




D155

Density Meter



Instruction & Operation Manual

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Table of contents	Page
1. Introduction.....	2
1-1. Overview of the instrument.....	2
1-2. About the manual.....	3
1-3.  Safety symbols.....	4
2. Preparations for measurement.....	7
2-1. Supplied parts with D155.....	7
2-2. Installation and start-up.....	9
2-2-1. Power cable.....	9
2-2-2. Connecting the tube lines – D155 with Peristaltic Pump.....	10
2-2-3. Connecting the tube lines – D155 without Pump.....	10
2-3. Parts name and functions.....	11
2-3-1. Outward appearance and configuration.....	11
2-3-2. Key functions (General description).....	13
2-3-3. LCD Display Layout.....	14
2-4. Display during initialization.....	14
2-4-1. The initial display upon power up.....	14
2-4-2. Display during warm up period.....	14
2-4-3. Display after warm-up.....	14
2-5. Preparation before measurements.....	15
3. Basic procedure.....	16
3-1. Flow chart for the basic measuring procedure.....	16
3-2. Factor calibration with pure water.....	17
3-3. Measuring procedure.....	20
3-4. Clean measuring cell after measurements.....	22
3-5. Procedure after a day’s measurements.....	23
4. Menu Navigation.....	24
4-1. Menu:1 View Stored Results.....	24
4-2. Menu 2: Set Sampling Time.....	25
4-3. Menu 3: Select Oil Table.....	25
4-4. Menu 4: Set Test Temperature.....	26
4-5. Menu 5: Set Date and Time.....	26
4-6. Menu 6: Set LCD Contrast.....	27
4-7. Menu 7: Reset Test Number.....	27
4-8. Menu 8: Clear Stored Results.....	27
4-9. Menu 9: Export Stored Data to USB Drive.....	28
4-10. Menu 10: View Serial No. & Firmware Ver.....	29
4-11. Parameters and default.....	30
4-12. How to connect the optional printer or a personal computer (PC).....	31

5. Maintenance	32
5-1. Daily check	32
5-1-1. Cleaning the measuring cell	32
5-2. Other maintenance	33
5-2-1. Replacement of the power fuse	33
5-2-2. Adjustment of Injection Adapter (and tightening of tube nozzles)	33
5-2-3. Replacement of optional peristaltic pump tubing	35
6. Troubleshooting.....	37
6-1. Error messages and remedies.....	37
6-2. Symptoms for error numbers and associated remedies.....	37
6-3. Troubleshooting.....	38
6-3-1. Cannot turn on the main unit with the power switch.....	38
6-3-2. “Ready to Test” message does not appear and/or cell temperature is unstable.....	39
6-3-3. The unit does not work even though power is on.....	39
6-3-4. LCD does not function	39
6-3-5. Key entry does not work	40
6-3-6. Air bubbles are easily trapped in the sample and visible in the measurement cell.....	40
6-3-7. There is poor repeatability on measured values	41
6-3-8. Sampling time is too long (optional peristaltic pump)	42
6-3-9. Measuring time is too long.....	43
6-3-10. Data cannot be stored in the memory.....	43
7. Others	44
7-1. Basic specifications.....	44
7-2. Principle of measurement	45
7-2-1. Oscillating U-tube Cell	45
7-2-2. Density Tables.....	46
7-3. Warranty/Return Information	48

1. Introduction

1-1. Overview of the instrument

Please read this manual thoroughly in advance for the best performance of the equipment.

Thank you for your patronage of CANNON products. The D155 Density Meter you have purchased is an oscillation-type density/specific gravity meter which can measure density, specific gravity and API degrees. This meter is equipped with thermal control, which enables you to set a measurement temperature. Also an optional peristaltic pump is available (factory installed) for sampling, thus measurement is made easier by just pressing a button.

Key Features


- 1) Density, specific gravity and API degrees can be easily measured.
- 2) Measurement can be started simply by pressing a button.
- 3) The built-in thermal control enables you to set a measurement temperature in the range between 15°C to 25°C.
- 4) Measurement results on the display can be selected from density, specific gravity or API degrees.
- 5) The meter can be calibrated on one-point with pure water.
- 6) An optional printer can be connected, or data can be exported as an MS-Excel file and saved to an external USB storage device for analysis on a personal computer.

1-2. About the manual


Please keep this manual near your system so that you can easily access to the necessary information you are looking for while operating or preparing for measurement.

The examples below represent the three types of messages (warning, caution, and note) encountered throughout the manual.

1. Where there exists a danger of physical injury or even possible death:

**Warning!**
There exists the danger of physical injury or even possible death if the instruction is disregarded.

2. Where there exists a danger of property damage:

**Caution!**
There exists the danger of property damage if the instruction is ignored.

3. When there exists a possibility of failure of instrument performance:





Note:
**There exists the possibility of failure of instrument performance.
If ignored, warranty may not be covered.**


- * It is prohibited to copy or reproduce in part or in whole this manual without authorization by copyright.
- * If you should find any part in this manual not clear to understand or missing article, contact your local dealer or sales representative.
- * Manufacturer will not be liable for any loss or damage directly or indirectly caused by use of the instrument or its consequences.
- * This manual pertains directly to the D155. For details relating to other accessories or equipment please refer to the appropriate manufacturers supplied documentation..

1-3. Safety symbols


Always observe these signs and instructions.

You must observe cautionary messages and warnings in order to protect yourself as well as prevent others from physical injury or property damages.

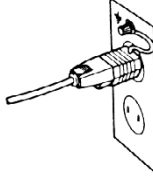
 Warning This symbol means "Danger of severe injury or possible death".	 This symbol means prohibition of an act.
 Caution This symbol means "Danger of injury or property damage".	 This symbol means mandatory.

 **WARNING!**


You must ground earth wire of power cable.

 Ground the green wire of adapter if power tap is 2-pin outlet.


3-pin plug has earth line to ground by itself when plugged in.




Danger of electric shock if not grounded to earth.


 **WARNING!**

Use the same type and rating of fuse. Be sure to plug out power cord before replace the fuse.






Danger of fire if a wrong fuse is loaded.

 **WARNING!**

Do not use volatile chemical or work in flammable gas.



Danger of explosion inside the instrument.

 **WARNING!**

Wear safety glasses, gloves or protective mask if necessary, and well ventilate the room.



Danger of injury on your skin or in the eyes by splashing chemical. Also your windpipe may get hurt if toxic gas is breathed in.

 **CAUTION!**

Unplug the power cord when the unit can be troubled or exposed to a lightning.



Failure to observe this caution may result in a damage to the instrument.

 **CAUTION!**

Do not operate in a way other than specified in the manual.



Danger of fire, electric shock or damage to the instrument.

 **CAUTION!**

Do not open housing case or overhaul the unit for repair except by an authorized service person.



Danger of fire, shock or malfunctioning of the unit.

About place for installation

Avoid the use of this instrument under the environment described below.

(Failure can lead to the degradation of performance and reliability of the system.)

- Operation of devices with strong electric motors using common power source
- Near strong magnetic/electric field
- Use of power source with too variable load
- Location of strong vibration
- Exposure to direct sunlight
- Location with large temperature difference
- Exposure to corrosive gas
- Exposure to extreme heat (Operation temperature: 5 to 35°C (41 to 95°F))
- Exposure to high humidity (Over 85%RH)

About power source

- Power for this instrument is 100-240V AC $\pm 10\%$ and 50/60Hz.
- Supply power direct from the outlet, and do not share power from a tap, extension cord, or power outlet strip.

About place for storage

- If the instrument is not operated for a long period of time (more than several weeks), rinse the measurement cell with a suitable solvent followed by pure water and a drying solvent, and then pack the whole unit into the carton box which contained the instrument when first delivered.
- For storage, avoid a place with temperature extremes, high humidities and dust.

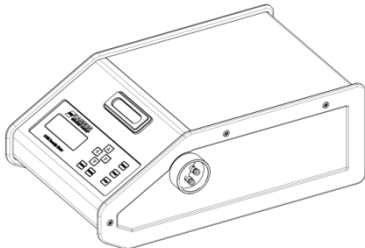
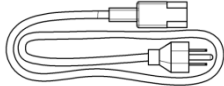
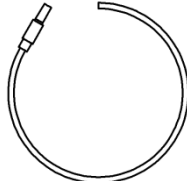
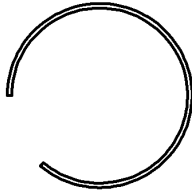
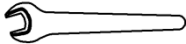
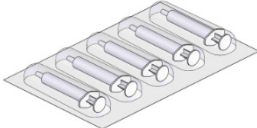
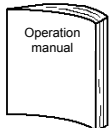
Other caution

- Do not use such a solvent as alcohol, acetone, thinner or the like for cleaning the external parts or surfaces of this instrument. Doing so may adversely affect the instrument, e.g. deformation, discoloration or cracks. When cleaning this instrument, wipe it with a soft cloth or tissue paper, after applying mild detergent diluted with water to the soft cloth or tissue paper and adequately wringing out excess water in order not to allow water to enter the instrument.
- Prior to the actual sample measurement, check the meter calibration with pure distilled water. Additionally, certified density reference oils are available from Cannon Instrument Company and can be used to verify the performance of the D155.

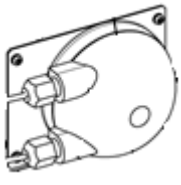

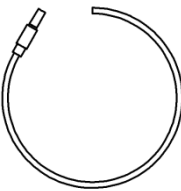
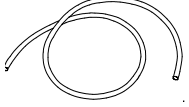
2. Preparations for measurement

2-1. Supplied parts with D155



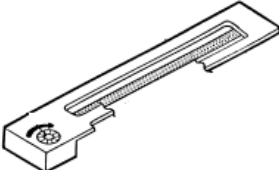
Check the supplied parts referring to the following parts list. If any missing or broken parts including main unit, accessories or manual are found, contact your sales representative or local dealer.

Part name	CANNON Part Number	Qty	Sketch
D155 unit	9726-P10 9726-P15 (with peristaltic pump)	1 unit	
115V AC Power cord w/ ground	74.2110	1 pc.	
Connection Tube with Union	95.0254	1 pc.	
Red Tubing, 1.5 mm OD, PTFE	95.0277	1 pc.	
Wrench, open-ended	95.0278	1 pc.	
Syringe 2mL	95.0238 (re-order in pack of 100)	5 pc.	
Operation manual	95.0250	1 copy	

Additional Parts supplied with optional peristaltic pump

Part name	CANNON Part Number	Qty	Sketch
Peristaltic Pump (includes all tubing below)	95.0255	1 pc.	
Peristaltic Pump Tube Gore400	95.0256	1 pc.	
Connection Tube with Union	95.0254	1 pc.	
Drain Tube	95.0253	1 pc.	 (L=2000mm)

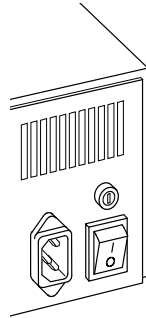
Additional Parts supplied with optional printer

Part name	CANNON Part Number	Qty	Sketch
Dot Matrix Printer Kit (includes cable and spare ribbon)	95.0239	1 pc.	
Null-Modem RS-232 Cable DB9F-DB25M	95.0240	1 pc.	
Ribbon, Black Theramark P5570	82.0059	1 pc.	

