity liquid 100	61-00028-00-48	0.855**	Pure water & viscosity liquid (100mPa·s) (one bottle each)
Viscosity liquid 200	61-00029-00-48	0.861**	Pure water & viscosity liquid (200mPa·s) (one bottle each)
Viscosity liquid 500	61-00030-00-48	0.871**	Pure water & viscosity liquid (500mPa·s) (one bottle each)
Viscosity liquid 2000	61-00031-00-48	0.879**	Pure water & viscosity liquid (2000mPa·s) (one bottle each)

* Each liquid is in a 10mL vial.

JCSS-accredited Density Standard Liquid (Alcohol)

Part Name	Part Number	g/cm^3 at 15°C	Remarks
5% ethanol	61-00054-00-48	0.991**	3 bottles/set
10% ethanol	61-00033-00-48	0.985**	3 bottles/set
15% ethanol	61-00020-00-48	0.980**	3 bottles/set
20% ethanol	61-00034-00-48	0.975**	3 bottles/set
25% ethanol	61-00021-00-48	0.970**	3 bottles/set
30% ethanol	61-00035-00-48	0.964**	3 bottles/set
35% ethanol	61-00055-00-48	0.958**	3 bottles/set
40% ethanol	61-00022-00-48	0.948**	3 bottles/set
15%/25%/40% ethanol	61-00023-00-48	0.980** 0.970** 0.948**	One bottle each

* Each liquid is in a 20mL vial.

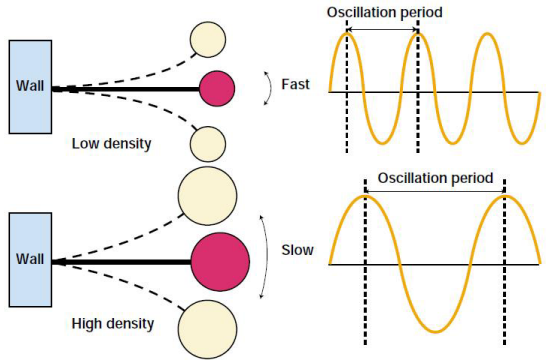
Hint	Ethanols of 45 to 100% are also available. Contact your local distributor for details.

9-2. Glossary and reference

Given in this section are "Measurement principle of oscillation-type density meters" and "Glossary and reference (incl. tables of air and pure water)."

Measurement principle of oscillation-type density meters

Suppose a weight hangs at the end of a rod. When the weight is flipped by a finger, the rod starts to vibrate. When the weight is heavy, it swings slowly. If it is light, it swings fast. This means the frequency depends on the mass of weight. Since density value is proportionate to mass, the density of unknown substance can be known by measuring the frequency of weight in cubic if the cubic volume is constant.



When the measuring is vibrated in a chamber filled with liquid or gas, its oscillation frequency differs from density of sample.
Suppose T is oscillation frequency, T can be expressed as follows:

$$T = 2\pi\sqrt{\frac{dVc + Mc}{K}}$$

Where d = Density of sample in cell
Vc = Volume of sample, that is cell volume
Mc = Mass of measurement cell
K = Constant

$$d = \frac{K}{4\pi^2 Vc}T^2 - \frac{Mc}{Vc}$$

The above equation tells the density is proportionate to the frequency.
By measuring standard substance of which density is known (density: da, dw), the oscillation frequency Ta, Tw are obtained, and then factor F.
F can be calculated from calibration.

$$F = \frac{K}{4\pi^2 Vc} = \frac{d_a - d_w}{T_a^{\,2} - T_w^{\,2}}$$

Therefore, density is obtained by measuring oscillation frequency T of unknown substance.

$$d = d_a - F(T_a^{\,2} - T^2)$$

Principle of viscosity correction

The oscillation-type density meter is under the influence of viscosity. Viscosity compensation corrects the effect of viscosity. Since low viscous standard liquid is used for calibration liquid (reference), measurement of highly viscous sample would turn out to be higher than true value.