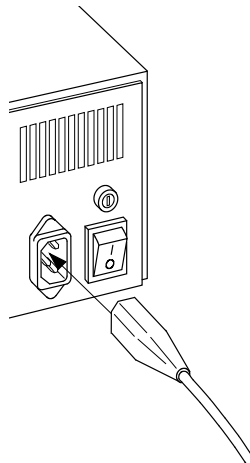
2-2. Installation and start-up

2-2-1. Power cable

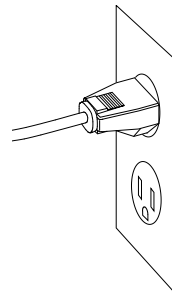
- 1) Make sure the power switch is in the OFF position.



- 2) Plug in the supplied power cable on the back of unit.



- 3) Connect the power cable to the power outlet.



< 3-pin plug >

The 3 pins plug has an earth terminal and grounds to the AC Mains earth.

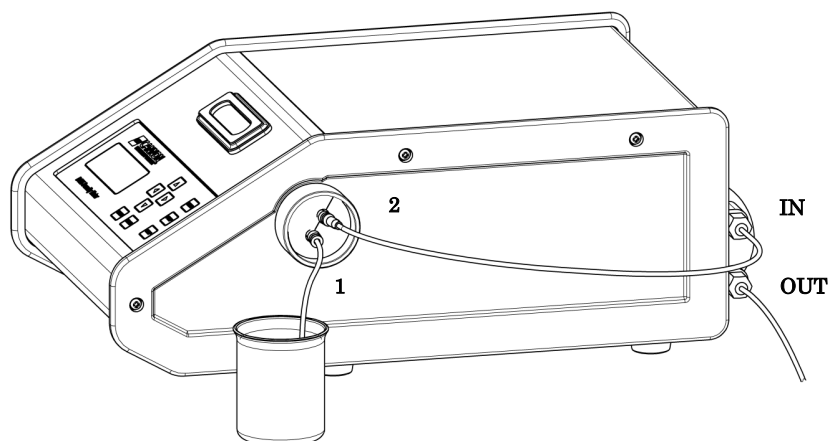


Warning!

The earth wire must be grounded. If not, there exists a danger of electric shock.

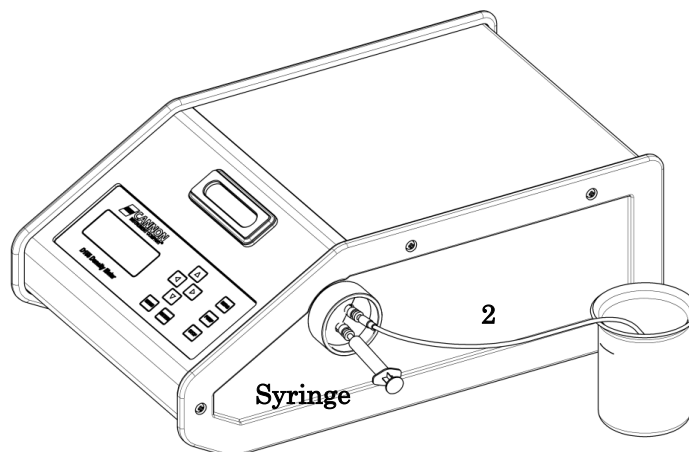
2-2-2. Connecting the tube lines – D155 with Peristaltic Pump

- 1) The sampling inlet and outlet ports (1) and (2) are Luer friction-type fittings. See image below for connecting the tubing.
- 2) Insert and press the first Connection Tube with Union into the sample inlet Port (1) of the D155 as shown below. The free end of this tube will later be inserted into the sample container.
- 3) Connect the second Connection Tube with Union to the sample outlet Port (2). The free end of this tubing is then connected to the peristaltic pump IN (upper port) fitting as shown below. Connect the Drain Tube to the peristaltic pump OUT fitting. The free end of the Drain Tube should then be placed in a suitable waste container such as a beaker or bottle.



2-2-3. Connecting the tube lines – D155 without Pump

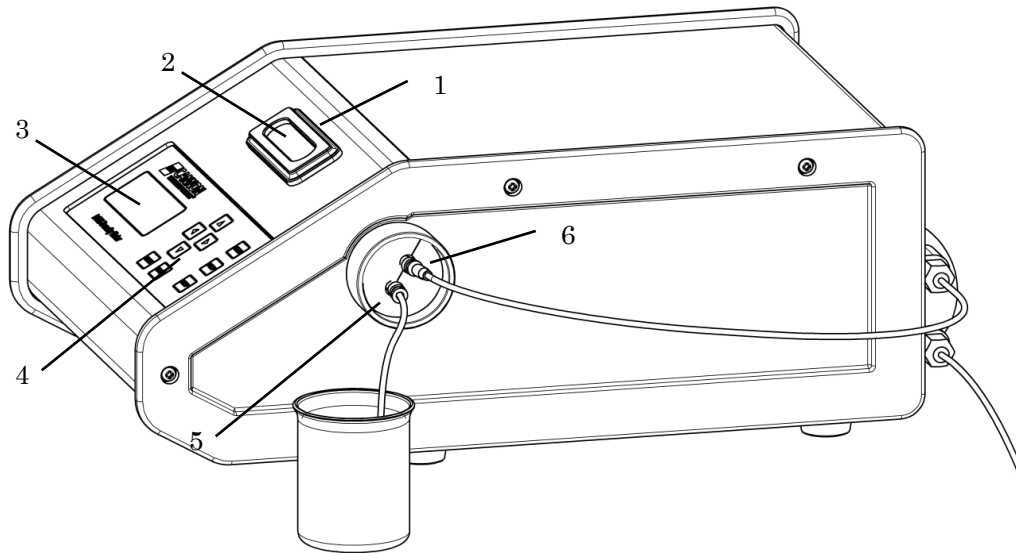
- 1) The sampling inlet and outlet ports (1) and (2) are Luer friction-type fittings. See image below for connecting the tubing.
- 2) Use a syringe with friction Luer fitting to inject sample into the sample inlet Port (1) noted as “syringe” of the D155 as shown below.
- 3) Insert and press the Connection Tube with Union into the sample outlet Port (2) on the D155 and place the other end of the tube in a suitable waste container such as a beaker or bottle.



2-3. Parts name and functions

2-3-1. Outward appearance and configuration

< Front and Right side panel >



1) **Measuring cell unit**

Internal to the instrument, this unit contains the oscillating U-tube measuring cell for sample measurement.

2) **Cell viewport**

The sample can be seen through this window to check if the liquid contains air. The cell is illuminated for easy viewing of the sample in the glass U-tube.

3) **LCD display**

The display of 20 digits by 4 lines shows measurement results, measured temperature, peristaltic pumping condition (if installed) and instrument prompts.

4) **Operating panel**

This keypad contains 9 soft-touch buttons for controlling the density meter for setup, measurement start, and function selection.

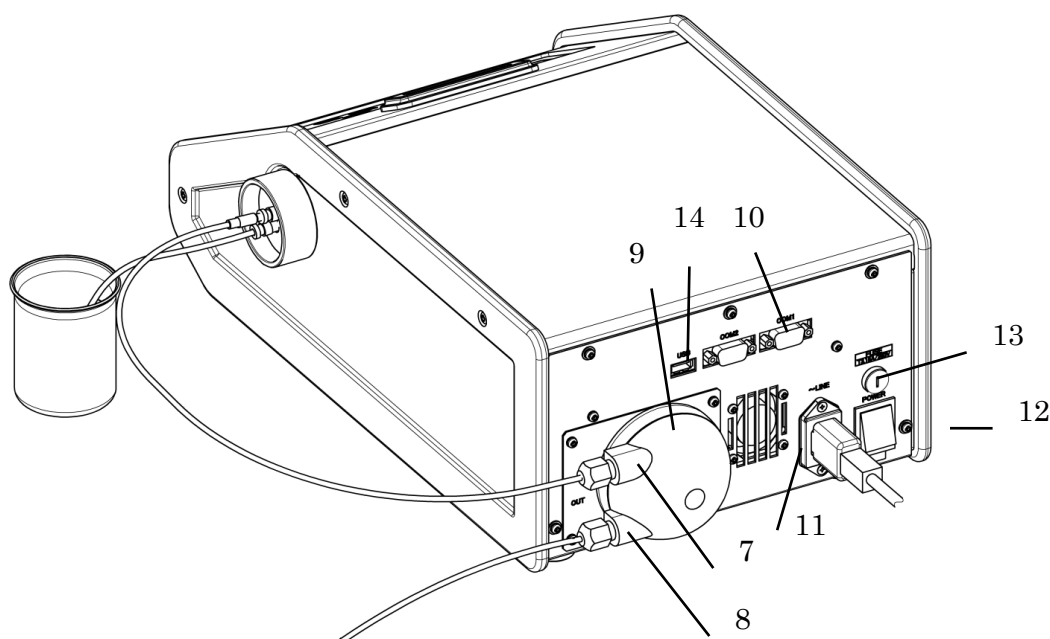
5) **Sample inlet**

Here is where the sample or cleaning solvent is injected either by syringe or the sampling tube is connected for units which have the peristaltic pump installed.

6) **Sample outlet**

This port is connected to either a suitable waste container or the peristaltic pump “IN” port for units with the peristaltic pump.

< Rear panel >



7) **Peristaltic pump “IN”** (if equipped)

The sample outlet is connected here.

8) **Peristaltic pump “OUT”** (if equipped)

The tube for draining out the sample or solvent can be connected here.

9) **Peristaltic pump** (if equipped)

This pump transfers sample liquid by peristaltic movement.

10) **RS-232C port**

An optional printer or a personal computer (PC) can be connected here.

11) **~ LINE**

The AC Mains power cord is connected with this receptacle.

12) **Power switch**

Turn on or off the unit with this switch.

13) **Fuse holder**

A miniature 5x20mm cartridge fuse is housed in here. Only replace the fuse with like rating fuses (T3.15A 250V) as noted on the rear label of the instrument

14) **USB port**

Use for connecting an external USB storage device for exporting stored data from the density meter. This port is also used to uploaded firmware to the density meter.