The effect of viscosity when measured is as follow:

Low-viscosity liquid (water, Japanese sake, whisky): less than 5mPa·s

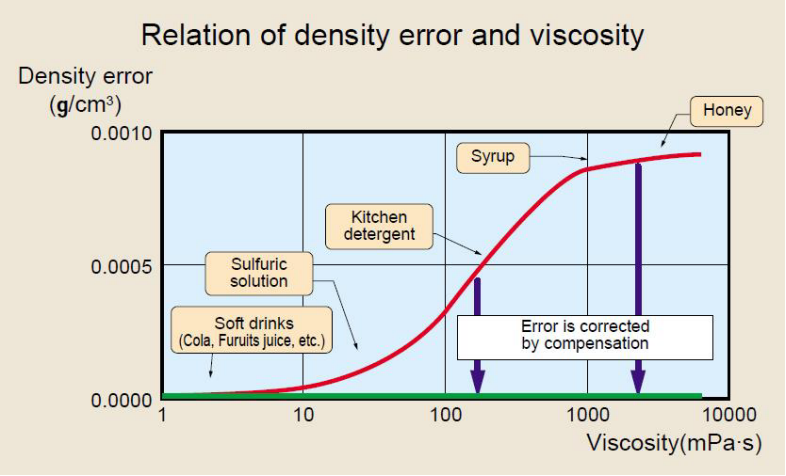
The effect: 0.0001g/cm^3 or less

Viscous liquid (olive oil, tomato juice, engine oil): 5~1000mPa·s

The effect: 0.0001~0.0008g/cm^3

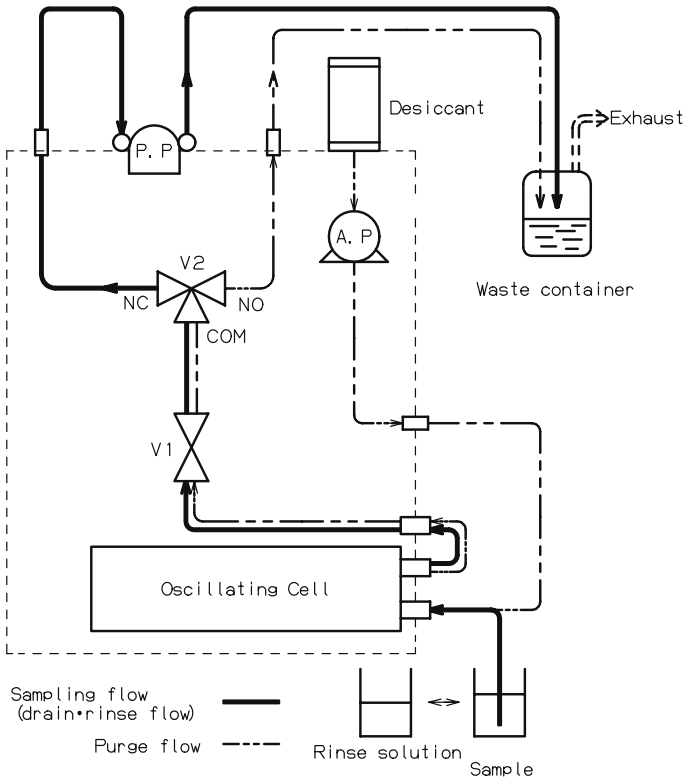
High-viscosity liquid (honey, mayonnaise, hair conditioner): over 1000 mPa·s

The effect: 0.0008 g/cm^3 ca.



Flow chart of oscillation-type density meter (DA-6xx series)

DA-6xx series features shortened drying time and free selection of waste container by providing drying pump (A.P.) and sampling pump (P.P) separately.



Density

Mass (e.g. gram) per unit volume (e.g. cm^3).

Specific gravity (SG) (= relative density)

SG is the ratio of mass between a substance and reference standard.
Typically, water (4°C unless otherwise specified) is designated as reference for solid and liquid.
Since it is the ratio of density, the unit is dimensionless.
Density of water at 4°C is 0.999972g/cm^3 while SG is approx. 30ppm.

DA-6xx series uses the following expressions on display or printout:

- d: Density calculation at measuring temperature.
- d(t/4): SG calculation for water density at 4°C. (For Fahrenheit °F, d(t/4)→d(t/60) and SG calculation for water density at 60°F.)
- d(t/t): SG calculation for water density at measuring temperature.