2-3-2. Key functions (General description)



Here is a brief description of function of each key:

- [△][▽][◀][▶] key : Key to select menu options, settings, or enter numeric values.
- [MEAS] key : Key to start density measurement.
- [PUMP] key : Key to turn on or off the optional peristaltic sampling pump. This key can be used during both calibration and measurement.
- [STOP] key : Key to abort density measurement or calibration and also escape or return back to standby mode (the main display screen) or previous menu selection.
- [ENTER] key : Key to confirm the menu selection or numeric data entry.
- [MENU] key : Key to select the menu selection screen. Pressing this key and then the Up/Down arrow keys will cycle through the following menu options:

Menu:0 Calibrate Cell	Calibrate with pure water standard
Menu:1 View Stored Results	Display measurement results
Menu:2 Set Sampling time	Select sampling time (amount of time the peristaltic pump runs)
Menu:3 Select Oil-Table	Select API temperature compensation table for oil
Menu:4 Set Test Temperature	Set measurement temperature
Menu:5 Set Date & Time	Select date and time for measurements
Menu:6 Set LCD Contrast	Adjust brightness of display screen
Menu:7 Reset Test Number	Reset Sample test number to "01"
Menu:8 Clear Stored Results	Clear the memory of stored measurement results
Menu:9 Export Stored Data to USB Drive	Export data to external USB storage device (MS-Excel format)
Menu:10 View Serial No. & Firmware Ver.	Check instrument serial number and firmware version

2-3-3. LCD Display Layout

1 0 / 3 0 / 1 2	0 9 : 5 0
D e n s i t y 0 . 9 9 8 5	g / c m ³
T e m p 2 0 . 0 0 ° C	T e s t 0 1
P r e s s E N T E R	t o P r i n t

Highlighted Text Denotes Blinking Cursor or Characters

2-4. Display during initialization

2-4-1. The initial display upon power up

The following display appears during power up.

	C A N N O N	
D 1 5 5	D e n s i t y	M e t e r
	V e r 2 . 0 0	
1 0 / 3 0 / 1 2		0 9 : 2 9

2-4-2. Display during warm up period

The instrument requires a warm up period to ensure an accurate measurement. Normally, the warm-up period is complete within 30 minutes this will vary room temperature and test temperature.

The following display occurs during warm up period.

1 0 / 3 0 / 1 2	0 9 : 3 0
E Q U I L I B R A T I N G	
T a r g e t 2 0 . 0 ° C	
< < P l e a s e W a i t > >	

2-4-3. Display after warm-up

The following display occurs after the instrument has stabilized. The instrument is now ready to measure a sample.

1 0 / 3 0 / 1 2	0 9 : 4 0
R e a d y	t o T e s t 2 0 . 0 ° C
P l e a s e	L o a d S a m p l e
P r e s s	M E A S t o S t a r t

2-5. Preparation before measurements

1) Tools required for sampling

2 to 5 mL Syringe (for manual injection) and a beaker or bottle to hold the sample

2) Solvent for cleaning the cell

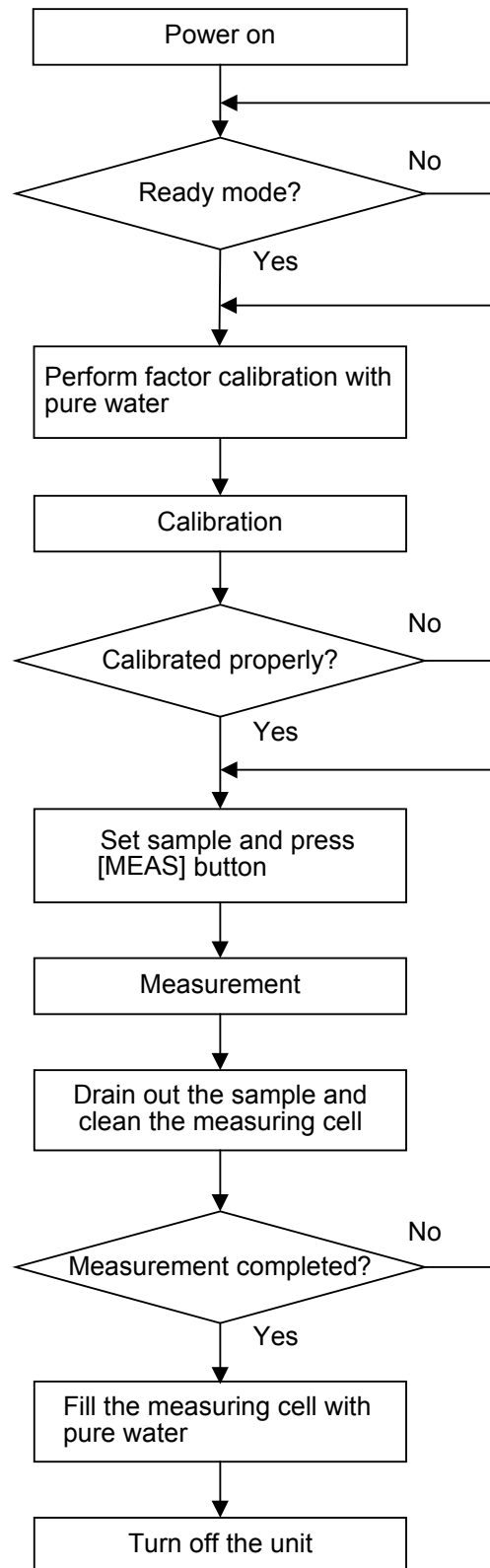
Solvent (e.g. water for aqueous solution or heptane for oil) is necessary to clean the cell. Note, user is responsible for determining the appropriate solvent for the sample type being measured.

3) Lint-free towels or tissues

Used for wiping the outside of the sampling tube or cell ports.

3. Basic procedure

3-1. Flow chart for the basic measuring procedure



3-2. Factor calibration with pure water

For correct measurement, the meter needs to be checked and adjusted to the reference using the density standard of water.

Prior to each day's work, measure the water by pressing [MEAS] key to make sure the result of specific gravity (SG) shows a value within ± 0.0005 of the nominal value of pure water at the test temperature. If the measuring cell and tube lines were filled with ethanol (for short-term storage), wash out the ethanol with as much pure water before measurement is started. If the result shows a SG (t/t) value outside of the ± 0.0005 range, repeat the cell cleaning and re-measure the water standard. If the measurement results for pure water continue to fall outside of this range, the meter should be factor calibrated as follows:

Note:

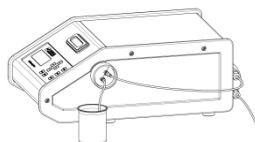
The measuring cell must be cleaned with water before calibration. Care must be taken to avoid air bubbles or other foreign materials/contaminates in the water in the cell during measurement to avoid measurement error.

- 1) Make sure that the cell temperature is stable at the set temperature and that “Ready to Test” appears on the main display as shown below.

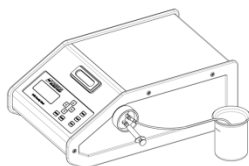
```

1 0 / 3 0 / 1 2           0 9 : 4 0
R e a d y   t o   T e s t   2 0 . 0 ° C
P l e a s e   L o a d   S a m p l e
P r e s s   M E A S   t o   S t a r t

```



D155 with pump



D155 with syringe

- 2) Clean the cell with pure water
- Put the tube into water as shown on the left or inject the water with a 10 mL syringe. If using a syringe, inject two full syringes so that a total of 20 mL is flushed through the cell.
 - If the optional peristaltic pump is installed, press [PUMP] key to flow in more than 20 mL water, to flush the cell well. For effective cleaning, lift up the tip of tube from the water a few times to allow some air to be pulled in.

Note:

When the measuring cell and tube lines were filled with ethanol, rinse out ethanol with as much pure water before measurement is started.

↓ [MENU]

- 3) Press [MENU] key
- 4) Move the cursor with [△] or [▽] key to “Menu:0 Calibrate Cell”

```

M e n u : 0
           C a l i b r a t e   C e l l
P r e s s   E N T E R   o r   U p / D n

```

↓ [ENTER]

- 5) Press [ENTER] key.

```

M e n u : 0
           C a l i b r a t e   C e l l
           P l e a s e   L o a d   W a t e r
P r e s s   E N T E R   t o   S t a r t

```

- 6) Inject the cell with a pure water standard
- If using a syringe, inject 2 mL taking care not to introduce any air bubbles in the measurement cell. Visually inspect the cell through the cell window to ensure that no bubbles are present in the cell.
 - If the optional peristaltic pump is installed, place the tube in the water standard.

↓ [ENTER] Press [ENTER] key.

If the peristaltic pump is installed, the pump will run for the amount of seconds set in the Menu:2 Sampling Time.

```

M e n u : 0
  C a l i b r a t e   C e l l
    S A M P L I N G : 1 0 s
  < < P l e a s e   W a i t > >

```

The above screen will only appear when using the optional peristaltic pump and the Sampling Time (Menu:2 Sampling Time) is set to a value greater than zero.

7) When sampling is complete, the display shows:

```

M e n u : 0
  C a l i b r a t e   C e l l
    C A L I B R A T I N G
  < < P l e a s e   W a i t > >

```

Visually inspect the cell through the cell window to ensure that no bubbles are present in the cell.

↓

8) When calibration is normally completed, the display shows:

```

M e n u : 0
  C a l i b r a t e   C e l l
                    O K
P r e s s   S T O P   o r   M E N U

```

When “NG” (No Good) appears instead of “OK”, press [STOP] and then repeat the calibration starting with step 3 above.

9) If the optional peristaltic pump is installed, press [PUMP] key to drain out water.

Otherwise use an empty syringe to push out the water with air.

10) Blot the sample drops on the sampling tube with tissue paper.

Note:

If calibration fails, previously calibrated values will be printed out.

3-3. Measuring procedure

Note:

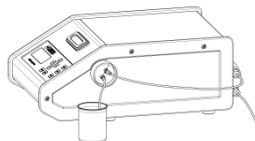
Prior to each day's work, measure pure water by pressing [MEAS] key to make sure the result of specific gravity (SG) shows a value within ± 0.0005 of the nominal value of pure water at the test temperature. If the measuring cell and tube lines were filled with ethanol (for short-term storage), wash out the ethanol with as much pure water before measurement is started. If the result shows a SG (t/t) value outside of the ± 0.0005 range, repeat the cell cleaning and re-measure the water standard. If the measurement results for pure water continue to fall outside of this range, the meter should be factor calibrated as per Section "3-2 Factor calibration with pure water."

```

1 0 / 3 0 / 1 2                                0 9 : 4 0
R e a d y   t o   T e s t   2 0 . 0 ° C
P l e a s e   L o a d   S a m p l e
P r e s s   M E A S   t o   S t a r t

```

- 1) Make sure that the cell temperature is stable at the set temperature and that "Ready to Test" appears on the main display as shown above.



D155 with pump

- 2) Inject the sample to be measured into a clean cell:
 - a. If using the optional peristaltic pump, put the tube into the sample liquid as shown on the left.
 - b. If using a syringe, inject 2 to 5 mL of the sample to be measured.



D155 with syringe

- 3) Press [MEAS] key. If using the peristaltic pump, the sample will be automatically injected for the Sampling Time (set in Menu:2.) as shown below:

```

1 0 / 3 0 / 1 2                                0 9 : 4 5
          S A M P L I N G : 1 0 s
          < < P l e a s e   W a i t > >

```

- 4) When measurement starts, the display will show:

```

1 0 / 3 0 / 1 2                                0 9 : 4 6
          M E A S U R I N G
          < <   P l e a s e   W a i t > >

```

Visually inspect the cell through the cell window to ensure that no bubbles are present in the cell

- 5) After measurements are completed, the results will appear on the screen display.

1 0 / 3 0 / 1 2	0 9 : 5 0
D e n s i t y 0 . 9 9 8 5	g / c m ³
T e m p 2 0 . 0 0 ° C	T e s t 0 1
P r e s s U p / D n	U n i t s

If a printer is connected, the results will automatically print.

There are four results display windows. To change between these windows, press the [△] [▽] keys. Below are the three additional results displays.

1 0 / 3 0 / 1 2	0 9 : 5 0
A P I D e g r e e 5 D :	2 4 . 1
T e m p 2 0 . 0 0 ° C	T e s t 0 1
P r e s s U p / D n	U n i t s

1 0 / 3 0 / 1 2	0 9 : 5 0
1 5 ° C D e n 5 3 D :	0 . 9 9 9 5
T e m p 2 0 . 0 0 ° C	T e s t 0 1
P r e s s U p / D n	U n i t s

1 0 / 3 0 / 1 2	0 9 : 5 0
S G (t / t) :	0 . 9 9 9 0
T e m p 2 0 . 0 0 ° C	T e s t 0 1
P r e s s U p / D n	U n i t s

- 6) When continuing measurement on the same sample, return to Step 1).

When the intended number of measurements is completed, remove the sample from the cell. If the optional peristaltic pump is installed, press [PUMP] key to drain out the sample. Otherwise use an empty syringe to push out the sample with air.

- 7) Clean the measuring cell according to Section “3-4. Clean measuring cell after measurements”.

Note:

When you have changed the measurement temperature, make sure to perform calibration before measuring at the new temperature. The D155 will not allow a measurement to be made at a temperature which has not been calibrated.

3-4. Clean measuring cell after measurements

The measuring cell must be cleaned when a different type of sample is to be measured or when a series of measurement is complete. Follow the following steps:

Instrument with optional peristaltic pump

- 1) Remove the sampling tube from the sample and wipe with tissue paper.
- 2) Put the sampling tube into the cleaning solution/solvent and draw the solution/solvent with [PUMP] key. For more effective cleaning, we suggest that you pull out the tube from the solution/solvent momentarily (while the pump is running) - several times to draw in some air. Continue pulling solution/solvent until roughly 10 mL have been pulled through the cell. Some samples may require more than 10 mL of cleaning solution/solvent to effectively remove the sample from the cell (see note below).
- 3) Take the sampling tube out of the cleaning solution/solvent. When the solution/solvent is clear from the sample tube, press [PUMP] key to stop the pump.
- 4) Remove the sampling tube from the cleaning solution/solvent and wipe with tissue paper.

Instrument without pump

- 1) Remove the sample syringe from the sample inlet and wipe the inlet with tissue paper.
- 2) Ensure the sampling tube (outlet) on the D155 (upper port) is placed in a suitable waste container such as a beaker or bottle.
- 3) Fill a 10 mL syringe with cleaning solution/solvent and inject the solution into the cell. Periodically remove the syringe and re-insert to allow air to be introduced into the cell for more effective cleaning. Repeat this step if necessary. Some samples may require more than 10 mL of cleaning solution/solvent to effectively remove the sample from the cell (see note below).

Note:

When viscous samples are measured, rinse the measurement cell thoroughly with the cleaning solvent/solution to remove the sample. Correct measurement results cannot be expected if any residue of the previous sample remains in the measuring cell.

3-5. Procedure after a day's measurements

When the day's work of measurement is completed, the measuring cell needs to be cleaned with the cleaning solution/solvent and be filled with pure water in order to avoid contamination on the glass measurement cell walls:

- 1) Clean the measuring cell according to the steps in Section 3-4.
- 2) When certain oily substances or deposits are adhered to the cell, follow the steps in Section 5-1-1.
- 3) Fill the measuring cell with pure water:
 - a. If using the optional peristaltic pump, put the sampling tube into pure water and press [PUMP] key to draw water into the cell. When the cell is filled with pure water, press [PUMP] key to stop the pump.
 - a. If using a syringe, inject two full 10mL syringes so that a total of 20 mL is flushed through the cell.

When the unit is not used longer than one week, the cell should be filled with 99% or higher concentration of Ethanol instead of pure water in order to avoid the growth of mold inside the cell.

Note:

When the cell is filled with Ethanol for storage, flush the inside cell with at least 20mL pure water using either a syringe or the [PUMP] key if using the optional peristaltic pump before starting next calibration or measurement. If the residue of Ethanol remains in the cell or tube lines, correct calibration or measurement cannot be performed.

4. Menu Navigation

4-1. Menu:1 View Stored Results

- 1) Press [MENU] then press [Δ] or [∇] to select Menu 1 as shown below

```

M e n u : 1
  V i e w   S t o r e d   R e s u l t s
P r e s s   E N T E R   o r   U p / D n
  
```

- 2) Press [ENTER]

- 3) Press [\leftarrow] or [\rightarrow] key to select the test result (numbered)

- 4) Press [Δ] or [∇] to select the preferred data result screen. There are four results display windows.

To change between these windows, press the [Δ] [∇] keys.

```

1 0 / 3 0 / 1 2                               0 9 : 5 0
D e n s i t y   0 . 9 9 8 5   g / c m 3
T e m p   2 0 . 0 0 ° C   T e s t   0 1
P r e s s   E N T E R   t o   P r i n t
  
```

```

1 0 / 3 0 / 1 2                               0 9 : 5 0
A P I   D e g r e e   5 D :   2 4 . 1
T e m p   2 0 . 0 0 ° C   T e s t   0 1
P r e s s   E N T E R   t o   P r i n t
  
```

```

1 0 / 3 0 / 1 2                               0 9 : 5 0
1 5 ° C   D e n   5 3 D :   0 . 9 9 9 5
T e m p   2 0 . 0 0 ° C   T e s t   0 1
P r e s s   E N T E R   t o   P r i n t
  
```

```

1 0 / 3 0 / 1 2                               0 9 : 5 0
   S G   ( t / t ) :   0 . 9 9 9 0
T e m p   2 0 . 0 0 ° C   T e s t   0 1
P r e s s   E N T E R   t o   P r i n t
  
```

- 5) Press [ENTER] to print test result (if optional printer is connected to the D155)

4-2. Menu 2: Set Sampling Time

Select sampling time adequate for the sample to be injected. The default is '10' (seconds).

- 1) Press [MENU] then press [△] or [▽] to select Menu 2 as shown below

```

M e n u : 2
   S e t   S a m p l i n g   T i m e
P r e s s   E N T E R   o r   U p / D n
  
```

- 2) Press [ENTER]

```

M e n u : 2
   S a m p l i n g   T i m e :   1 0 s
A r r o w   K e y s   t o   C h a n g e
   E N T E R   t o   A c c e p t
  
```

- 3) Press [◀] or [▶] key to select the digit to change
- 4) Press [△] or [▽] to increase or decrease the number. The D155 allows any value from 00 (pump off or disabled) to 99 seconds. The default setting for instruments with the pump installed is 10.
- 5) Press [ENTER] to accept the value entered

4-3. Menu 3: Select Oil Table

The API temperature compensation table for oil can be selected as follows. It depends on the samples you wish to measure.

- 1) Press [MENU] then press [△] or [▽] to select Menu 3 as shown below

```

M e n u : 3
   S e l e c t   O i l   T a b l e
P r e s s   E N T E R   o r   U p / D n
  
```

- 2) Press [ENTER]

```

M e n u : 3
   O i l   T a b l e :   5 3 A
A r r o w   K e y s   t o   C h a n g e
   E N T E R   t o   A c c e p t
  
```

- 3) Press [△] or [▽] to select the appropriate API temperature compensation table. The available tables are:

23A	Crude Oils 60/60°F
23B	Refined Products 60/60°F
23D	Lube Oils 60/60°F
53A	Crude Oils 15°C
53B	Refined Products 15°C

53D	Lube Oils 15°C
59A	Crude Oils 20°C
59B	Refined Products 20°C
59D	Lube Oils 20°C

- 4) Press [ENTER] to accept the selected table.

4-4. Menu 4: Set Test Temperature

Measurement temperature can be set as follows:

- 1) Press [MENU] then press [△] or [▽] to select Menu 4 as shown below

```

M e n u : 4
S e t   T e s t   T e m p e r a t u r e
P r e s s   E N T E R   o r   U p / D n

```

- 2) Press [ENTER]

```

M e n u : 4
  T e s t   T e m p . :  2 0 . 0 ° C
A r r o w   K e y s   t o   C h a n g e
          E N T E R   t o   A c c e p t

```

- 3) Press [◀] or [▶] key to select the digit to change
4) Press [△] or [▽] to increase or decrease the number. The D155 allows any temperature between 15.0 and 25.0 °C
5) Press [ENTER] to accept the value entered

4-5. Menu 5: Set Date and Time

Enter the present date and time so that they are stored/printed with each measurement result.

- 1) Press [MENU] then press [△] or [▽] to select Menu 5 as shown below

```

M e n u : 5
      S e t   D a t e   &   T i m e
P r e s s   E N T E R   o r   U p / D n

```

- 2) Press [ENTER]

```

M e n u : 5
  1 0 / 3 0 / 1 2           0 9 : 5 0
A r r o w   K e y s   t o   C h a n g e
          E N T E R   t o   A c c e p t

```

- 3) Press [◀] or [▶] key to select the digit to change
- 4) Press [▲] or [▼] to increase or decrease the number.
- 5) Press [ENTER] to accept the date and time entered

4-6. Menu 6: Set LCD Contrast

The contrast of the LCD display can be selected as follows:

- 1) Press [MENU] then press [▲] or [▼] to select Menu 6 as shown below

```
M e n u : 6
      S e t   L C D   C o n t r a s t
P r e s s   E N T E R   o r   U p / D n
```

- 2) Press [ENTER]

```
M e n u : 6
      L C D   C o n t r a s t :  7 5  ↑
A r r o w   K e y s   t o   C h a n g e
      E N T E R   t o   A c c e p t
```

- 3) Press [▲] or [▼] to increase or decrease the LCD display contrast.
- 4) Press [ENTER] to accept the setting

4-7. Menu 7: Reset Test Number

The sample number will be output together with measurement results. The number is incremented each time a new measurement is made up to 99. This resets the numbering to start again at "01".

- 1) Press [MENU] then press [▲] or [▼] to select Menu 7 as shown below

```
M e n u : 7
      R e s e t   T e s t   N u m b e r
P r e s s   E N T E R   o r   U p / D n
```

- 2) Press [ENTER]

```
M e n u : 7
      R e s e t   T e s t   N u m b e r ?
      E N T E R   t o   A c c e p t
S T O P   o r   M E N U   t o   Q u i t
```

- 3) Press [ENTER] to accept the reset, or [STOP] or [MENU] to quit.

4-8. Menu 8: Clear Stored Results

The last 10 measurement results are stored in memory. Subsequent data measurements will cause the D155 to delete the oldest stored result first. These data can be cleared using this function. Caution, data cannot be restored once it is cleared.