Brix

Brix is the name of scale for solid concentration in liquid, sometimes expressed as °Bx. The unit is '%' or 'degree.'
Brix is used to express sucrose concentration (sugar content) in those industries like foods, winery, sugar and fruit farm.
Usually they use the scale for density of sucrose at 20°C converted to weight percent concentration (w/w%).
Sucrose solution of weight percent 30% (100g solution contains 30g sucrose and 70g water) is expressed as Brix 30%.
Generally Brix is known as the measure of sucrose concentration (sugar content) but some liquids contain density of solids other than sucrose. Therefore, Brix does not necessarily express sucrose concentration only.
While soft drinks or fruit juice contain soluble solid in a large proportion, the Brix shows its sucrose concentration (sugar content) as is without problems.

Baling

Baling is the name of German scientist Karl Baling who developed Baling's concentration for weight percent of 17.5°C sucrose solution.
Brix comes from the name of Antoine Brix (Adolf Brix) who recalculated Baling's reference temperature at 15.5°C.

Plato

Plato % expresses the extract content of sweet wort or beer in sucrose weight % as the same SG (20°C/20°C) sucrose solution. It is based on "Plato's Extract Table" (correction of measurements made by C. J. N. Baling) compiled for German government by F. Plato in 1918. Later, further corrections were made by adding precise adjustments and thermal corrections. At preset, Plato is used in many analysis as the industry standard international unit (except UK) for wort and beer. When used as unit, it is abbreviated as %P or °P (degree Plato). Plato degree uses Baling's corrected 17.5°C reference temperature with constant weight g at 17.5°C: Plato degree = 260×(1-1/gravity)

Baume's hydrometer

Heavy Baume's degree

SG unit measured by Baume's hydrometer by French scientist A. Baume expressed as °Be.
Heavy Baume's degree is for SG larger than 1.
Heavy Baume's degree = ((1/SG (15/4°C))-1)×(-144.3)

Light Baume's degree

SG unit measured by Baume's hydrometer by French scientist A. Baume expressed as °Be.
Light Baume's degree is for SG smaller than 1.
Light Baume's degree = ((1/SG (15/4°C))-1)×144.3+10

Japanese sake degree

It is the unit for SG of sake, used as the measure to tell dry or sweet sake.
It is measured by a buoy for sake sample at 15°C.
Distilled water at 4°C is referenced (0). Those lighter than reference are determined as + (plus)/dry whilst heavier than reference are – (minus)/sweet.
Japanese sale degree is defined by law as follows:
Japanese sake degree = ((1/SG (15/4°C))-1)×1443
From the above, below equation derives:
SG (15/4°C) = 1443/(1443+sake degree)

Ethanol degree

Unit of volume percentage of ethanol and water
Table of Ethanol degree and density is available. Reference temperature is 15°C. This unit is used in quality control of alcohol in beverages.

Extract

Scale name for extracted component of solution (Japanese sake).
The following formula is obtained from SG d_S from ethanol degree and SG d_A (15/4°C) from Japanese sake degree:
Extract = $(d_S-d_A)\times260+0.21$

API degree (API Baume's degree)

This is the unit for SG of crude oil defined by the American Petroleum Institute.
API degree is obtained from the following equation:
API degree = (141.5/G)-131.5
Where G is mass of crude oil at 60°F (15.56°C) and shows ratio of mass of the same volume of water at 60°F.
Crude oil varies in quality from place to place where produced. Some oil contains mostly gasoline, some mostly heavy oil or those easily solidified or none solidified.

Dwaddell degree

Unit for SG of dye
Water at 4°C is the reference (0).
Dwaddell is expressed by:
Dwaddell = (SG (15/4°C)-1)×200

Milk degree

Unit for SG of milk
Water at 4°C is the reference (0).
Milk degree is expressed by:
Milk degree = (SG (15/4°C)-1)×1000

Uncertainty

Uncertainty is the measure of dispersion (reliability) of measurement results. Unification of expression and computation method has been initiated by the International Committee of Weights and Measures (CIPM), and as the results, in 1993, the International Standard Organization and seven other international institutes co-edited "Guide to the Expression of Uncertainty in Measurement"(GUM), where the word Uncertainty is used.

Traceability

The accuracy of measurement results can be traced, linked or related up to the national or international standard.
Measuring instruments are calibrated by standard equipment, which is calibrated by further accurate instrument (less uncertainty). If this process of searching calibration continues, finally it reaches the national standard. When the accuracy of a measuring instrument can be traced back to the national or international standard, it is called traceable.
When the reference substance used in the analytical instrument is traceable, the instrument can be defined as traceable to national standard.
Density/Specific Gravity Meters of the DA-6xx series are scientific instruments traceable to the Japanese national standard.

Average (mean value)

The mean value is batch calculated by averaging dispersed measurand.

$$\overline{X} = \frac{X_1 + X_2 + \cdots + X_n}{n}$$

Standard Deviation

Expressed by σ or *s* showing dispersion of statistics or random variable:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(Xi - \overline{X}\right)^2}{n-1}}$$

RSD (Relative Standard Deviation)

RSD is SD divided by Mean, showing how dispersed against the average. RSD is the same as Coefficient Variable (CV).

$$RSD = \frac{SD}{\overline{X}} \times 100 \quad (\%)$$

Density of dry air

Density of dry air can be calculated from below formula: θ(°C), P (hPa).

$$\rho\ (g/cm^3) = \frac{0.0012932}{1 + 0.00367(\theta / °C)} \cdot \frac{P / hPa}{1013.25}$$

Below chart shows density of dry air at 1013.25hPa by 5-place equipment.

Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)
0	0.00129	25	0.00118	50	0.00109	75	0.00101
1	0.00129	26	0.00118	51	0.00109	76	0.00101
2	0.00128	27	0.00118	52	0.00109	77	0.00101
3	0.00128	28	0.00117	53	0.00108	78	0.00101
4	0.00127	29	0.00117	54	0.00108	79	0.00100
5	0.00127	30	0.00116	55	0.00108	80	0.00100
6	0.00127	31	0.00116	56	0.00107	81	0.00100
7	0.00126	32	0.00116	57	0.00107	82	0.00099
8	0.00126	33	0.00115	58	0.00107	83	0.00099
9	0.00125	34	0.00115	59	0.00106	84	0.00099
10	0.00125	35	0.00115	60	0.00106	85	0.00099
11	0.00124	36	0.00114	61	0.00106	86	0.00098
12	0.00124	37	0.00114	62	0.00105	87	0.00098
13	0.00123	38	0.00113	63	0.00105	88	0.00098
14	0.00123	39	0.00113	64	0.00105	89	0.00097
15	0.00123	40	0.00113	65	0.00104	90	0.00097
16	0.00122	41	0.00112	66	0.00104		
17	0.00122	42	0.00112	67	0.00104		
18	0.00121	43	0.00112	68	0.00103		
19	0.00121	44	0.00111	69	0.00103		
20	0.00120	45	0.00111	70	0.00103		
21	0.00120	46	0.00111	71	0.00103		
22	0.00120	47	0.00110	72	0.00102		
23	0.00119	48	0.00110	73	0.00102		
24	0.00119	49	0.00110	74	0.00102		

Density of dry air

Below chart shows density of dry air at 1013.25hPa by 4-place equipment.

Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)
0	0.0013	25	0.0012	50	0.0011	75	0.0010
1	0.0013	26	0.0012	51	0.0011	76	0.0010
2	0.0013	27	0.0012	52	0.0011	77	0.0010
3	0.0013	28	0.0012	53	0.0011	78	0.0010
4	0.0013	29	0.0012	54	0.0011	79	0.0010
5	0.0013	30	0.0012	55	0.0011	80	0.0010
6	0.0013	31	0.0012	56	0.0011	81	0.0010
7	0.0013	32	0.0012	57	0.0011	82	0.0010
8	0.0013	33	0.0012	58	0.0011	83	0.0010
9	0.0013	34	0.0011	59	0.0011	84	0.0010
10	0.0012	35	0.0011	60	0.0011	85	0.0010
11	0.0012	36	0.0011	61	0.0011	86	0.0010
12	0.0012	37	0.0011	62	0.0011	87	0.0010
13	0.0012	38	0.0011	63	0.0011	88	0.0010
14	0.0012	39	0.0011	64	0.0010	89	0.0010
15	0.0012	40	0.0011	65	0.0010	90	0.0010
16	0.0012	41	0.0011	66	0.0010		
17	0.0012	42	0.0011	67	0.0010		
18	0.0012	43	0.0011	68	0.0010		
19	0.0012	44	0.0011	69	0.0010		
20	0.0012	45	0.0011	70	0.0010		
21	0.0012	46	0.0011	71	0.0010		
22	0.0012	47	0.0011	72	0.0010		
23	0.0012	48	0.0011	73	0.0010		
24	0.0012	49	0.0011	74	0.0010		