- 1) Press [MENU] then press [△] or [▽] to select Menu 8 as shown below

```

M e n u : 8
C l e a r   S t o r e d   R e s u l t s
P r e s s   E N T E R   o r   U p / D n

```

- 2) Press [ENTER]

```

M e n u : 8
  C l e a r   A L L   R e s u l t s ?
      E N T E R   t o   A c c e p t
S T O P   o r   M E N U   t o   Q u i t

```

- 3) Press [ENTER] to clear all 10 stored results, or [STOP] or [MENU] to quit.

4-9. Menu 9: Export Stored Data to USB Drive

The D155 memory only stores the last 10 measurement results. Subsequent data measurements will cause the D155 to delete the oldest stored result first. This function allows the data to be exported to an external USB storage device in an MS-Excel file format. The D155 will create a folder on the USB drive named X:/D155/Parameter, where 'X:' is the USB drive designation. If this folder already exists, then it will continue to use this folder. The D155 will create a new file each time data is exported. The filename will be created using the date and time of the export. Below is an example of the MS-Excel file format for exported data:

Date & Time	'07/13/13 04:31	Sample No.	2 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:31	Sample No.	3 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:32	Sample No.	4 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:33	Sample No.	5 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:34	Sample No.	6 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:35	Sample No.	7 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:36	Sample No.	8 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:37	Sample No.	9 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:38	Sample No.	10 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***
Date & Time	'07/13/13 04:44	Sample No.	11 Meas. Temp.	20.000000	Density	0.1035 SG(t/t)	0.1037 Oil-Table	53A	15C Den	0.1035 API Degree	***

- 2) Press [MENU] then press [△] or [▽] to select Menu 9 as shown below

```

M e n u : 9
  E x p o r t   S t o r e d   D a t a
      t o   U S B   D r i v e
P r e s s   E N T E R   o r   U p / D n

```

- 4) Press [ENTER]

```

M e n u : 9
  E x p o r t   A L L   D a t a ?
    E N T E R   t o   A c c e p t
S T O P   o r   M E N U   t o   Q u i t

```

Press [ENTER] to export stored results to USB device, or [STOP] or [MENU] to quit.

4-10. Menu 10: View Serial No. & Firmware Ver.

You can check the serial number and firmware version of the unit. Such information will be necessary to identify your density meter when calling for help.

- 1) Press [MENU] then press [△] or [▽] to select Menu 10 as shown below

```

M e n u : 1 0
  V i e w   S e r i a l   N o .   &
    F i r m w a r e   V e r .
P r e s s   E N T E R   o r   U p / D n

```

- 2) Press [ENTER]

```

M e n u : 1 0
      S / N :   J J A 0 8 B 4 3
      V e r :   2 . 0 0 A 2
  E N T E R   t o   C o n t i n u e

```

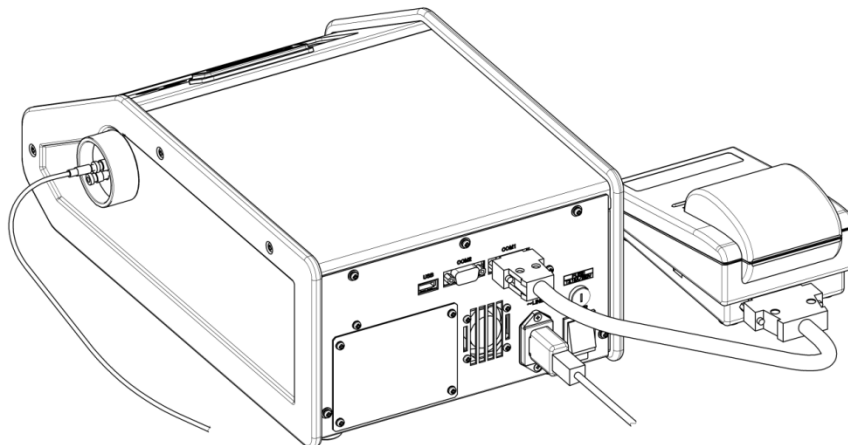
- 3) Press [ENTER] to continue back to the menu selection screen.

4-11. Parameters and default

Menu/Parameter	Description	Setting range	Default
0: Calibrate Cell	Calibration with pure water	—	—
1: View Stored Results	Display measurement results	—	—
2: Set Sampling Time	Select sampling time	00 to 99s	10s
3: Select Oil Table	Select temperature compensation table for oil 23A: Crude Oils 60/60°F 23B: Refined Products 60/60°F 23D: Lube Oils 60/60°F 53A : Crude Oils 15°C 53B : Refined Products 15°C 53D : Lube Oils 15°C 59A: Crude Oils 20°C 59B: Refined Products 20°C 59D: Lube Oils 20°C	23A/23B/23D/ 53A/53B/53D/ 59A/59B/59D	53A
4: Set Test Temperature	Set measurement temperature	15.0 to 25.0°C	20.0°C
5: Set Date & Time	Enter date and time. Date format: MM/DD/YY Time format: HH:MM (24 hour format)	01/01/00 00:00 to 12/31/99 23:59	—
6: Set LCD Contrast	Adjust LCD brightness	0/25/50/75/100	50
7: Reset Test Number	Reset Sample Test No. to '01'	—	01
8: Clear Stored Results	Erase the memory of stored results. The D155 only stores the last 10 measurement results.	—	—
9: Export Stored Data to USB Drive	Export Stored Data from Memory to an MS-Excel formatted file.	—	—
10: Serial No. & Firmware	View D155 Serial Number and Firmware Version	—	—

4-12. How to connect the optional printer or a personal computer (PC)

The optional printer can be connected to the D155 unit so that the measurement and calibration results together with the date and time of measurement can be printed out. Connect the supplied printer cable to the RS-232C port (DB-9M) on the back of D155 unit as shown.



A personal computer (PC) can be connected instead of the printer so that data can be exported. A data collection software package – SOFT-CAP Data Capture Software is available as an option with the D155. Please consult the separate SOFT-CAP Operation Manual for more details on installation and use.

Warning!

Use correct AC power adapter suitable for the AC line voltage. Make sure to use the proper rated voltage before plugging it into the outlet. Failure may damage the printer or even cause the adapter itself to catch fire.

Note:

Do not place the printer on the top of the main unit in order to avoid the influence magnetic field of the printer on the measuring cell.

The DIP switch on the Dot Matrix printer kit (P/N: 95.0239) is configured as shown below. When you have changed this switch configuration, refer to the Instruction manual for the printer and set it as shown below:

	1	2	3	4	5	6	7	8
Dip SW-1	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF

5. Maintenance

5-1. Daily check

5-1-1. Cleaning the measuring cell

When the repeatability of measurements has degraded or measuring time is prolonged, the measuring cell is considered to be contaminated. Also, when the cell is apparently contaminated with a sample of such nature, the measuring cell must be cleaned with an appropriate solvent like household chlorine bleach, acid or alkali. When particular samples containing fatty acids or protein (such as biodiesel) are measured, the cell must be cleaned once a week as described below.

The following example describes how to rinse out fats and oils with Sodium hydroxide:

- 1) For units with the optional peristaltic pump installed
 - a. Insert the sampling tube into 0.1~0.5mol/L Sodium hydroxide and press [PUMP] key to inject.
 - b. When the cell becomes filled with Sodium hydroxide, press [PUMP] key to stop filling.
 - c. Leave the sodium hydroxide in the cell for about 15 minutes.
 - d. Drain out Sodium hydroxide solution with [PUMP] key.
- 2) For units without the pump
 - a. Inject 0.1~0.5mol/L Sodium hydroxide using a suitable 2-5 mL syringe.
 - b. Leave the sodium hydroxide in the cell for about 15 minutes.
 - c. Push out the sodium hydroxide from the cell using an empty syringe filled with air.
- 3) Clean the measuring cell with pure water according to the Step “3-4”.



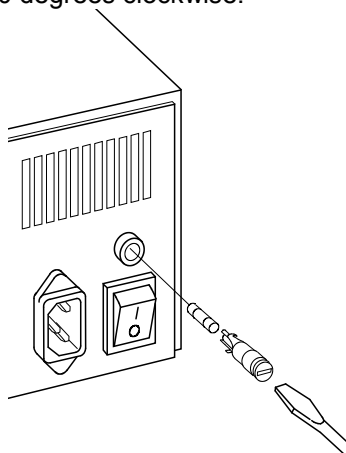
Warning!

The alkali may etch the glass of the measuring cell. Avoid rinsing the cell with strong alkali for hours. Always rinse the cell with plenty of pure water after cleaning the cell with alkali cleaners.

5-2. Other maintenance

5-2-1. Replacement of the power fuse

If the power fuse should blow, replace it with a like size and power rating. Note the fuse size and rating is listed on the rear of the instrument immediately above the fuse holder. As shown below, turn the fuse holder cover by 90 degrees counterclockwise using a flat screw driver. After the fuse is replaced, turn the fuse holder cover back 90 degrees clockwise.



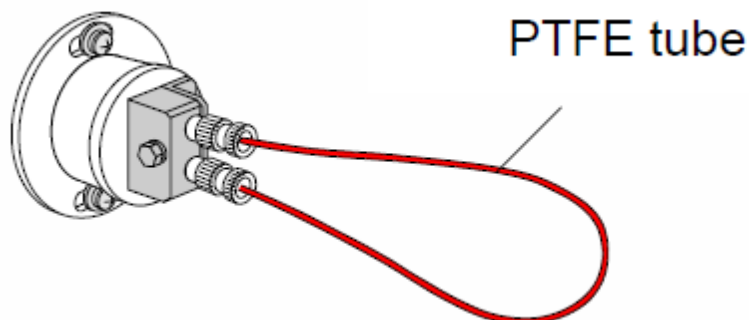
Warning!

Be aware of the danger of electric shock. Turn off the main switch and remove the AC mains power cord before replacing the power fuse.