Density of pure water

Below chart shows density of pure water by 5-place equipment.

Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)
0	0.99984	25	0.99705	50	0.98804	75	0.97484
1	0.99990	26	0.99679	51	0.98758	76	0.97424
2	0.99994	27	0.99652	52	0.98712	77	0.97364
3	0.99997	28	0.99624	53	0.98665	78	0.97303
4	0.99997	29	0.99595	54	0.98617	79	0.97241
5	0.99997	30	0.99565	55	0.98569	80	0.97179
6	0.99994	31	0.99534	56	0.98521	81	0.97116
7	0.99990	32	0.99503	57	0.98471	82	0.97053
8	0.99985	33	0.99470	58	0.98421	83	0.96990
9	0.99978	34	0.99437	59	0.98371	84	0.96926
10	0.99970	35	0.99403	60	0.98320	85	0.96861
11	0.99961	36	0.99368	61	0.98268	86	0.96796
12	0.99950	37	0.99333	62	0.98216	87	0.96731
13	0.99938	38	0.99297	63	0.98163	88	0.96664
14	0.99925	39	0.99259	64	0.98109	89	0.96598
15	0.99910	40	0.99222	65	0.98055	90	0.96531
16	0.99895	41	0.99183	66	0.98000		
17	0.99878	42	0.99144	67	0.97945		
18	0.99860	43	0.99104	68	0.97890		
19	0.99841	44	0.99063	69	0.97833		
20	0.99821	45	0.99021	70	0.97776		
21	0.99800	46	0.98979	71	0.97719		
22	0.99777	47	0.98936	72	0.97661		
23	0.99754	48	0.98893	73	0.97603		
24	0.99730	49	0.98848	74	0.97544		

Values of 0~40°C in this chart are based on calculations formulated by CIPM (Comité international des poids et mesures; International Committee of Weights and Measures) in regard to the density of SMOW (Standard Mean Ocean Water); those of 41~90°C by IAPWS-95.

Density of pure water

Below chart shows density of pure water by 4-place equipment.

Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)	Temp (°C)	Density (g/cm^3)
0	0.9998	25	0.9970	50	0.9880	75	0.9748
1	0.9999	26	0.9968	51	0.9876	76	0.9742
2	0.9999	27	0.9965	52	0.9871	77	0.9736
3	1.0000	28	0.9962	53	0.9866	78	0.9730
4	1.0000	29	0.9959	54	0.9862	79	0.9724
5	1.0000	30	0.9956	55	0.9857	80	0.9718
6	0.9999	31	0.9953	56	0.9852	81	0.9712
7	0.9999	32	0.9950	57	0.9847	82	0.9705
8	0.9999	33	0.9947	58	0.9842	83	0.9699
9	0.9998	34	0.9944	59	0.9837	84	0.9693
10	0.9997	35	0.9940	60	0.98312	85	0.9686
11	0.9996	36	0.9937	61	0.9827	86	0.9680
12	0.9995	37	0.9933	62	0.9822	87	0.9673
13	0.9994	38	0.9930	63	0.9816	88	0.9666
14	0.9992	39	0.9926	64	0.9811	89	0.9660
15	0.9991	40	0.9922	65	0.9806	90	0.9653
16	0.9989	41	0.9918	66	0.9800		
17	0.9988	42	0.9914	67	0.9795		
18	0.9986	43	0.9910	68	0.9789		
19	0.9984	44	0.9906	69	0.9783		
20	0.9982	45	0.9902	70	0.9778		
21	0.9980	46	0.9898	71	0.9772		
22	0.9978	47	0.9894	72	0.9766		
23	0.9975	48	0.9889	73	0.9760		
24	0.9973	49	0.9885	74	0.9754		

Values of 0~40°C in this chart are based on calculations formulated by CIPM (Comité international des poids et mesures; International Committee of Weights and Measures) in regard to the density of SMOW (Standard Mean Ocean Water); those of 41~90°C by IAPWS-95.