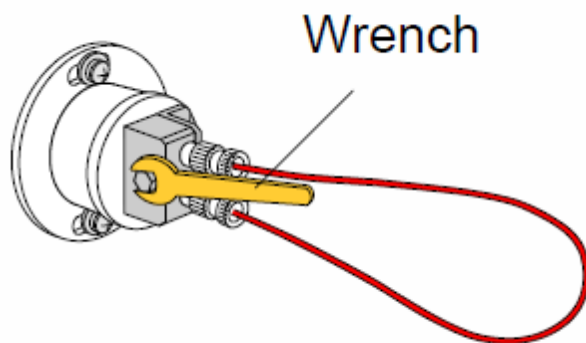
5-2-2. Adjustment of Injection Adapter (and tightening of tube nozzles)

If leakage from the Injection Adapter (Sample inlet and outlet port nozzles) is observed, they need to be re-tightened

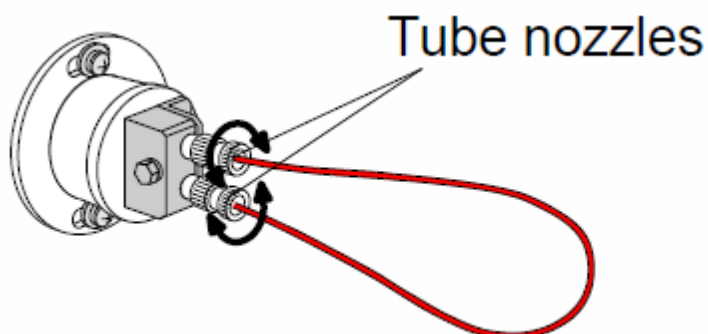
- 1) Twist to remove the Connection Tubes with Unions from the Injection Adapter Nozzles.
- 2) Remove the black protective foam insert
- 3) Insert the red PTFE tubing into the tube nozzles as shown



- 4) Loosen the screw with the provided wrench



- 5) Tighten the tube nozzles clockwise – hand-tighten only

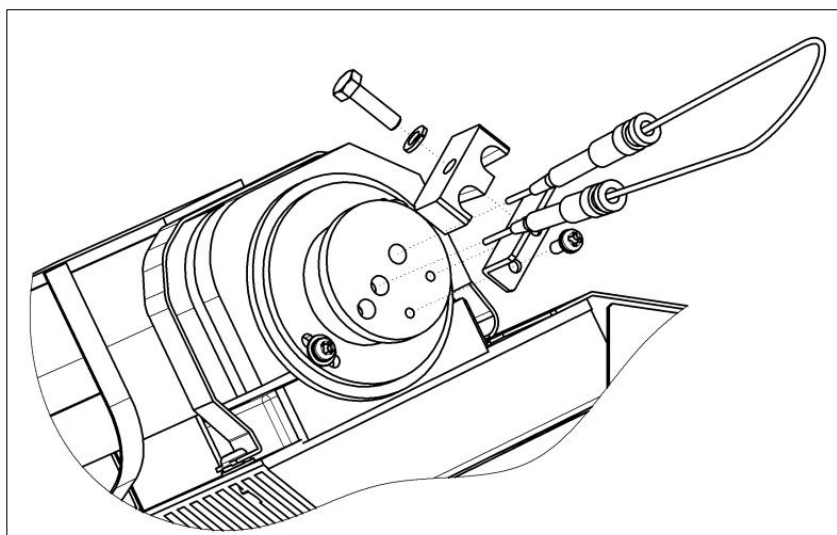


- 6) Follow steps 1 thru 4 in reverse to tighten the Injection Adapter nut and remove the red PTFE tubing

Note!

Make sure to insert the PTFE tube into the tube nozzles before working on it. With no PTFE tube in the tube nozzles, their heads may be crushed.

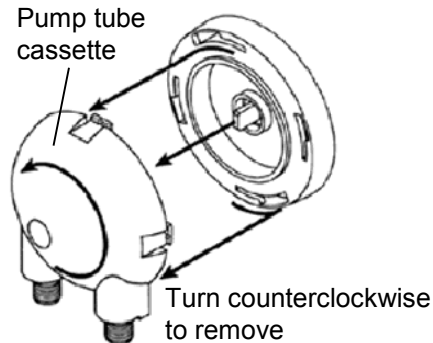
<Detailed drawing>



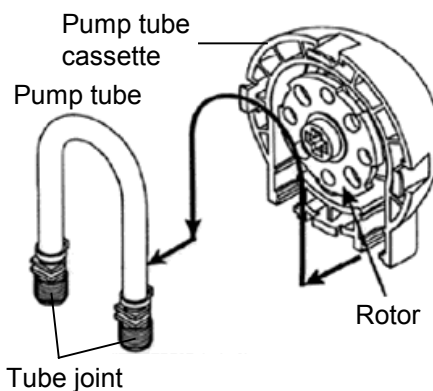
5-2-3. Replacement of optional peristaltic pump tubing

If the pump tube is deteriorated, the tubing may fail causing sample liquid to leak. This may eventually lead to pump failure. Replace pump tubing as follows:

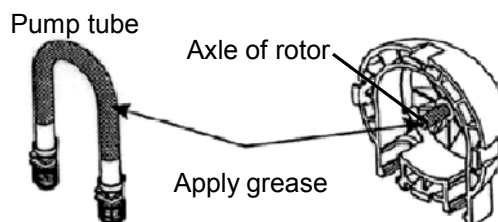
- 1) Disconnect the tubes connected to the pump tube cassette.
- 2) Turn the cassette counterclockwise to remove it.



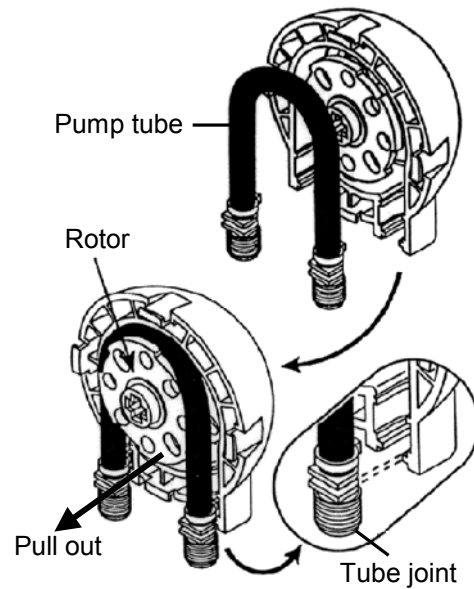
- 3) Remove the tube joint from the cassette by pulling one of the ends, and then pull out the tube.



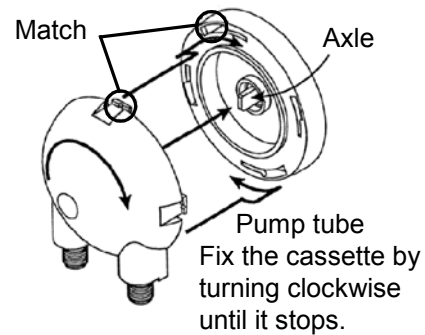
- 4) Apply grease (such as petroleum jelly) over the tube and the axle of pump cassette as illustrated.



- 5) Fit in the new pump tube around the rotor as shown by pulling it out a little bit.
Fix the tube joint securely to the groove as illustrated.



- 6) Match the axle and rotor, and fix the cassette by turning clockwise until it stops.



Caution!

Some samples may shorten the life of the pump tubing. Replace the pump tubing when appropriate.

6. Troubleshooting

6-1. Error messages and remedies

When the main unit is operated improperly, the following error messages will appear with a corresponding beep sound.

Error message	Description	Remedy
Time Over	Measuring time exceeds 10 minutes.	Check the window to see if air bubbles are trapped in the measuring cell. If this message persists while nothing wrong is observed, Contact CANNON or your local dealer.

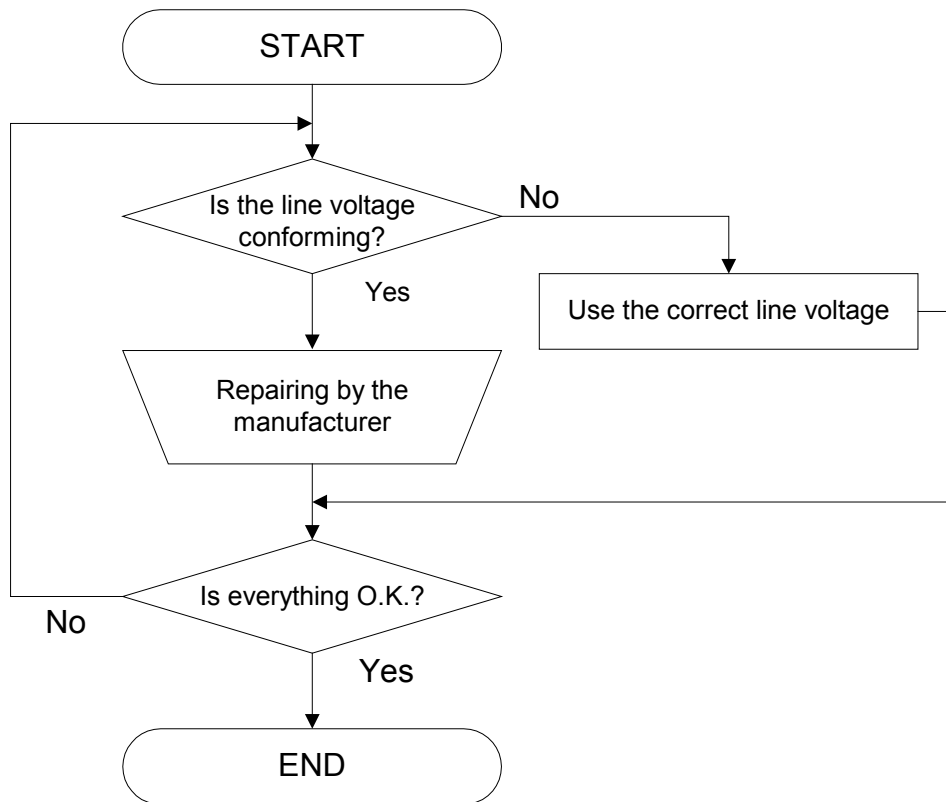
6-2. Symptoms for error numbers and associated remedies

When a fault occurs within the D155 unit, the following warning number will appear with a beep sound.

Error message	Description	Remedies
2, 3, 4	The thermistor is defective (broken).	<ul style="list-style-type: none"> • Contact CANNON or your local dealer.
5	The measuring cell is defective or the wiring to the cell is damaged.	<ul style="list-style-type: none"> • Contact CANNON or your local dealer.
6	Temperature is not stabilized in an hour.	<p>After the following two steps are confirmed, turn on the power again.</p> <ul style="list-style-type: none"> • The ambient temperature for D155 is 5~35°C. Check to see if the ambient temperature does not exceed this range during operations. • Make sure that the air vents at the front, rear, and bottom of unit are not clogged with dust or blocked in any way. If the error persists, Contact CANNON or your local dealer.
7	The voltage level of the back-up battery becomes low. This will cause memory to be initialized and all stored data/calibrations cleared.	<ul style="list-style-type: none"> • Contact CANNON or your local dealer.