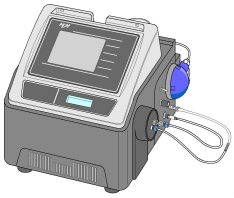
9-3. Convenient and useful optional devices

We have various optional devices for your easier and more convenient work on our Density/Specific Gravity Meters.

Print out results

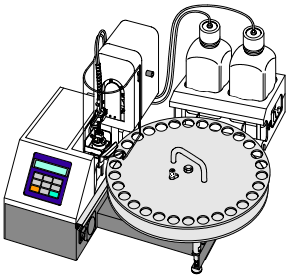
Thermal Printer DP-600

Dot Matrix Printer IDP-100

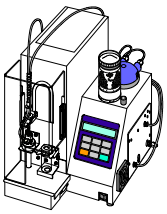


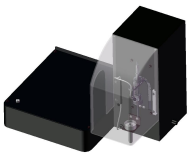
DA-650/
DA-645/DA-640

Auto measurement & cleaning



Multiple Sample Changer
CHD-502N (30 samples)

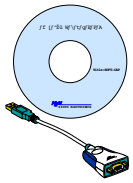




Auto Clean and Sampling Unit
DCU-551N DCU-600

Operation from your PC

Measurement data transfer to your PC



Data Capture Software SOFT-CAP

Contact your local distributor for details.

9-4. Specifications

Specifications of three models: DA-650, DA-645 and DA-640.

Model		DA-650 (5-place)	DA-645 (4.5-place)	DA-640 (4-place)
Measurement Method		Resonant frequency oscillation		
Measurement Range		0 ~ 3 g/cm^3		
Temperature Range		0 ~ 90 °C (32 ~ 194 °F)		
Accuracy[*1]	Density	around 1.0 g/cm^3 ±2×10^{-5} g/cm^3 around 1.5 g/cm^3 ±4×10^{-5} g/cm^3	around 1.0 g/cm^3 ±5×10^{-5} g/cm^3 around 1.5 g/cm^3 ±1×10^{-4} g/cm^3	±1×10^{-4} g/cm^3
		(Calibration with air and water required.)		
	Temp	±0.02°C/±0.04°F (10~30°C/50~86°F) ±0.05°C/±0.09°F (0~90°C/32~194°F)	±0.03°C/±0.05°F (10~30°C/50~86°F) ±0.05°C/±0.09°F (0~90°C/32~194°F)	±0.05°C/±0.09°F (0~90°C/32~194°F)
Repeatability[*2]	Density	SD 5×10^{-6} g/cm^3	SD 1×10^{-5} g/cm^3	SD 5×10^{-5} g/cm^3
Minimum Sample Required		1) Approx. 1.2mL (Syringe) 2) Approx. 2.0mL (Pump)		
Measurement Time		1) 1 to 4 mins (Manual) 2) 2 to 10 mins (Auto)		
Display		1) 5.7-inch colour TFT LCD; VGA (640×480) 2) Shows density, SG, oscillation frequency, temp, concentration, And other messages.		
Viscosity Correction		Yes		
Sampling		1) Manual by syringe 2) Auto by peristaltic pump[*2]		
Method		Saves up to 100 different methods in built-in memory including measurement parameters, density auto correction, concentration conversion, etc.		
Stability		Four modes of stability according to measurement accuracy and time.		
Density Auto Correction		1) Saves conversion table or formula at your desired temperatures according to your samples. 2) Temperature conversion table preprogrammed according to ASTM standard for petroleum, petroleum products and lubricating oils.		
Auto Conversion		1) Between concentration and density. 2) Between temperature and density.		
Statistics		1) Auto or manual calculation of mean value, SD and coefficient. 2) Recalculation, data deletion.		
Interfaces		1) LAN: × 1; Personal computer (PC) 2) USB 1.1: × 2; USB flash drive, keyboard, barcode reader, Epson inkjet printer[*3], Thermal Printer 3) RS-232C: × 2; Dot Matrix Printer, Auto Clean and Sampling Unit, Multiple Sample Changer		
Options		1) Printer: DP-600, IDP-100 2) Sampling Unit, Changer: DCU-551N/H, CHD-502N/H/C 3) Software: SOFT-CAP (Data Capture Software)		
Data I/O		1) USB flash drive as data storage medium. 2) Application Notes provided in USB flash drive.		
Wetted Materials		PTFE, borosilicate glass, SUS304		
Ambient Conditions		1) Temperature : 5 ~ 35 °C (41 ~ 95 °F) 2) Humidity : 85%RH or below (No condensation allowed.)		
Power Supply		DC 24V 5A (Main Unit) AC 100 ~ 240 V; 50/60 Hz (Comes with AC adapter.)		
Power Consumption		40 W (max. 120 W, min. 20 W)		