6-3. Troubleshooting

6-3-1. Cannot turn on the main unit with the power switch

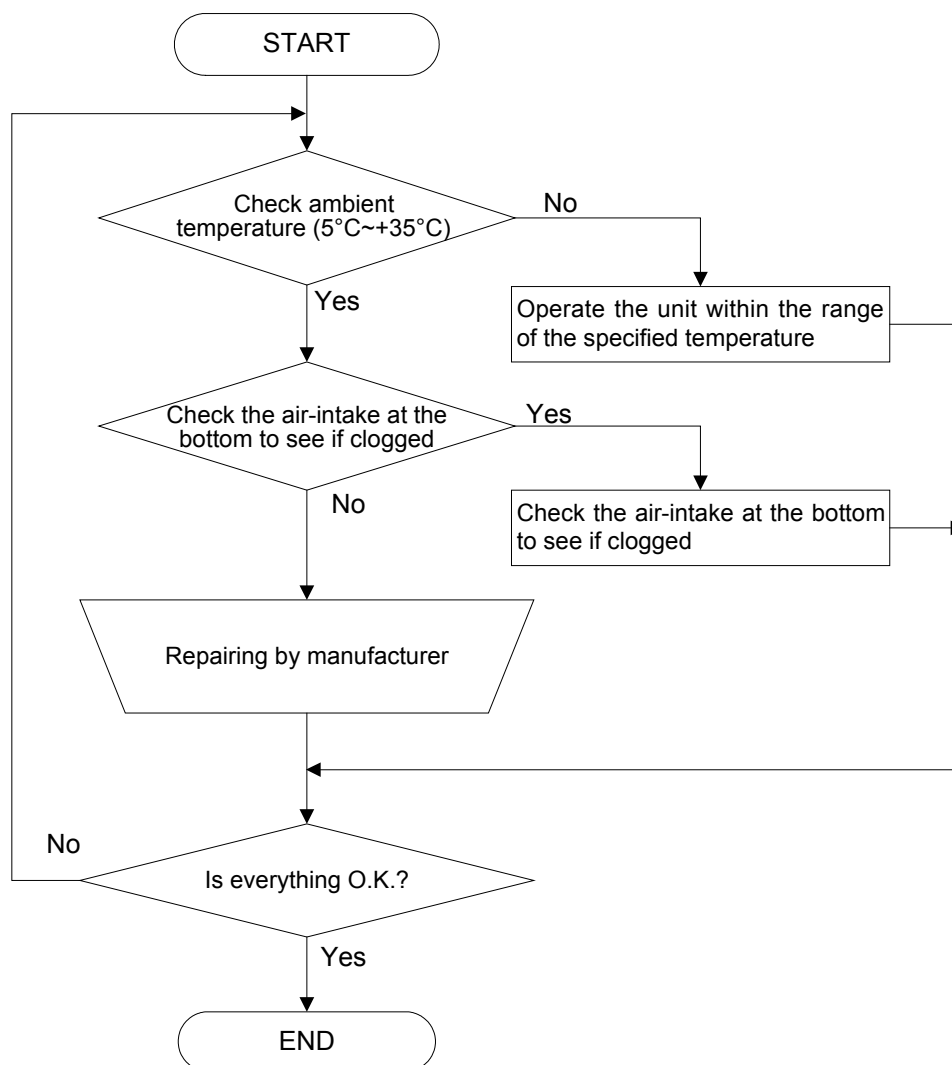


(Note 1) Specifications on power source

AC Mains Voltage	Wattage	Fuse	Frequency
100-240V	30 Watts	T3.15A/250V	50/60Hz

6-3-2. “Ready to Test” message does not appear and/or cell temperature is unstable.

Follow the following steps if “Ready to Test” message does not appear after more than 1 hour or the cell temperature appears unstable after having reached the preset measurement temperature.



6-3-3. The unit does not work even though power is on.

If the “Ready to Test” message does not appear after the D155 has been powered on for more than 30 minutes, check on the line voltage. If correct power voltage is supplied, Contact CANNON or your local dealer.

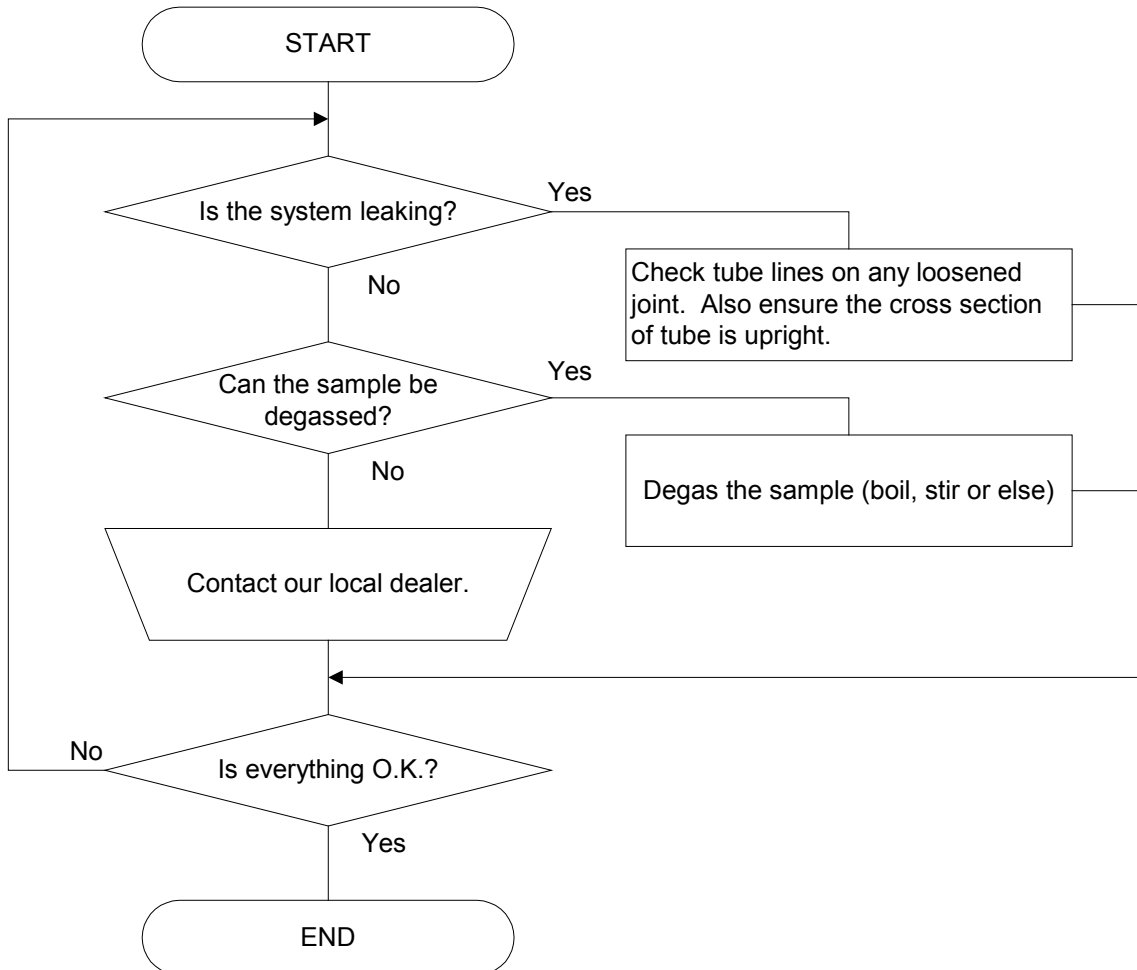
6-3-4. LCD does not function

If the LCD display is found to be defective (no message appears on screen) or the brightness of display cannot be adjusted, Contact CANNON or your local dealer.

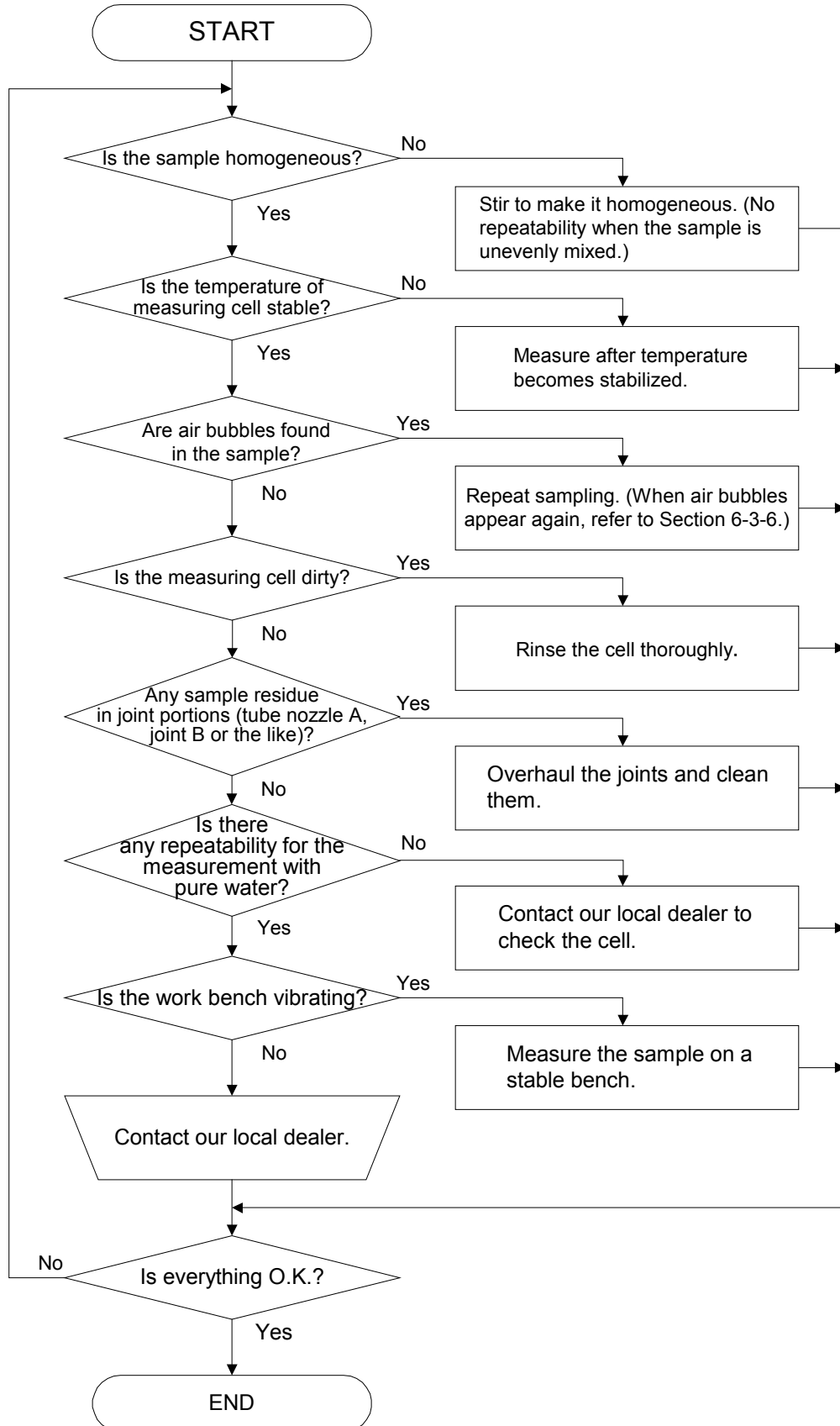
6-3-5. Key entry does not work

If beep sound is not heard each time any keys are pressed or key entry itself does not function, Contact CANNON or your local dealer.