Dimensions	320 (W) × 382 (D) × 272 (H) mm (12.6 (W) × 14.3 (D) × 10.7 (H) inches)
Weight	18 kg (39.7 lbs)
Export Packing in Double Carton Box	G/W 21 kg; 540 (W) × 480 (D) × 460 (H) mm (May vary in some cases.) (G/W 46.3 lbs; 21.3 (W) × 18.9 (D) × 18.1 (H) inches)

*1, *2: According to KEM standard measurement conditions.

*3: Enquire for applicable models.

9-5. International standards

The DA-650, DA-645 and DA-640 comply with the following international standards:

Standard	Country
ASTM (American Society for Testing and Materials)	U.S.A.
DIN (Deutsches Institut für Normung)	Germany
Her Majesty's Revenue and Customs (HMRC)	U.K.
Pharmacopoeia	Eur., Japan, U.S.A.
ASTM D 1250 (Temperature Compensation Table for Petroleum Products)	U.S.A.
JIS K 2249	Japan
ASTM D 4052 (Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter)	U.S.A.
ASTM D 5002 (Standard Test Method for Density and Relative Density of Crude Oils by Digital Density Analyzer)	U.S.A.
ISO 12185 (Crude petroleum and petroleum products - Determination of density - Oscillating U-tube method)	International
ISO 15212 (Oscillation-type density meters -- Part 1: Laboratory instruments)	International
Official Methods of the National Tax Agency Japan for the Evaluation of Content	Japan

9-6. Index

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W

9-7. Warranty and after-the-sale service

Warranty period
One year after the date of purchase

Warranty
The product you have purchased passed stringent in-line testing and inspection at KEM, however, if you should find any defects, your unit is under warranty for free repair or replacement except consumables, provided the unit has been in normal use and operated to the specification. (Supply of parts continues for 7 years after the model is discontinued.)

Exceptions
1) Modified by someone other than authorized service personnel. 2) Used under the condition or in a range other than specified. 3) Operated in a way other than instructed in manual or help. 4) Caused by user's misuse or careless operation. 5) Due to user's inadequate environmental condition 6) Attributed to fire, earth quake, lightning, God's act 7) Maker will not be liable for any damage or loss whether physically or monetary caused by the use of or in relation to the product.

Repair
Before you call for repair service, let us know the following information: ▪ Type or model of product ▪ Serial No. ▪ Nature of trouble or defect ▪ Your contact information ▪ Peripherals connected to the unit (where applicable)

Enquiry
Contact your local distributor.

Overseas Sales & Marketing Division

9F, Yamawaki Bldg., 4-8-21, Kudan-minami,
Chiyoda-ku, Tokyo 102-0074 Japan
Ph: +81-3-3239-7333 Fax: +81-3-3237-0537
URL: http://www.kyoto-kem.com

Factories

56-2, Ninodan-cho, Shinden, Kisshoin,
Minami-ku, Kyoto 601-8317 Japan
Ph: +81-75-691-4122 Fax: +81-75-691-9961
&
74, Ninodan-cho, Shinden, Kisshoin,
Minami-ku, Kyoto 601-8317 Japan
Ph: +81-75-691-4121 Fax: +81-75-691-4127