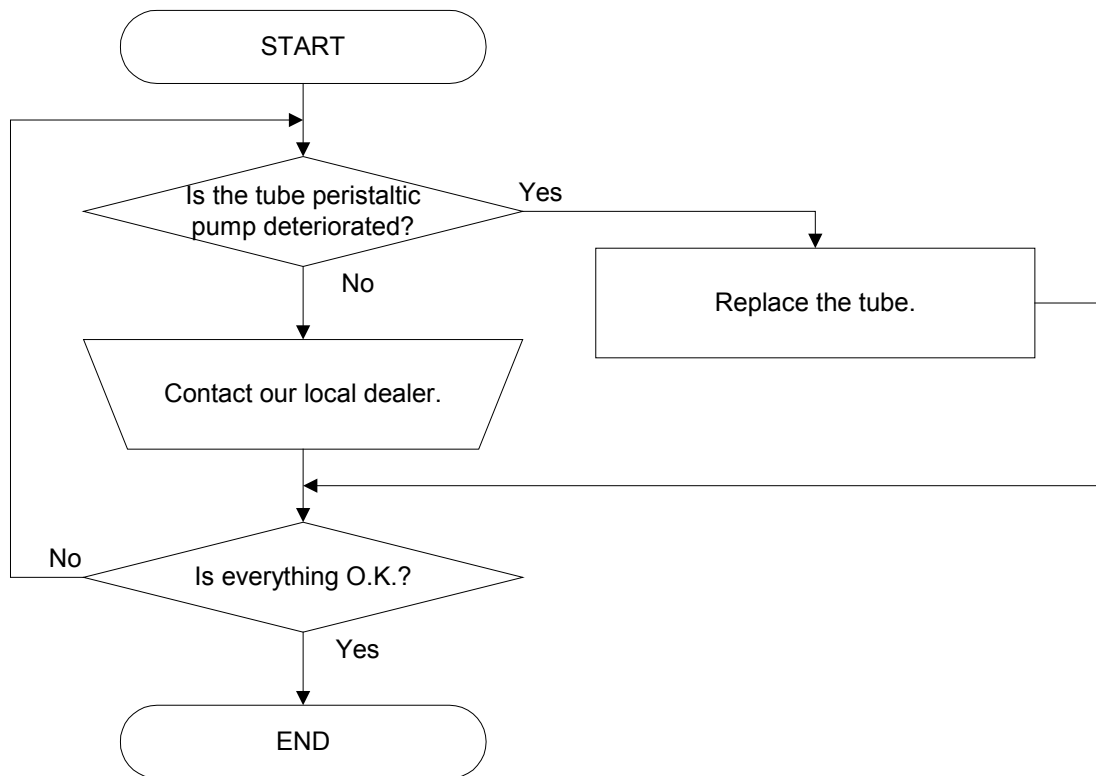
6-3-6. Air bubbles are easily trapped in the sample and visible in the measurement cell



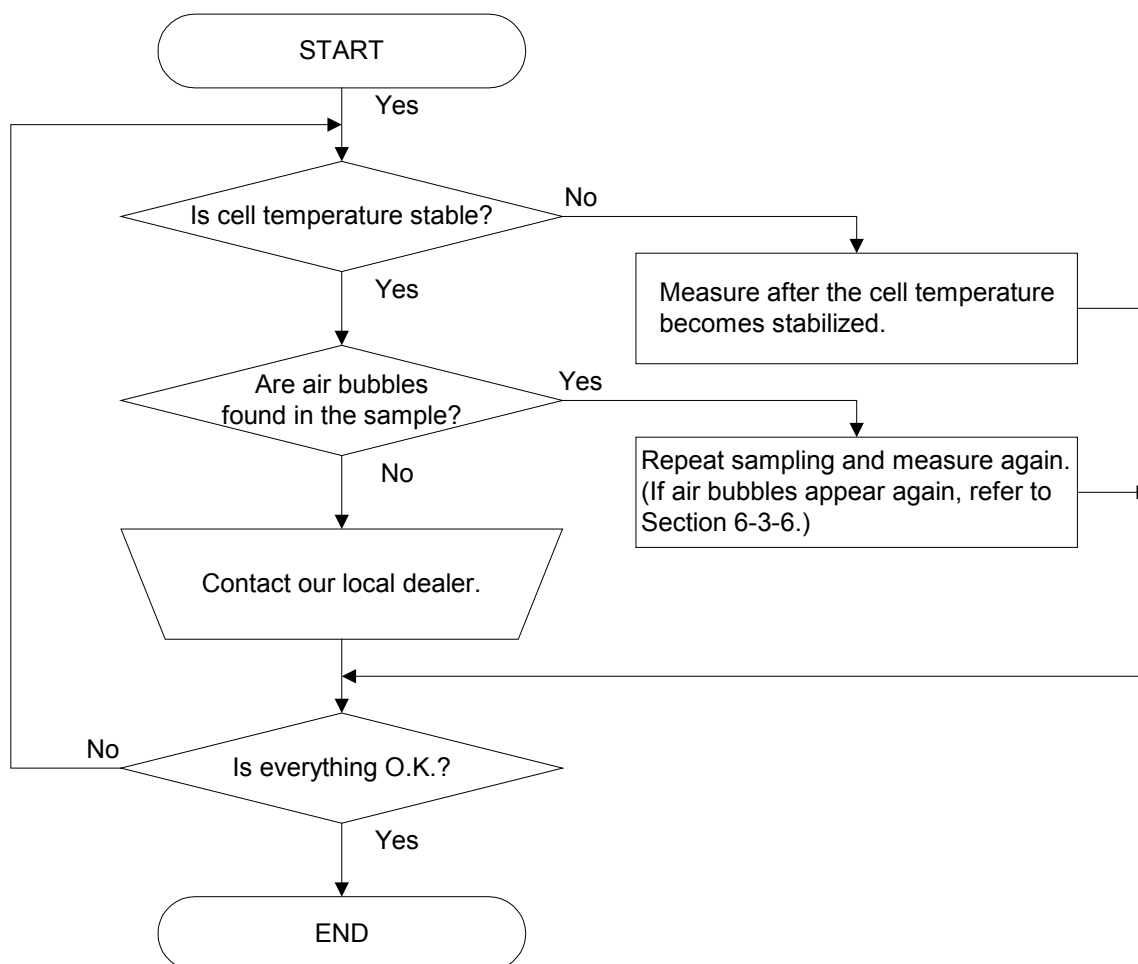
6-3-7. There is poor repeatability on measured values



6-3-8. Sampling time is too long (optional peristaltic pump)



6-3-9. Measuring time is too long



6-3-10. Data cannot be stored in the memory

The back-up battery needs to be replaced when the clock function does not work or preset parameters cannot be saved. Contact CANNON or your local dealer.

7. Others

7-1. Basic specifications

Type and Model	D155 Density Meter	
Discipline	Oscillating Glass U-tube	
Measuring Range	0 to 2g/cm ³	
Measuring Temperature Range	15 to 25°C	
Precision	Density	±0.001g/cm ³
	Temperature	±0.1°C
Repeatability	Density	SD 0.0005g/cm ³
Resolution	Density	0.0001g/cm ³ step
	Temperature	0.05°C step (Setting Resolution: 0.1°C step)
	Specific Gravity	0.0001 step
	Temperature Compensated Parameter	0.0001 step
	API Degree	0.1 step
Measurement Time	2 to 4 min	
Viscosity Correction	None	
Display	1) Screen: 4×20 LCD backlight 2) Displayed Parameter: Temperature (°C)/ Density/ Specific Gravity Number of temperature compensation tables for petroleum products Temperature Compensated Parameter (60°F Specific Gravity/ 15°C Density/ 20°C Density)/ API Degree/ Other messages	
Sampling Method	Manual sampling by syringe (optional peristaltic pump for automatic sampling)	
Min. required Sample Amount	Syringe: Approx. 1mL, Pump: 8mL	
Maximum Sample Viscosity	Approximately 1000 mPa·s when using optional peristaltic pump	
Calibration	Pure Water (factory/service calibration of air)	
Storage of Measurement Result	Last 10 measurement results stored in internal memory	
Temperature Compensation Table for Petroleum Products	ASTM D1250 Table 23(A,B,D), 53(A,B,D), 59(A,B,D)	
Interface	RS-232C×1ch, USB×1ch	
Ambient Conditions for unit	1) Temperature: 5 to 35°C 2) Humidity: Below 85%RH (No condensation)	
Power Source	AC100~240V 50/60Hz	
Power Consumption	Approx. 30W	
Dimension	251mm (W) × 408mm (D) × 165mm (H) [10" x 16" x 6.5"]	
Weight	11.6kg (25.64 lbs)	
Standard Supplied Accessory	<ul style="list-style-type: none"> - Connection Tube: Qty 1 - Syringe 2ml: Qty 5 - AC Power Cord: Qty 1 - Wrench: Qty 1 - Tube 0.5×1.5 L=400 PTFE: Qty 1 	
Optional Accessories	<ul style="list-style-type: none"> - Dot matrix printer - Peristaltic pump - Soft-Cap Data Capture Software 	

7-2. Principle of measurement

7-2-1. Oscillating U-tube Cell

When a measurement cell filled with liquid or gas is oscillated spontaneously, resultant oscillating cycle varies with the density of the sample in the measurement cell. The oscillating cycle T is expressed follows.

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

where,

d = Density of sample in measurement cell

V_c = Volume of sample in measurement cell, or measurement cell internal volume

Mc = Mass of measurement cell

K = Constant

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

Supposing that the oscillating cycles T_a and T_w are obtained through measurement of reference materials of known density (density d_a and d_w), the facto value F is calculated as follows.

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

Accordingly, the density “d” of unknown sample can be calculated according to the following formula by measuring its oscillating cycle T.

$$d = d_a - F(T_a^2 - T^2)$$

7-2-2. Density Tables

Dried air density

Density of dried air at t°C and 1013.25hPa is calculated according to the following formula.

$$d(g/cm^3) = \frac{0.0012932}{1 + 0.00367 \times t(^{\circ}C)} \times \frac{P(hPa)}{1013.25}$$

Density of air at 1013.25hPa of air pressure;

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		

Chemical Handbook Fundamental Version, Rev. 3, Table 5 • 1

Water density

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	0.98805
1	0.99990	26	0.99679	55	0.98570
2	0.99994	27	0.99652	60	0.98321
3	0.99996	28	0.99624	65	0.98057
4	0.99997	29	0.99595	70	0.97779
5	0.99996	30	0.99565	75	0.97486
6	0.99994	31	0.99534	80	0.97183
7	0.99990	32	0.99503	85	0.96862
8	0.99985	33	0.99471	90	0.96532
9	0.99978	34	0.99438		
10	0.99970	35	0.99404		
11	0.99961	36	0.99369		
12	0.99950	37	0.99333		
13	0.99938	38	0.99297		
14	0.99925	39	0.99260		
15	0.99910	40	0.99222		
16	0.99894	41	0.99183		
17	0.99878	42	0.99144		
18	0.99860	43	0.99104		
19	0.99841	44	0.99033		
20	0.99821	45	0.99022		
21	0.99799	46	0.98980		
22	0.99777	47	0.98937		
23	0.99754	48	0.98894		
24	0.99730	49	0.98849		

Chemical Handbook Fundamental Version, Rev. 3, Table 5 • 2

7-3. Warranty/Return Information

1. Products limited warranty

In addition to other manufacturers' warranties, **CANNON**[®] Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole election, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

2. Reagent and chemical warranty

CANNON[®] Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole option, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.



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